IN THE MATTER OF the Resource Management Act 1991

AND

IN THE MATTER OF applications for resource consents and notices of requirement in relation to the Ōtaki to North of Levin Project

BY **WAKA KOTAHI NZ TRANSPORT AGENCY**

Applicant

ŌTAKI TO NORTH OF LEVIN HIGHWAY PROJECT

TECHNICAL ASSESSMENT J:

TERRESTRIAL ECOLOGY

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EXECUTIVE SUMMARY

1. The Ōtaki to north of Levin highway Project ("**Ō2NL Project**" or "**Project**") involves the construction, operation, use, maintenance and improvement of approximately 24 kilometres of new four-lane median divided state highway (two lanes in each direction) and a shared use path ("**SUP**") between Taylors Road, Ōtaki (and the Peka Peka to Ōtaki expressway ("**PP2Ō**") and State Highway 1 ("**SH1**") north of Levin.

2. The proposed route passes through rural land in the Horowhenua lowlands, between the foothills of the Tararua Range and the sea. Most of the route lies in the southern Manawatū Plains Ecological District, with a small area within the Tararua Ecological District.

3. Prior to human settlement, almost all of the Project area (as defined later in this assessment) would have been densely forested, broken only by rivers and larger streams, and wetlands. The gentle terrain and fertile soils encouraged the conversion of the land to intensive agriculture, and now only small remnants of forest and scrub remain. Many wetland areas have been drained, and most of those that remain are highly degraded by grazing. All areas of indigenous terrestrial vegetation and wetlands within the Ō2NL Project Area lie within an 'Acutely Threatened Land Environment' (less than 10% cover of indigenous vegetation remaining).

4. The area subject to designations covers 618 hectares, within which the Ō2NL Project construction footprint (being actual area of works, such as road surface, earthworks, stormwater treatment devices, along with a 20-metre wide construction buffer on either side of the physical work) covers 364 hectares.

5. The Ō2NL Project construction footprint comprises 86% (312.8 hectares) pasture and cropping land, with a further 5.5% (19.8 hectares) occupied by houses and associated gardens, quarries, and road and rail corridors occupying 2% (7.5 hectares). Terrestrial vegetation dominated by indigenous species, including forest, treeland, scrub, and fernland covers 3.25 hectares (0.9%), with an additional 0.8 hectare (0.2%) of forest and scrub comprising a mix of indigenous and exotic plant species in the canopy. Terrestrial vegetation dominated by exotic species comprise 6.6 hectares (1.8%).

6. Wetland habitats (including open water) within the Ō2NL Project construction footprint cover 3.81 hectares (1%), comprising 0.61 (0.1%) hectare of indigenous wetland vegetation, 0.8 hectare (0.2%) of mixed indigenous-exotic wetland vegetation, 2.06 (0.4%) hectare of exotic wetland vegetation, and 0.34 (0.1 %) hectare of open water habitat. The wetland habitats within the Ō2NL Project construction footprint are primarily swamps on valley floors, but there are also smaller areas of oxbow wetlands associated with meandering streams, and hillslope seepage wetlands. Most of the wetlands are grazed, exotic-dominated wetlands of relatively low ecological value.

7. The preferred alignment avoids High and Very High value forest habitats, which has resulted in the selection of a route that inevitably passes through adjacent terrestrial habitats of Low to Moderate ecological value such as mixed indigenous-exotic forest and scrub, and planted indigenous forest.

8. The indigenous terrestrial and wetland vegetation within the Project construction footprint have been assessed as ranging from Negligible to Very High ecological value. This assessment considered the high level of historical loss of habitats in the Horowhenua lowlands, the availability of habitat for common indigenous flora and fauna species, and the presence of Threatened, At Risk, and locally uncommon species. The vegetation and habitats along the route provide habitat for up to 73 bird species (28 indigenous species confirmed by field surveys to date), at least two lizard species, and a wide range of terrestrial invertebrates. No bats were detected by acoustic surveys and bats are likely to be absent from the Ō2NL Project Area.

9. Threatened or At Risk species confirmed to be present in the Ō2NL Project construction footprint include two Threatened bird species (koekoeā/long-tailed cuckoo, karakahia/grey duck), five At Risk bird species (spotless crake (*Porzana tabuensis tabuensis*), New Zealand dabchick (*Poliocephalus rufopectus*), black shag (*Phalacrocorax carbo novaehollandiae*), koitareke/marsh crake, and pihoihoi/New Zealand pipit), and one At Risk lizard (ornate skink). *Powelliphanta traversi*, a giant land snail (Threatened - Nationally Critical) was not confirmed as present, but could persist in low numbers in forest remnants adjacent to the Ō2NL Project construction footprint, and is confirmed as being present in Waiopehu Scenic Reserve to the east of the Ō2NL Project construction footprint. *Wainuia urnula* (ngata; Not Threatened), a large endemic land snail is present in riparian habitats on the banks of the Waikawa Stream and is regarded as locally uncommon.

Habitats dominated by a mix of indigenous and exotic flora species, or exotic flora species, are also likely to provide important habitat for indigenous fauna, including At Risk lizard species. The key potential adverse terrestrial and wetland ecological effects of the Ō2NL Project include:

(a) loss of forest, treeland, scrub and wetland habitats within the Ō2NL Project construction footprint;

(b) injury or mortality of indigenous fauna during construction;

(c) alteration of the adjacent retained habitats; and

(d) potential ongoing effects of the road on fauna populations (for example, by fragmentation of habitats or road kill).

10. These potential effects are addressed by further avoidance measures, where habitats are located within the construction footprint and in particular the construction buffer zone. Where avoidance is not possible, effects are minimised by actions such as:

(a) clear physical marking of habitats that are to be retained;

(b) seasonal controls on the timing of vegetation clearance works and draining ponds;

(c) salvage and relocation of lizards and lands snails within areas of vegetation clearance;

(d) remedial restoration of habitats within the construction buffer;

(e) reducing edge effects and effects of dust deposition through buffer plantings; and

(f) alterations to the Ō2NL Project detailed design to reduce mortality of indigenous fauna, for example, plantings to increase flight heights over roads and directional/ shrouded low UV lighting.

11. The Ō2NL Project design also provide opportunities to retain or restore connectivity of habitats under the highway at the larger river crossings.

12. These measures to avoid or minimise potential adverse effects will be detailed in an Ecological Management Plan and will reduce the residual adverse effects of the Ō2NL Project.

13. Three indigenous-dominated wetland types will have effects mitigated by undertaking ‘direct transfer’ at the point of impact. This involves the translocation of wetland vegetation via excavation from the impact site and replanting it at the mitigation site. The vegetation types are rautahi sedgeland (0.07 hectare), bracken-whekī fernland (0.03 hectare), and kiokio-spike sedge- kāpūngāwhā sedgeland (0.04 hectare).

14. Residual adverse effects that are Low, Moderate, High, or Very High on all terrestrial indigenous and mixed indigenous-exotic vegetation of natural origin, and through the loss of all significant habitats, are addressed by habitat restoration and enhancement at sites within the affected catchments. The quantum of these restoration and enhancement measures have been determined by using a Biodiversity Offset Accounting Model ("**BOAM**"), which incorporates quantifiable data from the impact sites and the proposed habitat restoration and/or enhancement site. If offsetting could not be verified for any habitat or species, or is not appropriate, biodiversity compensation has been applied.

15. All restoration and/or enhancement measures seek measurable conservation outcomes, and adhere to the key principles of offsetting, including permanence of outcomes, ecological equivalence, additionality, and a Net Gain of indigenous biodiversity. Opportunities being considered include:

(a) restoration of former hydrology to reverse historical wetland loss;

(b) restoration of degraded wetland habitats by fencing and/or planting;

(c) plantings to extend and link isolated forest remnants; and

(d) constructing a predator-proof fence around one nominated forest remnant to protect and enhance populations of indigenous skinks and land snails.

16. The BOAM demonstrates that:

(a) 4.1 hectares of restoration planting is required to offset the loss of māhoe-dominant forest and scrub (2.85 hectares);

(b) 1.7 hectares of restoration planting is required to offset the loss of mixed indigenous-exotic forest and scrub (0.80 hectare);

(c) 0.67 hectare of restoration planting is required to offset the loss of planted indigenous forest (0.40 hectare);

(d) 0.68 hectare of restoration planting is required to offset the loss of indigenous vegetation within exotic forest and treeland (0.68 hectare, indigenous component only);

(e) 0.42 hectare of restoration planting is required to offset the loss of exotic riparian forest, scrub and vineland (0.40 hectare);

(f) 0.25 hectare of restoration planting (including direct transfer of vegetation from the impact site) is required to compensate for the loss of 0.12 hectare of raupō reedland;

(g) 4.65 hectares of wetland restoration is required to compensate for the loss of 3.31 hectares of combined wetland habitat; and

(h) 0.48 hectare of open water creation is required to compensate for the loss of 0.34 hectare of ponds.

17. The loss of indigenous treeland (0.23 hectare) will be offset by planting 486 trees (comprising ten species) at three offset locations. A BOAM was not used in this instance; instead, tree replacement ratios were based on trunk diameter and species.

18. While the BOAMs for wetland and open water habitats seek to trade extent for condition (ie, compensation), the rehabilitation of the three proposed material supply sites will include the establishment of three large areas of open water and several hectares of wetland vegetation. The successful establishment of wetland habitat at these sites will mean that the Project complies with Policy 6 of the National Policy Statement on Freshwater Management ("**NPS-FM**"), which seeks to avoid loss of extent of natural wetlands.

19. The BOAMs for terrestrial vegetation types indicate that restoration works would achieve an overall Net Gain of biodiversity within 20-25 years, based on key attributes such as species diversity, basal area, and ground cover of understorey and ground tier. The BOAMs for wetlands and open water indicate that restoration works would, conservatively, achieve a Net Gain of biodiversity within 8-15 years.

20. The restoration and enhancement measures will require monitoring to track progress of outcomes against the Ō2NL Project conditions and Ecology Management Plan ("**EMP**"), and to document the ecological gains that have been achieved. The ecological response package (the actions proposed to

be undertaken in response to the effects) for the Ō2NL Project is currently being developed in consultation with iwi Project partners and stakeholders, including the Department of Conservation, the district (Kāpiti Coast District Council ("**KCDC**") and Horowhenua District Council ("**HDC**")) and regional councils (Manawatū-Whanganui Regional Council ("**Horizons**") and Greater Wellington Regional Council ("**GWRC**")) and Forest and Bird. This ecological response package identifies where restoration planting is proposed to occur and how it can be integrated with other aspects of the Project, such as earthworks, stormwater treatment, natural character and landscape planting. The design of the response package has been developed in collaboration with our Iwi Partners and input of Forest and Bird and the Department of Conservation.

INTRODUCTION

21. My full name is Nicholas Paul Goldwater. I have prepared this technical assessment with the support and collaboration of Tim Martin (Principal Ecologist, formerly Wildland Consultants, Auckland), Keely Paler (Senior Ecologist, formerly Wildland Consultants, Wellington), Ella Buckley (Senior Ecologist, formerly Wildland Consultants, Wellington), and Sarah Budd (Principal Ecologist, Wildland Consultants, Auckland). This technical assessment addresses the terrestrial ecology aspects of the Ō2NL Project.

Qualifications and experience

22. I have the following qualifications and experience relevant to this assessment:

23. I am a Principal Ecologist with Wildland Consultants Ltd, based in Auckland. I have been employed as a consultant ecologist with Wildland Consultants since 2008.

24. In 2008 I graduated with a Masters with First Class Honours in Environmental Science from the University of Auckland. I also have a Graduate Diploma in Science and Post-Graduate Diploma in Environmental Science from the University of Auckland.

25. My work as an ecological consultant has covered a wide range of habitat types, including forests, shrublands, wetlands, streams, grasslands, dunelands, and estuarine ecosystems. I have provided assessments of ecological effects for a range of development activities in natural areas,

provided technical advice on community-led restoration projects, and undertaken surveys for threatened species.

26. I have undertaken surveys for a wide range of indigenous fauna throughout the North Island and parts of the South Island, including herpetofauna, bats, birds, and land snails.

27. I provided freshwater ecological advice to New Plymouth District Council on the application for a resource consent application and designation to construct a new state highway through indigenous forest and wetland vegetation at Mt Messenger, and to the Department of Conservation for the resource applications and designations for the Te Ahu a Turanga (Manawatū Tararua Highway Project).

28. I undertook freshwater surveys with **Dr Alex James** (EOS Ecology, Palmerston North) on 28-29 April 2021. On 3-4 August 2021, I participated in site inspections with members of the Project team and representatives from local iwi, Department of Conservation, Horizons, HDC, and Forest and Bird. I undertook additional site visits on 2 December 2021, including to Waiopehu Scenic Reserve and Kimberley Reserve, accompanied by Dr Tim Martin. On 4 February 2022, I visited a wetland near Koputaroa, accompanied by representative from Kereru Marae and Nicki Papworth (Field Botanist, formerly Wildland Consultants, Wellington).

29. I have attended multiple workshops with Iwi Partners and stakeholders (being the Department of Conservation, Forest and Bird, and Council staff) for the Ō2NL Project.

Code of conduct

30. I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2014. This assessment has been prepared in compliance with that Code, as if it were evidence being given in Environment Court proceedings. In particular, unless I state otherwise, this assessment is within my area of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

Purpose and scope of assessment

31. The purpose of this assessment is to assess the potential effects of the Ō2NL Project on terrestrial and wetland ecology in order to inform the notices

of requirement for designations and applications for resource consents for the Ō2NL Project.

32. The scope of the assessment includes:

(a) review of existing information for the Ō2NL Project Area for vegetation, habitats, birds, bats, terrestrial invertebrates, and lizards;

(b) a desktop review of the Ō2NL Project Area to identify habitats for field surveys;

(c) field surveys to identify, map, and describe habitats;

(d) assessment of ecological values, including fauna values, in collaboration with the other technical specialists;

(e) assessment of effects on ecological values;

(f) assessment of measures to avoid, remedy, or mitigate potential adverse ecological effects;

(g) identification of residual ecological effects; and

(h) Assessment of measures to offset and compensate residual ecological effects.

33. For this assessment:

(a) the **Ō2NL Project construction footprint** refers to the extent of the proposed road surface, cut and fill earthworks, stormwater treatment devices, access roads, and a 20-metre construction buffer (discussed below);

(b) the **Ō2NL Project designations** is a larger area, being the total area of land to be designated for construction of the Project. The Ō2NL Project construction footprint is entirely within the Ō2NL Project designations, but does not occupy all of the space within the Ō2NL Project designations;

(c) the **Ō2NL Project Area** refers to all of the land within the Ō2NL Project designations and, for ecology, any immediately adjacent areas that are of particular terrestrial or wetland ecology value and could reasonably be subject to adverse effects by construction of the road (for example, a forest remnant within 100 metres of the road, but beyond the boundary of the designations). These areas have also been mapped, described, and assessed for effects.

Assumptions and exclusions in this assessment

34. This assessment addresses the potential for adverse effects on terrestrial and wetland habitat types and associated flora and fauna that are anticipated from the works described in the description of the Project included in Volume II, Part 3 of the documents that support the Notices of Requirement ("**NoRs**") and applications for resource consent.

35. The effects are based on the potential habitat removal and modification associated with the Ō2NL Project construction footprint, including laydown areas, spoil sites, and material supply sites.

36. A 20-metre construction buffer has been incorporated into the Ō2NL Project construction footprint based on discussions with the design team. The buffer would facilitate access for heavy machinery required for earthworks and equipment for performing various ancillary activities. As such, all habitats within the construction buffer are assumed in this assessment to be lost. That is a conservative approach, because not all of the full 20-metre-wide buffer along the length of the Project will be required for construction. That conservative assessment then flows through to the assessment of mitigation, offset and compensation measures.

37. The construction buffer comprises setbacks from the physical work needed to allow for all construction activities and access. The construction buffer is generally 20 metres wide (on both sides). The buffer width differs across locations and construction activities, as outlined below:

    (a) twenty-metre buffer at top of cuts and at the bottom of fills (including those associated with stormwater ponds/devices, stream diversions or the shared use path), except where it is reduced to less than 20 metres by encountering the designation boundary or the forest habitats at property #465; and

    (b) ten-metre buffer for the shared use path, where this deviates from the footprint of the highway and is located on existing roads.

38. The cultural values that underpin the Ō2NL Project are acknowledged, particularly those with relevance to the importance of water to tangata whenua. Cultural Impact Assessments ("**CIAs**") have been prepared in

respect of the Ō2NL Project and these address ecology impacts from a cultural perspective (and are included in Volume V).

39. Representatives from hapū of Ngāti Raukawa ki te Tonga, and Muaūpoko Tribal Authority, along with the HDC, KCDC, GWRC, Horizons, Department of Conservation and Forest and Bird have been involved in all four Ecology workshops that have been conducted since July 2021. These workshops have provided a useful forum for iwi to share their views and actively participate in the effects assessment process, particularly with regards to providing input into the overall approach to addressing adverse effects. Notably, one of the key restoration sites selected to address the residual effects of wetland loss is Te Ripo O Hinemata wetland, managed by Manawatu Kukutauaki No. 3 Sec 2E5 Trust. The intention is to partner with our Iwi Partners to create a legacy project that sees the hydrology and vegetation of the wetland fully restored (see section below on Biodiversity Offsetting).

Ō2NL Project Description

40. The Ō2NL Project involves the construction, operation, use, maintenance and improvement of approximately 24 kilometres of new four-lane median divided state highway (two lanes in each direction) and a SUP between Taylors Road, Ōtaki (and **PP2Ō**) and State Highway 1 ("**SH1**") north of Levin. The Ō2NL Project includes the following key features:

    (a) a grade separated diamond interchange at Tararua Road, providing access into Levin;

    (b) two dual lane roundabouts located where Ō2NL crosses SH57 and where it connects with the current SH1 at Heatherlea East Road, north of Levin;

    (c) four lane bridges over the Waiauti, Waikawa and Kuku Streams, the Ohau River and the North Island Main Trunk ("NIMT") rail line north of Levin;

    (d) a half interchange with southbound ramps near Taylors Road and the new Peka Peka to Ōtaki expressway to provide access from the current SH1 for traffic heading south from Manakau or heading north from Wellington, as well as providing an alternate access to Ōtaki.

(e) local road underpasses at South Manakau Road and Sorenson Road to retain local connections;

(f) local road overpasses to provide continued local road connectivity at Honi Taipua Road, North Manakau Road, Kuku East Road, Muhunoa East Road, Tararua Road (as part of the interchange), and Queen Street East;

(g) new local roads at Kuku East Road and Manakau Heights Road to provide access to properties located to the east of the Ō2NL Project;

(h) local road reconnections connecting:

  (i) McLeavey Road to Arapaepae South Road on the west side of the Ō2NL Project;

  (ii) Arapaepae South Road, Kimberley Road and Tararua Road on the east side of the Ō2NL Project;

  (iii) Waihou Road to McDonald Road to Arapaepae Road/SH57;

  (iv) Koputaroa Road to Heatherlea East Road and providing access to the new northern roundabout;

(i) the relocation of, and improvement of, the Tararua Road and current SH1 intersection, including the introduction of traffic signals and a crossing of the NIMT;

(j) road lighting at conflict points, that is, where traffic can enter or exit the highway;

(k) median and edge barriers that are typically wire rope safety barriers with alternative barrier types used in some locations, such as bridges that require rigid barriers or for the reduction of road traffic noise;

(l) stormwater treatment wetlands and ponds, stormwater swales, drains and sediment traps;

(m) culverts to reconnect streams crossed by the Ō2NL Project and stream diversions to recreate and reconnect streams;

(n) a separated (typically) three-metre-wide SUP, for walking and cycling along the entire length of the new highway (but deviating away from being alongside the Ō2NL Project around Pukehou (near Ōtaki)) that will link into shared path facilities that are part of the PP2Ō expressway (and further afield to the Mackays to Peka Peka expressway SUP);

(o) spoil sites at various locations along the length of the Project; and

(p) five sites for the supply of bulk fill /earth material located near Waikawa Stream, the Ohau River and south of Heatherlea East Road.

41. The components of the Ō2NL Project particularly relevant to terrestrial ecology are the earthworks, vegetation clearance, and landform modifications required to construct the highway.

42. There are construction and operational activities that could have adverse effects on habitats retained, and the flora and fauna associated with these habitats.

Greater Wellington Region and Kāpiti Coast District

43. The southern end of the proposed highway to 426 State Highway 1, lies in the Greater Wellington Region (administered by the GWRC and KCDC).

Manawatū-Wanganui Region and Horowhenua District

44. To the north of 426 State Highway 1, the remainder of the Ō2NL Project Area lies in the Manawatū-Wanganui Region (administered by Horizons and HDC).

ECOLOGICAL CONTEXT (TERRESTRIAL ECOLOGY)

Overview

45. The Ō2NL Project falls almost entirely in the southern Manawatū Plains Ecological District, in the Manawatū Ecological Region. A small section of the proposed route, near Manakau, lies within the western edge of the Tararua Ecological District.

46. The southern parts of the Manawatū Plains Ecological District lie between the coastal sands of the Foxton Ecological District to the west, and the ranges of the Manawatū Gorge South and Tararua Ecological Districts to the east.

Manawatū Plains Ecological District

47. The Manawatū Plains Ecological District covers approximately 313,300 hectares and is characterised by low altitude, predominantly undissected, loess covered plains and terraces of marine and alluvium origin.

The climate within this ecological district is characterised by warm summers and mild winters, with prevailing west to north-west winds and a reliable and evenly distributed rainfall of between 800-1200 millimetres per annum (McEwen 1987).

48. Prior to human settlement, most of the Manawatū Plains Ecological District would have been covered in tall forest, only broken by rivers, larger streams, and some wetland areas. The vegetation formerly included semi-swamp forests on low-lying land near rivers dominated by kahikatea (*Dacrycarpus dacrydioides*), pukatea (*Laurelia novae-zelandiae*), and more locally, maire tawake (swamp maire, *Syzygium maire*; Threatened – Nationally Critical). Tōtara (*Podocarpus totara* var. *totara*) forest and mataī (*Prumnopitys taxifolius*) would have been abundant on free-draining alluvial soils close to rivers, with lowland ribbonwood (*Plagianthus regius* subsp. *regius*), tītoki (*Alectryon excelsus* subsp. *excelsus*) and tawa (*Beilschmiedia tawa*) being locally common (Ravine 1995). On marine terraces and older river terraces, mixed podocarp-broadleaved forest was the most extensive forest type, characterised by northern rātā (*Metrosideros robusta*; Threatened – Nationally Vulnerable), tawa, rimu (*Dacrydium cupressinum*), mataī, tōtara, kahikatea, and in places, pukatea. Kāmahi (*Weinmannia racemosa*) may also have been present in these terrace forests, but is now uncommon, and generally restricted to the inland boundary of the ecological district.

49. On terrace risers (the steeper slopes that bound the flat top of a terrace, also referred to as scarps), the forests were similar to those on the terrace treads (the flat or gently sloping parts of terraces). However, springs are more frequent on terrace risers, and at these locations, moisture-loving forest species such as pukatea and nīkau (*Rhopalostylis sapida*) were locally abundant (Ravine 1995).

50. Where forests graded into permanently inundated wetlands, the margins of the wetlands likely supported small tree and shrub species such as mingimingi (*Coprosma propinqua* var. *propinqua*), swamp coprosma (*Coprosma tenuicaulis*), and narrow-leaved lacebark (*Hoheria sexstylosa*) before grading into tī kōuka (*Cordyline australis*), toetoe (*Austroderia* spp.), pūrei (*Carex secta*), and harakeke (*Phormium tenax*). The margins of open water bodies would have supported indigenous sedgeland and rushland, including kuta (*Eleocharis sphacelata*), *Machaerina articulata*, and *Schoenoplectus* sp. (Ravine 1995).

51. The Manawatū Plains Ecological District has been almost entirely cleared for farms, with more recent conversion of many areas to orchards and market gardens (McEwen 1987).

52. Approximately 98% of original vegetation cover has been lost, and now only isolated areas of indigenous wetland and forest remain, including locally characteristic tōtara forest, some black beech (*Fuscospora solandri*) forest and mixed podocarp-broadleaved forest, and in the south, forest remnants dominated by kohekohe (*Dysoxylum spectabile*) and/or tawa. Most of the remaining areas of indigenous vegetation are very small, being less than a few hectares in extent, and have regenerated following earlier vegetation clearance. Very few of these areas are on flat land (Ravine 1995).

53. Forest on terrace tread landforms is the most depleted forest type in the ecological district (Ravine 1995).

Tararua Ecological District

54. The Tararua Ecological District covers approximately 249,141 hectares and lies between the Foxton and Manawatū Plains Ecological Districts to the west, and the Wairarapa Plains, Puketoi, and Woodville Ecological Districts to the east.

55. The Tararua Ecological District is characterised by the steep, high, dissected hills and the mountains of the Tararua and Remutaka Ranges. These ranges are heavily faulted and bisected by major rivers, with steep hillslopes dropping to small river flats. Many rivers in this ecological district are gorged near the foothills.

56. In the western foothills of the Tararua Ecological District, westerly winds predominate, and rainfall is significantly higher than on the adjacent plains, at approximately 1600 millimetres per annum.

57. Vegetation within Tararua Ecological District shows altitudinal zonation, from extensive lower altitude forests to tūpare (leatherwood, *Olearia colensoi*) scrub to tussockland (mid-ribbed snow tussock, *Chionochloa pallens* subsp. *cadens*), to alpine herbfield. Red beech (*Fuscospora fusca*)/kāmahi forest and northern rātā/kāmahi forest is present in the western Tararua foothills. Rimu, mountain tōtara (*Podocarpus laetus*) and miro (*Pectinopitys ferruginea*) are found throughout, and hard beech (*Fuscospora truncata*) also occurs in places.

58. The portion of the Tararua Ecological District within the Ō2NL Project area, to the east of Manakau, is lowland terraces and foothills and is similar to the Manawatū Plains Ecological District in character. The cluster of small forest remnants near the southern end of the proposed alignment (including Pukehou, Staples Bush) lie on the southeast border of the Manawatū Plains Ecological District, and are similar to the Tararua Ecological District in character.

Threatened Land Environments

59. The Threatened Environment Classification ("**TEC**") is a combination of three national databases: Land Environments New Zealand (LENZ), Land Cover Database (LCDB4), and the protected areas network. The TEC shows how much indigenous vegetation remains within a particular area and therefore how rare such vegetation is within a particular ecological district or region. The TEC is most appropriately applied to identify places to prioritise for formal protection against clearance and/or incompatible land uses, and for ecological restoration to restore lost species, linkages, and buffers (Cieraad *et al*. 2015). All of the wetlands and indigenous vegetation within the construction footprint lies within an area classified as Acutely Threatened (<10% indigenous cover left). This places greater importance on any indigenous habitats remaining, including areas that have been modified.

Significant Natural Areas

60. Within the Manawatū Plains Ecological District, the largest remaining areas of primary indigenous forest lie well to the north of the Ō2NL Project Area. That is, Tōtara Reserve (including Pohangina Valley Domain) lies approximately 65 kilometres to the northeast and is 286 hectares of floodplain and terrace forest, and Bushy Park, 90 kilometres to the northwest, is 110 hectares of forest on a marine terrace.

61. Closer to the Ō2NL Project Area, the largest areas of indigenous forest vegetation are small, but are the only remaining examples of the former vegetation of the Horowhenua Plains. These areas also provide critical habitat for Threatened invertebrate species such as the giant land snail *Powelliphanta traversi*.

62. Protected Natural Areas in close proximity to the Ō2NL Project Area include:

    (a) Kimberley Scenic Reserve (77 hectares, 1.4 kilometres to the east). Tawa and tawa-tōtara forest with *Powelliphanta traversi* present;

(b) Waiopehu Scenic Reserve (9.7 hectares, 1.4 kilometres to the southeast). Tawa forest with *Powelliphanta traversi* present; and

(c) Prouse's Bush (5 hectares, 1.6 kilometres to the northwest). Tītoki-tawa forest with *Powelliphanta traversi* present.

63. Some of the sites in close proximity to the Ō2NL Project Area have been previously surveyed as part of the Protected Natural Area Programme (PNAP) and were identified as recommended areas for protection (RAP) (Ravine 1995), including:

(a) RAP 12 Fordwich Bush is on the southern bank of the Waikawa Stream, *c*.250 metres to the east of the Ō2NL Project Area. The site is 0.5 hectare of kohekohe forest on a terrace tread.

(b) RAP 13 Ohau River Bush is on the south bank of the Ohau River, 1.1 kilometres to the east of the Ō2NL Project Area. The site comprises 0.5 hectare of swamp maire-pukatea forest and 0.5 hectare of tawa- māhoe (*Melicytus ramiflorus* subsp. *ramiflorus*) forest on a terrace riser. *Powelliphanta traversi* is present.

(c) RAP 15 Heatherlea Park lies 200 metres to the north of the northern end of the Ō2NL Project Area. The site comprises 14.5 hectares of wetland and forest habitats, but since 1995 some wetland areas have been drained, or excavated to form areas of open water. The threatened maire tawake was present in 1995.

64. Ravine (1995) also provides a list of natural areas seen during the PNAP survey but not recommended for protection.[1] The following sites that are within or close to the Ō2NL Project Area:

(a) 77 – Arapaepae Bush (Property #465, within the Ō2NL Project designation). Diverse forest dominated by tawa and māhoe over kawakawa (*Piper excelsum* subsp. *excelsum*) and hangehange (*Geniostoma ligustrifolium* var. *ligustrifolium*). *Powelliphanta traversi* is present.

(b) 67C – known as Brown's Bush (Property #287, c.130 metres to the west of the Ō2NL Project designation). A small remnant containing

[1] Note that plant species composition and ecological values are likely to have changed for some of these sites.

dense tawa over abundant kawakawa. High numbers of skinks, formerly recorded, and high invertebrate numbers.

(c) 62A – Triplow's Bush (Property #222/234/251, *c*.350 metres to the east of the Ō2NL Project designation). Māhoe, lowland ribbonwood, tītoki treeland. Floodplain of Ohau River.

(d) 49A – Knight's Bush (east of Property #75, *c*.300 metres to the southeast of the Ō2NL Project designation). Māhoe, supplejack (*Ripogonum* scandens), pōhuehue (*Muehlenbeckia australis*), kawakawa, kahikatea treeland on terrace tread.

(e) 47B – Pukehou - Staples Bush (Property #42 and #43, *c*.<7 metres outside the Ō2NL Project designation). Two areas of kohekohe-māhoe-kawakawa-tawa- pōhuehue forest, one on a terrace and one on colluvium.

(f) 50A wetland (northwest of Property #48, outside the Ō2NL Project designation). Raupō and *Carex* spp. wetland, now largely drained and converted to pasture. Was formerly much more extensive within the northern section of the site.

(g) 60B (Property #207, partly within the Ō2NL Project designation). One hectare of indigenous treeland on floodplain. Small and open, with limited species diversity.

65. The size and characteristics of natural areas for which protection is recommended has changed significantly since the time of the Manawatū Plains Ecological District PNAP survey in 1995. Later surveys undertaken within other ecological districts (such as the Wairarapa Plains Ecological District, Beadel *et al.* 2000) commonly include much smaller natural areas in the list of sites recommended for protection. If the Manawatū Plains survey was undertaken more recently, it is likely that most if not all of the sites listed above would have been listed as natural areas for which protection is recommended. Any sites with *Powelliphanta traversi* (Threatened - Nationally Endangered) would have also been identified as areas for protection (such as, Site 77, Arapaepae Bush).

66. All of the sites above provide useful context for understanding the former vegetation and habitat types within the wider area, and the ecological values of the natural areas that remain.

METHODOLOGY

Introduction

67. A best practice approach to the assessment of ecological effects has been adopted on the basis that:

    (a) The assessment follows the Environment Institute of Australia and New Zealand (EIANZ) Ecological Impact Assessment Guidelines (EcIAG) (Roper-Lindsay *et al*. 2018) ("**EcIAG**"). The EcIAG provides a systematic approach to assessing ecological effects.

    (b) A preliminary concept design and corridor for the Ō2NL Project was assessed using Google Earth imagery to identify all properties that may contain indigenous woody vegetation and/or wetland habitats. By doing so, 77 properties were identified for field survey. The remaining properties only comprised pasture, cropland, or house and garden habitats that did not warrant further survey. Where the desktop analysis was unable to determine if indigenous woody vegetation and/or wetland habitats were present, a conservative approach was taken and the property was identified for field surveys.

    (c) Since this original assessment, the concept design has been refined and the width of the corridor reduced to the proposed designations as shown in Volume III - Drawings. Gaps between the initial corridor and the proposed designation were checked and where necessary additional surveys undertaken. Therefore, the surveys cover a wider area than just the proposed designations and results have been tailored accordingly.

    (d) Of the 77 properties identified for field surveys, landowner permission was granted to access 69 properties. The following properties were therefore assessed only using aerial imagery: 33, 132, 139, 200, 577, 592, and 600.

    (e) Identification, mapping, and description of vegetation types follows Atkinson (1985), with amendments to allow its application to more rapid, qualitative techniques. Atkinson provides a framework for consistently identifying habitat types according to structure, composition, and substrates. The use of Atkinson facilitates an understanding of the intactness, age (for vegetation types), and associated ecological values for a habitat.

(f) The methods provided by Atkinson (1985) have also been extended to allow for the mapping and identification of 'human landscape' components such as gardens and roads. This approach allowed for the full extent of the Ō2NL Project Area to be identified, mapped, and described.

68. Areas of potential wetland within the Project area were assessed against the NPS-FM definition for natural wetland using the following indicator status ratings outlined in Clarkson (2013):

(a) Obligate (OBL): occurs almost always in wetlands (estimated probability >99% in wetlands).

(b) Facultative Wetland (FACW): occurs usually in wetlands (67–99%).

(c) Facultative (FAC): equally likely to occur in wetlands or non-wetlands (34–66%).

(d) Facultative Upland (FACU): occurs occasionally in wetlands (1-33%).

69. Wetted areas where pasture grass species formed greater than 50% cover were not mapped as natural wetlands, as per the definition in the NPS-FM.

70. Vegetation plots were not considered necessary, given that the presence of wetland plant species and topographic features (such as gully floors) made it relatively straightforward to discern the wetland boundaries.

Coding of habitat types

71. Vegetation types were coded according to:

(a) The dominance of indigenous species (I), exotic species (E) or a mixture of both (M).

(b) The location within terrestrial (T) or wetland habitats (W).

(c) By the Atkinson vegetation structural class (and coding): Facultative Upland (FACU): occurs occasionally in wetlands (1-33%).

(i) Grassland (G);

(ii) Vineland (V);

(iii) Sedgeland (Se);

(iv) Herbfield (H);

(v) Rushland (Rs);

(vi) Reedland (Re).

(d) To differentiate wetlands on valley floors from wetlands on hillslope seepages, seepages are coded ‘SPG’.

72. A combination of the above three categories provides a code that was used to group similar vegetation types (for example, all indigenous terrestrial forests will have the code ‘ITF’). All vegetation types were then numbered to provide a unique code for each vegetation type, which followed the format in Atkinson (1985).

73. Six habitat types did not fit within the above coding scheme and were labelled as follows:

(a) Open water (OW);

(b) Gravel field (TG1);

(c) House, gardens and farm buildings (EHG);

(d) Cropping / Pasture (ETP);

(e) River / Road / Rail (RRR);

(f) Quarry (QRY).

74. All habitat types that were mapped using only aerial imagery are further coded with a ‘d’ to denote desktop methods, and the lower confidence for the associated mapping.

Application of the EcIAG

75. The terrestrial ecological values, and the 'Level of Effects' of the Ō2NL Project on these values, are assessed using the guidelines provided by the EcIAG (as outlined in Roper-Lindsay *et al*. 2018).

76. The EcIAG were prepared to provide direction on the general approach to be adopted when assessing ecological impacts. In brief, the EcIAG approach involves four steps, summarised as follows:

(a) Assigning the level of 'Ecological Value' of the areas of vegetation, habitats, and species present in the Ō2NL Project designation and immediate surrounds. The 'Ecological Value' is scored on a scale of

‘Negligible' to ‘Very High’. The criteria used to assess ecological values under the EcIAG are listed below:

(i) Representativeness of the habitat, including species assemblages;

(ii) Rarity / distinctiveness: whether the area represents a threatened ecosystem (naturally or induced), and the rarity of the species the area supports;

(iii) Diversity and Pattern: biotic and abiotic diversity; and

(iv) Ecological Context: how the area contributes to ecosystem functioning through its relationship with the surrounding landscape.

(b) The 'Magnitude of Effect' of a proposed activity on the environment is assigned after all efforts to avoid, remedy or minimise potential adverse effects have been implemented. The Magnitude of Effect is a measure of the extent or scale of the effect of an activity and the predicted degree of change that it will cause. The Magnitude of Effect is scored on a scale of 'Negligible' to ‘Very High’ and is assessed in terms of:

(i) level of confidence in understanding the expected effect;

(ii) spatial scale of the effect;

(iii) duration and timescale of the effect;

(iv) the relative permanence of the effect; and

(v) timing of the effect in respect of key ecological factors.

(c) An overall level of residual effects that cannot be avoided or minimised for each habitat or species value is determined using a matrix approach that combines the 'Ecological Values' with the Magnitude of Effects resulting from the activity. The matrix describes an overall 'Level of Effect' on a scale from ‘Very Low’ to ‘Very High’.

(d) The level of residual effect that cannot be avoided or minimised is then used to guide the type and quantum of offsetting or compensation measures that are proposed to address residual adverse effects. The

EcIAG guidelines[2] equate 'not more than minor' effects to a 'very low level of effect', and suggest that 'low or very low' levels of effect are not normally of concern. The EcIAG also notes that effects that are of 'Very High', 'High' or 'Moderate' level of effect require further management (including offsetting or compensation where relevant).

77. Where the EcIAG does not specify the geographic scale at which ecological value should be assessed, I have favoured an assessment with strong regard for the context of the local area (that is, most of the route passes through the southern section of the Manawatū Ecological District, and the highly modified Horowhenua lowlands). By doing so, the assessment better recognises the high level of loss of lowland indigenous habitats in the Ō2NL Project Area, and consequently the relatively higher value of the lowland indigenous habitats that remain.

78. The EcIAG provides guidance on how the ecological values assigned for the four criteria listed above are combined to obtain an overall ecological value for the assessed site. It should be noted that the scoring system provided in EcIAG Section 5.2.2, Table 6, is a "broad guide" for how values "could be determined" and that ecologists must use their "expert judgement". I agree with this approach, and have adjusted overall ecological value scores as needed.

79. Considering the EcIAG (which also notes the overriding effect of Regional or District Plans), and Policy 13-5 of the Horizons One Plan, I consider a level of effect of 'Low' on significant habitats (as defined by EIANZ and following remedy and mitigate steps) post-avoidance and mitigation equates to a <u>more than minor</u> adverse effect. Consequently, these effects are addressed by offsetting and compensation. This conservative approach better addresses the consequences of the cumulative loss of areas of 'Low' ecological value across a wider landscape.

80. I note that for GWRC's Natural Resources Plan – Appeals Version ("**NRP**") (Policy P32), where adverse effects on biodiversity cannot be avoided, <u>more than minor</u> adverse effects should be minimised or remedied, and where residual adverse effects remain, the use of biodiversity offsets is provided where possible. Similarly, in the Horizons One Plan ("**One Plan**") (Policy 13-4), consents within significant habitats must generally not be granted unless any effects that are <u>more than minor</u> are avoided, remedied, mitigated, or

[2] EcIAG, at page 84.

offset to result in a net indigenous biodiversity gain. The approach in those regional policies is consistent with my approach to the level of residual effects that should be addressed by offsetting and compensation.

STATUTORY CONSIDERATIONS, INCLUDING NATIONAL STANDARDS, REGIONAL AND DISTRICT PLANS, AND OTHER RELEVANT POLICIES

Resource Management Act 1991 ("RMA")

81. "The *protection of areas of significant indigenous vegetation significant habitats of indigenous fauna*" is a matter of national importance to be recognised and provided for by RMA decision-makers under section 6(c) of the RMA.

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

82. Wetlands are defined in section 2 of the RMA as:

> "*includes 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*."

83. The NPS-FM defines ‘natural wetland’ as a wetland (as defined in the RMA) that is not:

    (a) a wetland constructed by artificial means (unless it was constructed to offset impacts on, or to 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.

84. According to this definition, the prerequisite for a site to be classed as a natural wetland is for the area to meet the wetland definition under the RMA and not meet any of the exceptions in the NPS-FM. Areas identified as natural wetland under the NPS-FM are subject to regulations in the Resource Management (National Environmental Standards for Freshwater) Regulations 2020 ("**NESFW**").

85. This assessment addresses wetlands, in terms of the Section 2 RMA definition. Not all of the wetlands assessed are 'natural wetlands' with respect to the NPS-FM.

86. The NPS-FM includes a policy directive to avoid the loss of extent of natural (inland) wetlands unless the activity seeking consent is 'specified infrastructure' and meets the exceptions stated in the NPS-FM.[3] This means that the more ‘permissive’ provisions of the NESFW apply to the works in wetlands.

National Environmental Standards for Freshwater ("NESFW")

87. Regulation 45 of the NESFW regulates, among other things, activities associated with the construction of specified infrastructure such as vegetation clearance, earthworks, and the taking use, damming, diversion and discharge of water within, or within specified distances, of a natural wetland. Specifically, the NESFW requires that, when undertaken for the purpose of constructing specified infrastructure, the following are discretionary activities:

    (a) Vegetation clearance within, or within a 10-metre setback from, a natural wetland;

    (b) Earthworks or land disturbance within, or within a 10-metre setback from, a natural wetland;

    (c) Earthworks or land disturbance outside a 10-metre, but within a 100-metre, setback from a natural wetland if it results or is likely to result, in the complete or partial drainage of all or part of the natural wetland; and

    (d) The taking, use, damming, diversion, or discharge of water within, or within a 100 m setback from, a natural wetland.

Horizons One Plan ("One Plan")

88. Objective 6-1 of the One Plan for Indigenous Biological Diversity is to:

    (a) Protect areas of significant indigenous vegetation and significant habitats of indigenous fauna and maintain indigenous biological diversity, including enhancement where appropriate.

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[3] NPSFM, clause 3.22.

89. Policy 6-2 states that:

(a) Rare and Threatened habitats under Schedule F must be recognised as significant indigenous vegetation or significant habitats of indigenous fauna,

(b) At Risk habitats that are assessed as significant under Policy 13-5 must be recognised as significant indigenous vegetation or significant habitats of indigenous fauna; and

(c) the Regional Council must protect these habitats by the regulation of activities and through decisions on resource consents.

90. For the regulation of activities affecting indigenous biological diversity, Policy 6-2 states that biological diversity offsets must be considered where appropriate as defined by Policy 13-4.

91. Policy 13-4 states that consent decision making for Rare, Threatened, or At Risk habitat that is an area of significant indigenous vegetation or significant fauna habitat must consider:

(a) The significance of the area of habitat; and

(b) The potential adverse effects of the proposed activity on significance.

92. Guidance for offsetting of effects is also provided in Policy 13-4.

93. Under Policy 13-4, consent must generally not be granted unless:

(a) any **more than minor adverse effects** on a Rare, Threatened or At Risk habitat’s representativeness, rarity, or distinctiveness are avoided;

(b) where these effects are not avoided, they are remedied or mitigated; and

(c) where these effects are not avoided, remedied or mitigated, they are offset to result in a net biological diversity gain.

94. Where an activity is proposed for an At Risk habitat that is not significant indigenous vegetation or significant fauna habitat, consent may be granted if there will be no significant adverse effects on that habitat's representativeness, rarity, distinctiveness or ecological context, or significant adverse effects are avoided, remedied, mitigated, or offset to result in a net indigenous biological diversity gain (Policy 13-4).

95. Policy 13-5 provides criteria for assessing the significance of habitats. Policy 13-5 refers to the Rare, Threatened, or At Risk habitats defined in Schedule F of the One Plan and provides additional criteria that may also trigger a habitat being assessed as significant, including:

(a) representativeness;

(b) the presence of threatened species, or species at their distributional limits;

(c) ecological connectivity and/or buffering; and

(d) ecological sequences.

96. The criteria for representativeness, rarity and distinctiveness and ecological context are similar to the criteria for assessment of ecological values using the EcIAG.

97. Habitat types in the Manawatū-Wanganui Region are identified and then assigned the following status categories developed by Maseyk (2007):

(a) Rare: habitat types that were originally (pre-human) uncommon in the landscape and remain so.

(b) Threatened: habitat types that have been reduced to 20% or less of former extent.

(c) At Risk: habitat types that have been reduced to 50% or less of former extent.

(d) No threat category: Habitat where 50% or greater of former extent remains.

98. Schedule F of the One Plan details indigenous biological diversity types subject to protection within the Plan. A resource consent is required if the area is determined to be a habitat type classified as Rare, Threatened or At Risk in Table F.1, it meets any of the criteria in Table F.2(a), and it is not excluded by any of the criteria in Table F.2(b).

99. Schedule F1 of the One Plan identifies habitat types that are classified as Rare or Threatened.

100. Table F2(a) provides a list of further criteria (such as size thresholds) that must be met before an area of any habitat type described in Table F.1

qualifies as a Rare, Threatened or At Risk habitat for the purposes of this Plan.

101. Policy 3-3 of the One Plan makes specific provision for addressing the adverse effects of infrastructure of national or regional importance. It provides that:

(a) Minor adverse effects will be allowed;

(b) More than minor adverse effects should be avoided, remedied or mitigated, taking into account:

(i) The need for the infrastructure;

(ii) Constraints on location or design; and

(iii) Whether there are any reasonably practicable alternative designs or locations; or

(iv) Whether effects that cannot be avoided, remedied or mitigated can be appropriately offset "including through the use of financial contributions".

102. With regards to the location of proposed biodiversity offsetting works, Policy 13-4(d)(iii) requires offsetting to:

"*generally be in the same ecologically relevant locality as the affected habitat".*

Natural Resources Plan for the Wellington Region (Appeals Version) ("NRP")

103. Key policies of the NRP that relate to the effects of the Ō2NL Project on terrestrial ecology include:

(a) **Policy P37**: Activities in and adjacent to natural wetlands shall be managed to maintain and, where appropriate, restore their condition and their values including:

(i) as habitat for indigenous flora and fauna;

(ii) for their significance to mana whenua;

(iii) for their role in the hydrological cycle including flood protection;

(iv) for nutrient attenuation and sediment trapping;

(v) as a fisheries resource;

(vi) for recreation; and

(vii) for education and scientific research.

(b) **Policy 38**: The restoration of natural wetlands and the construction of artificial wetlands to meet the water quality, aquatic ecosystem health and mahinga kai objectives set out in Tables 3.7 and 3.8 (of the NRP), to provide habitat for indigenous flora and fauna, and to carry out the physical and ecological functions of natural wetlands, and to provide for amenity values where this aligns with restoration appropriate to the area and wetland type shall be encouraged and supported.

(c) **Policy P40(c)**: Protect and where appropriate restore natural wetlands, including the natural wetlands identified in Schedule F3 (identified as **significant natural wetlands**).

104. With respect to the location of proposed biodiversity offsetting works, Schedule G2 (Principles to be applied when proposing and considering a biodiversity offset) requires that any proposals for biodiversity offsetting will:

> *"demonstrate that positive effects are achieved preferentially, first at the site, then the relevant catchment, then within the ecological district, except where there is an appropriate ecological rationale for doing otherwise."*
> **Operative Greater Wellington Regional Policy Statement**

105. Objective 16 is that indigenous ecosystems and habitats with **significant** biodiversity values are maintained and restored to a healthy functioning state.

106. Policy 47 provides a list of effects to be considered when preparing an application for a resource consent that may affect indigenous ecosystems and significant indigenous biodiversity values.

107. Policy 23 provides guidance for how significant indigenous ecosystems and habitats are identified. Five criteria are provided within Policy 23; these match the four criteria provided by the EcIAG (described above), with the addition that tangata whenua values are also considered.

108. Policy 23 includes an advice note, that states:

> "*All natural wetlands in the Wellington Region are considered to be significant natural wetlands as they meet at least two of the criteria (representativeness and rarity) listed in Policy 23 of the Regional Policy Statement 2013 for*

identifying indigenous ecosystems and habitats with significant indigenous biodiversity values."

Horowhenua District Plan 2015

109. Objective 3.2.1 (Indigenous Biological Diversity) in the Horowhenua District Plan 2015 requires the protection of significant indigenous vegetation and significant habitats of indigenous fauna. The Objective is implemented by Policies 3.2.2 and 3.2.3.

Kāpiti District Council District Plan 2021

110. Relevant policies in the Ecosystems and Indigenous Biodiversity section of the Kāpiti District Council District Plan 2021 include: ECO-P1; ECO-P2; ECO-P3, ECO-P4, ECO-P5, ECO-P6 and ECO-Table 2 (Principles to be applied when proposing and considering Biodiversity Offsets). Relevant policies under the Natural Environment section of the Kāpiti District Council District Plan 2021 include NE-P1, NE-P2, NE-P3, NE-P4 and NE-P5.

TERRESTRIAL AND WETLAND ECOSYSTEMS AND HABITATS

Overview

111. The proposed designations for the Ō2NL Project cover 618 hectares. Within this, the proposed Project construction footprint, including a construction buffer, covers 364 hectares.

112. Most of the Project construction footprint (86%) is over pasture and cropping land (312.8 hectares), with a further 12.3 hectares (3.3%) occupied by houses and associated gardens with road and rail corridors occupying 7.4 hectares (2.1%). The remaining 4.7% comprises terrestrial and wetland vegetation.

113. A map of vegetation and habitats within the designations is provided in Volume III - Drawings.

114. Detailed descriptions and photographs of the habitats present are provided in Appendix J.1. A brief overview of the location of key ecological features along the route, from north to south, is provided below:

    (a) From Chainage 9,800 to 11,300,[4] the Ō2NL Project construction footprint passes through pasture and cropping land, with numerous

[4] Chainage being the engineering system used to refer to parts of the route, in this case from north to south. Note that the Chainage for this project starts at 9800, not 0.

dwellings and associated gardens, stands of trees, ponds, and wetlands also present. The notable ecological features of this section include an area of open water habitats and marginal wetlands at Chainage 10,500-10,700, and a valley floor wetland with raupō reedland at Chainage 11,050. The section south of Chainage 10,500 is in the headwaters of the Koputaroa catchment.

(b) From Chainage 11,300 to 13,600, the Ō2NL Project construction footprint passes through pasture and cropping land, with scattered, grazed valley floor wetlands dominated by exotic plant species.

(c) From Chainage 13,600 to 20,500, the Ō2NL Project construction footprint passes through cropping and pasture, with frequent houses and associated gardens. There are no ecological features of note within the footprint of this section. Between Chainage 16,500 and 16,600, the Ō2NL Project construction footprint passes between two forest areas, one on either side of the proposed highway. The western forest is Arapaepae Bush (Site 77).

(d) Between Chainage 20,500 and 22,600, most of the Ō2NL Project construction footprint again passes through cropping and pasture land, with associated houses and gardens. The Ō2NL Project construction footprint includes the upper arm of a valley floor wetland at Chainage 20,550, and scrub with emergent indigenous trees on a scarp at Chainage 22,200-22,350.

(e) Between Chainage 22,600 and 22,700, the Ō2NL Project construction footprint crosses the Ohau River and the associated forest, scrub, and vineland on its riparian margins.

(f) From Chainage 22,700 to 26,400, most of the Ō2NL Project construction footprint passes through pasture, with small areas of wetland and scrub habitats in close proximity to the Kuku Stream (Chainage 23,500-23,900) and Waikokopu Stream (Chainage 25,500).

(g) From Chainage 26,400 to 26,550, the Ō2NL Project construction footprint passes over the Waikawa Stream and associated forest, scrub, rank grassland, and gravel deposits on its riparian margins.

(h) From Chainage 26,550 to 31,100, most of the Ō2NL Project construction footprint continues through pasture, with small, grazed valley floor wetlands, areas of indigenous treeland (Chainage 29,800-

29,900), and some localised residential areas with houses and gardens (such as Chainage 28,100-28,350). Some areas of wetland habitat, on valley floors and in one stream oxbow, occur close to the Waiauti Stream at Chainage 30,300-30,500.

(i) From Chainage 31,100 to 31,950, the Ō2NL Project construction footprint continues through pasture, with four forest remnants in close proximity (two to the north and two to the south). These are the highest value forest habitats immediately adjacent to the route. The Ō2NL Project construction footprint also includes an area of planted indigenous forest (Chainage 31,550).

(j) From Chainage 32,000 to 34,100, the Ō2NL Project construction footprint crosses several low ridges and valley floor habitats in the upper catchment of the Paruauku Swamp. Most of the Ō2NL Project construction footprint encompasses pasture, as the valley floors have been extensively drained, but there are small valley floor wetlands within the construction footprint (Chainage 31,500), and one hillslope seepage wetland directly adjacent to the south (Chainage 31,650). Between Chainage 33,660 and 33,950, the Ō2NL Project construction footprint includes the valley floor wetland. This is the largest area of wetland habitat within the Ō2NL Project construction footprint, and it lies approximately 500 metres to the southwest of more extensive, high value wetland habitats in the Paruauku Swamp - also known as O te Pua (Pukehou Swamp) (Forsyth 2005).

(k) From Chainage 34,100 to the southern end of the Ō2NL Project at Chainage 34,400, the Ō2NL Project construction footprint continues through pasture.

Flora

115. A vascular plant species list for the Ō2NL Project Area is provided in Appendix J.2.

116. Site surveys for the habitat mapping confirm the presence of two indigenous species that were not planted and are listed as Threatened. Several kānuka trees (*Kunzea robusta*; Threatened - Nationally Vulnerable) were recorded at one site, on a scarp adjacent to the Manakau Stream. Aka (*Metrosideros perforata*; Threatened - Nationally Vulnerable) is present in indigenous forest and scrub habitats throughout the Ō2NL Project Area. These two species

are still common and widespread, both in the region and nationally, and have been elevated from Not Threatened to Threatened - Nationally Vulnerable due to the risk posed by myrtle rust (*Austropuccinia psidii*) (de Lange *et al.,* 2018).

117. A detailed survey of the Ō2NL Project Area for threatened flora was undertaken in February of 2022 (Appendix J.3). These surveys targeted indigenous forest, scrub, and treeland habitats, riparian vegetation, and wetlands, and searched for Threatened, At Risk, or regionally uncommon species. No notable naturally occurring plant species were found during the survey.

Bats

118. An assessment of potential indigenous bat values within the Ō2NL Project Area has been carried out (Appendix J.4). A desktop assessment identified seventeen sites as providing potential roosting habitat for long-tailed bats (*Chalinolobus tuberculatus*; Threatened – Nationally Critical). Two further survey sites were identified following anecdotal reports of bat presence near the Ō2NL Project Area, resulting in a total of 19 potential survey locations.

119. Following habitat assessments, two of the 19 sites initially identified (Properties #473 and #493) were excluded from the survey due to a lack of appropriate habitat.

120. A total of 28 automatic bat monitors ("**ABMs**") were deployed throughout the Ō2NL Project Area and nearby habitats for between 10-22 valid survey nights. Most ABMs within the Ō2NL Project Area recorded 15 or more valid survey nights each in accordance with Department of Conservation protocols for surveys in areas where bats have not been previously recorded.

121. No bats were detected during the surveys. This indicates that although potential bat roosting habitat exists within the Ō2NL Project Area, these habitats are not currently used by indigenous bats.

Birds

122. An assessment of potential avifauna values within the Ō2NL Project Area and surrounding landscape has been carried out (Appendix J.5). In summary:

(a) The Ō2NL Project Area was assessed using Google Earth imagery to identify all properties that may contain key avifauna habitats. These sites were surveyed between 22 and 26 March 2021, 29 November and 3 December 2021 (inclusive) and 24 February 2022 using five-minute bird counts, transect surveys, and playback calls. Incidental observations of bird species were also recorded when arriving, leaving or moving between survey sites on each property.

(b) A total of 28 indigenous birds were recorded, including koekoeā/long-tailed cuckoo (Threatened - Nationally Vulnerable), karakahia/grey duck (Threatened - Nationally Vulnerable), pihoihoi/New Zealand pipit (At Risk - Declining), pūweto/spotless crake (At Risk – Declining), koitareke/marsh crake (At Risk - Declining), kawau/black shag (At Risk – Relict), tūturiwhatu/black-fronted dotterel (At Risk - Naturally Uncommon), and weweia/New Zealand dabchick (At Risk - Recovering). A single kākāriki (yellow-crowned parakeet; Not Threatened) was notable as an uncommon species flying over an open area.

(c) A further seven notable bird species that were not recorded during the survey have been identified as potentially present based on other records from the local area.

Lizards

123. An assessment of potential indigenous lizard values within the Ō2NL Project Area has been carried out (Appendix J.6). A desktop assessment identified the potential presence of up to seven indigenous lizard species and identified 25 properties potentially containing lizard habitat. Access was granted for 24 of these properties in order to undertake lizard surveys.

124. The lizard surveys consisted of day-searches, spotlighting, pitfall trapping, Onduline artificial cover objects, and closed-cell foam covers.

125. To date, two lizard species, the ornate skink (*Oligosoma ornatum*, At Risk – Declining) and the Northern grass skink (*Oligosoma polychroma*, Not Threatened) have been detected. Ornate skink was located at four of the 24 properties surveyed within exotic grassland, gardens, and mixed indigenous-exotic forest and scrub. Northern grass skink was located in one property within rank grassland.

126. This survey may have detected a potential localised extinction event of a significant population of ornate skink at one property (Property #287; see Volume III - Drawings).

127. The final lizard survey was completed in March 2022. It is evident that the area of the proposed designations is characterised by low species diversity and abundance. This is likely due to the degraded ecological values throughout the highly developed landscape, where there are limited natural ecological sites, and likely a high number of exotic mammalian and avian predator species present.

128. The most likely lizard species present throughout the Ō2NL Project Area is ornate skink (already discovered at four properties as noted above) and northern grass skink (discovered in February 2022). Copper skink (*O. aeneum*; At Risk – Declining) and glossy brown skink (*O. zelandicum*, At Risk – Declining) are also possibly present, although they were not detected during the surveys.

129. Lizards are likely to be concentrated around rank exotic grasslands and in gardens throughout the area of the proposed designations. Lizard populations may also occur along wide rough grass margins along farm tracks and road and rail verges, hedges, forest edges, wetlands, and around farm buildings, and retired sections of quarries. Amenity plants (such as harakeke (*Phormium tenax*), agapanthus (*Agapanthus* sp.), rough grasslands (such as kikuyu; *Cenchrus clandestinus*), weeds (such as tradescantia; *Tradescantia fluminensis*) and artificial cover objects (such as corrugated roofing iron, firewood stacks, bricks and pavers) in gardens provide hiding places for lizards. Rough grassland provides considerable and diverse food sources for lizards as these habitats support a significant invertebrate biomass, thermal and humidity benefits (through provision of a range of open basking sites and microclimates), and protective cover from a range of potential predators.

130. It is unlikely that arboreal geckos are present within the Ō2NL Project Area. There is only one identified site where indigenous forest is present and affected by the Ō2NL Project (ITF6 on Property #40, Volume III - Drawings), although this forest was likely planted during the 1970s or 1980s. It is difficult for arboreal lizards to colonise isolated habitat patches where there is a hard edge between habitats (for instance, from isolated forest patches to pasture), and thus it is likely this site was never colonised.

Terrestrial Invertebrates

131. An assessment of the ecological values in regard to terrestrial invertebrates has been carried out (Appendix J.7). In summary:

(a) No terrestrial invertebrates classified as At Risk or Threatened have been recorded within the Ō2NL Project construction footprint during surveys. A total of 130 taxa were recorded during the survey period, including 84 Lepidoptera species (moths and butterflies).

(b) Desktop invertebrate assessments show that several species and their habitats are present within the Ō2NL Project construction footprint, including species that are classified as Threatened or At Risk under the Department of Conservation's New Zealand Threat Classification System.

(c) Two notable species were recorded: peripatus (*Peripatoides novaezeelandiae*) and *Wainuia urnula*, a land snail. While these species are not Threatened or At Risk they are considered locally significant. Within the Ō2NL Project Area, both of these species are confined to areas of woody vegetation with abundant cover in the ground tier, and an absence of livestock. The extent of potential habitat for these species is therefore very limited, and they can be reliably regarded as locally uncommon within the Ō2NL Project Area.

(d) Notable species that may be present within or adjacent to the Project construction footprint but were not recorded during the surveys include: *Powelliphanta* spp. (*P. traversi florida*, *P. traversi otakia*, and *P. traversi traversi*), the spiny longhorn beetle (*Blosyropus spinosus*), and the New Zealand mantis (*Orthodera novaezealandiae*).

(e) An opportunistic survey of understorey vegetation in Waiopehu Scenic Reserve on 2 December 2021 resulted in the discovery of two live adult *Powelliphanta traversi* snails, which demonstrates that this species persists in the wider area.

ASSESSMENT OF ECOLOGICAL VALUES

132. Tables J.1a, J.1b, and J.1c provide an Ecological Values assessment for each habitat type within the Ō2NL Project construction footprint. Some habitats beyond, but immediately adjacent to, the Ō2NL Project construction footprint (for example, remnants of tawa-kohekohe forest on Property #42,

tawa forest on property #154, and Arapaepae Bush on Property #465) have also been included in the assessment on the following basis:

(a) The habitat is of Moderate to High ecological value or has previously been recognised as a natural area, or

(b) The habitat is of a type that may be subject to adverse effects other than direct clearance or loss, due to its proximity to the footprint (such as deposition of construction dust, traffic noise, or increased isolation of resident fauna).

133. A more detailed analysis of ecological values is presented in Appendix J.8, including an assessment of vegetation types against the four criteria of significance: Representativeness, Rarity / Distinctiveness, Diversity and Pattern, and Ecological Context.

134. The ecological values of all habitat types within the Ō2NL Project Area were assessed, including habitats such as pasture and cropping land, houses and associated gardens, river beds, and roads.

135. Site specific information for some species is limited, for instance bird use was surveyed for representative habitats along the route rather than for every area of each habitat. Therefore, species that are likely to be present in any one area of habitat, based on habitat preference and known distribution, are assumed to be present for the purposes of the ecological values assessments.

136. The ecological value assessments rely on and incorporate the relevant objectives and policies of the relevant regional and district plans, and other guidance documents for assessments of ecological values.

137. Further explanation of this assessment of ecological values is provided below:

(a) The Threatened Environment Classification, considered as part of the criteria for Rarity and Distinctiveness, is only relevant to areas of naturally occurring indigenous vegetation (ie, it excludes vegetation dominated by exotic species in terrestrial or wetland habitats, or planted indigenous vegetation). Where indigenous vegetation is present on an Acutely Threatened Land Environment, the corresponding value score considers the maturity of that vegetation (ie, forest vs scrub) and also its intactness (ie, is the vegetation dominated by indigenous species or has it been invaded by pest plants).

(b) Within the Ō2NL Project Area, small but degraded valley floor wetland habitats (ie, grazed wetlands dominated by exotic herbs and grasses) are locally common. These exotic wetlands do not comprise habitats that should be assessed as High for Rarity / Distinctiveness as they are not indigenous wetlands, unless other factors come into play (such as the presence of Threatened or At Risk Species).

(c) When assessing the ecological value of a single polygon of a habitat type (such as an area of exotic herbfield in a wetland) there is a risk it is undervalued if it is assessed in isolation from the adjacent habitat. The ecological value of any one polygon therefore also considers the greater area of habitat it contributes to, if any. As an example, areas of exotic wetland within the wider Paruāuku Swamp were assessed as being of higher ecological value than areas of isolated exotic wetland surrounded by pasture.

138. Input from relevant fauna experts is incorporated to ensure that the values of each vegetation type as habitat for indigenous fauna is accounted for (refer to these technical assessments in Appendices J.3 to J.7). Note that exotic vegetation and abiotic habitat, such as rocky habitat, can provide high value habitat for some fauna species.

Table J.1a: Ecological values assessment for terrestrial habitats in the Ō2NL Project area.

Vegetation/Habitat Type	Ecological value
ITF1 - Tawa forest	Very high
ITF2 - Tawa-kohekohe forest remnants	Very high
ITF3 - Kohekohe-tītoki-karamū forest	Moderate
ITF4 - Māhoe forest and scrub	Moderate
ITF5 - Puka-kōhūhū forest	Moderate
ITF6 - Tarata-rewarewa forest	Moderate
ITF7 - Tītoki forest	High
ITS1 - Māhoe-karamū scrub	Moderate
ITS1 - Māhoe-karamū scrub ITS1d – Māhoe-karamū scrub (desktop only)	Moderate
ITT01 - Kāmahi-kānuka treeland	Moderate
ITT02 - Karaka-tawa treeland	Moderate
ITT03 - Planted indigenous treeland ITT03d – Planted indigenous treeland (desktop only)	Low

Vegetation/Habitat Type	Ecological value
ITT04 - Tī kōuka treeland	Low
ITT05 - Tītoki treeland	Low
ITT06 - Tītoki-hīnau-maire treeland	Moderate
ITT07 - Tawa-tītoki treeland	High
ITFn01 - Kiokio fernland	Moderate
MTF1 - Māhoe-barberry-*Muehlenbeckia australis* forest and scrub	Moderate
MTF2 - Māhoe-sweet cherry scrub and forest	Low
MTF3 - False acacia-tītoki-cherry forest	Moderate
MTF4 - Crack willow-māhoe forest/scrub	Moderate
MTF5 - Mixed indigenous-exotic planted forest	Low
MTF6 - Karaka-māhoe-kawakawa forest and scrub	Moderate
MTF6d - Karaka-māhoe-kawakawa forest and scrub (desktop only)	Moderate
MTF7 - Tītoki-karaka forest	Moderate
MTF8 - Tītoki-false acacia-poataniwha-karaka forest	Moderate
MTS1 - Māhoe-karo scrub with emergent pine	Moderate
MTS2 - Barberry scrub with emergent tōtara	Moderate
MTS3 - Barberry-blackberry-*Muehlenbeckia australis*-greater bindweed-(māhoe) scrub	Low
MTS4 - Māhoe-mamaku-blackberry-barberry scrub	Moderate
ETF1 - Crack willow forest/scrub (riparian)	Low
ETF1 - Crack willow forest/scrub (riparian area with *Wainuia* land snails)	Moderate
ETF1 - Crack willow forest/scrub (other)	Low
ETF2 - Eucalyptus forest	Low
ETF3 - Radiata pine forest	Low
ETF4 - Exotic treeland and forest	Low
ETF5 - Sweet cherry forest	Moderate
ETF6 - Redwood forest	Moderate
ETF7 - False acacia-karaka forest	Moderate
ETF8 - Macrocarpa-radiata pine-false acacia forest	Moderate
ETG1 - Rank grassland	Low
ETS1 - Crack willow-brush wattle-tree lucerne scrub	Moderate
ETS2, ETS3 - Gorse scrub, gorse-pampas shrubland	Low
ETV1 - Blackberry vineland	Low

Table J.1b: Ecological Values assessment for wetland habitats in the Ō2NL Project area.

139. Vegetation/Habitat Type	Assigned Value
IWFn1 - Bracken-whekī fernland on valley floor (Paruauku Swamp)	High

139. Vegetation/Habitat Type	**Assigned Value**
MWFn1- Kiokio-spike sedge-Yorkshire fog fernland on valley floor (Paruauku Swamp)	Moderate
IWRe1 - Raupō reedland on valley floor	High
IWSe1 - *Isolepis prolifera* sedgeland on the valley floor	Moderate
IWSe1-SPG - *Isolepis prolifera* sedgeland within a seepage wetland	Moderate
IWSe2 - *Isolepis prolifera*-kiokio-spike sedge sedgeland on valley floor	Moderate
IWSe3 - Rautahi sedgeland on valley floor (Paruauku Swamp)	Moderate
IWSe4 - *Isolepis prolifera-Juncus planifolius* sedgeland on valley floor (Paruauku Swamp)	Moderate
IWSe5 - Kiokio-spike sedge- kāpūngāwhā sedgeland on valley floor (Paruauku Swamp)	Moderate
MWSe1-SPG - *Isolepis prolifera*-soft rush sedgeland within a seepage wetland	Moderate
MWSe2 - *Isolepis prolifera*-floating sweet grass sedgeland on valley floor	Moderate
MWSe3 - *Isolepis prolifera*-Mercer grass sedgeland on valley floor	Moderate
MWSe3 - *Isolepis prolifera*-Mercer grass sedgeland on oxbow wetland	Moderate
MWSe4 - Pūrei-spike sedge-Yorkshire fog sedgeland on valley floor (Paruauku Swamp)	Moderate
MWG1 - Yorkshire fog-*Isolepis prolifera*-spike sedge grassland on valley floor	Moderate
MWG2 - Yorkshire fog-spike sedge grassland on valley floor (Paruauku Swamp)	Moderate
MWG1d – Mixed wetland species grassland on valley floor	Low
MWG3 - Yorkshire fog-*Isolepis prolifera* grassland on valley floor	Low
MWV1 - Blackberry-spike sedge vineland on valley floor	Moderate
EWF1 - Crack willow forest on valley floor (Paruauku Swamp)	Moderate
EWG1 - Floating sweet grass grassland on valley floor	Low
EWG2 - Mercer grass grassland on valley floor	Low
EWG3 - Blue sweetgrass-creeping buttercup grassland on valley floor	Low
EWG4 - Mercer grass-water pepper grassland on valley floor	Low
EWG5 - Yorkshire fog-creeping buttercup grassland on valley floor	Low
EWG6 - Yorkshire fog-creeping buttercup-Mercer grass grassland on valley floor	Low
EWG7 - Creeping bent grassland on valley floor	Low
EWG8 – Soft rush/Yorkshire fog-creeping buttercup grassland on valley floor	Low
EWG9 - Mercer grass-open water grassland on valley floor	Low

139. Vegetation/Habitat Type	**Assigned Value**
EWG1d - Exotic grassland in wetland on valley floor	Low
MWH1 - Water celery-kikuyu-*Isolepis prolifera* herbfield on valley floor	Moderate
EWH1 - Creeping buttercup herbfield on valley floor (Paruauku Swamp)	Moderate
EWH1d - Creeping buttercup herbfield on valley floor (desktop only)	Moderate
EWH2 - Creeping buttercup-water pepper herbfield on valley floor	Low
EWH3 - Water celery herbfield on valley floor (Paruauku Swamp)	Moderate
EWH4 – Herbfields dominated by water celery on valley floor	Low
EWH5 - Water pepper herbfield on valley floor (Paruauku Swamp)	Moderate
EWH6 – Herbfield dominated by water pepper on valley floor	Low
EWH7 - Water pepper-Mercer grass herbfield on valley floor	Low
EWH8 - Broadleaved fleabane/Yorkshire fog herbfield on valley floor (Paruauku Swamp)	Moderate
EWH9, EWH9d - Exotic dominant wetland on valley floor	Low
EWH10, EWH10d – Soft rush/creeping buttercup-Yorkshire fog-mercer grass herbfield on valley floor	Low
MWRs1 - Soft rush/Yorkshire fog-spike sedge rushland (Paruauku Swamp)	Moderate
EWRs1, EWRs1d - Soft rush rushland on valley floor	Low
EWRs2 - Soft rush-creeping buttercup-Yorkshire fog rushland on valley floor (Paruauku Swamp)	Moderate
EWRs3 - Soft rush-Yorkshire fog rushland (Paruauku Swamp)	Moderate
OW-Open water	Moderate

Table J.1c: Ecological Values assessment for other habitats in the Ō2NL Project area.

Vegetation/Habitat Type	**Assigned Value**
TG1 - Gravelfield	Moderate
EHG - House, gardens and farm buildings	Negligible
ETP - Cropland and pasture	Negligible
RRR - River/road/rail	Negligible
QRY - Quarry	Negligible

ASSESSMENT OF STATUTORY SIGNIFICANCE OF TERRESTRIAL AND WETLAND HABITATS

140. The 89 vegetation and habitat types described in tables J.1a, J.1b, and J.1c were also assessed for statutory significance under Policy 23 of the Regional Policy Statement for habitats in the Greater Wellington Region, and under Policy 13-5 and Schedule F for habitats in the Manawatū-Wanganui Region.

141. A summary of this assessment is provided in Table J.2 below.

142. The significance of habitats due to the possible or confirmed presence of Threatened, At Risk, or locally uncommon species are assessed as follows:

(a) The presence of common Myrtaceae species (such as kānuka) that are listed as Threatened has not been used as a trigger for significance, as the threat ranking considers a potential threat, and these species are still widespread and in places locally abundant.

(b) The potential presence of New Zealand mantis (At Risk - Declining) has not been used as a trigger for significance. This species is currently widespread in both indigenous and exotic habitats, and is not in decline due to loss of habitat, but competition with an introduced mantis species.

(c) The likely intermittent presence of mobile Threatened or At Risk bird species within a habitat (such as North Island kākā, karearea/bush falcon, or pōpokatea within small forest remnants) has not been used as a trigger for significance. These bird species can be found at times in almost any part of the landscape, including towns, orchards, and plantation forests. The habitats within the Ō2NL Project Area do not comprise core feeding and or breeding habitat for these species due to their small size, and lack of mammalian predator control.

(d) Similarly, the possible presence of At Risk bird species that utilise pasture habitats such as torea (*Haematopus unicolor;* At Risk – Recovering), or rank exotic grassland (such as New Zealand pipit; At Risk - Declining) has not been used as a trigger for significance for these habitats. For these two species, significance would be triggered if the area of habitat was large, and was a core part of the locally available habitat for these species.

143. Indigenous lizards, including ornate skink, copper skink, and glossy brown skink, all classified as At Risk - Declining, could potentially be present in any areas of rank grassland, blackberry (*Rubus fruticosus*) vineland, gorse (*Ulex europaeus*) scrub, exotic treeland, roadsides, rail corridors, quarries, spoil sites, material supply sites, laydown areas, and gardens within the Ō2NL Project Area. If an overly conservative approach was taken for the assessment of significance, the potential presence of At Risk lizard species would result in all habitats within the Ō2NL Project Area being assessed as significant, except for areas of pasture and cropping land. An exhaustive survey for lizards throughout all habitats within the Ō2NL Project Area is not practical. Adverse effects on indigenous lizards are addressed by mitigation and compensation later in this assessment.

144. Significance of habitats due to the presence of Threatened or At Risk fauna is triggered where the species is known to occur, or has been historically present at a site, and where the species is reliant on that particular area of habitat for the persistence of a population. Examples where significance has been triggered due to Threatened, At Risk, or locally uncommon species include:

(a) The presence of ornate skink at Property #465.

(b) The possible presence of *Powelliphanta traversi* at Property #465.

(c) The presence of *Wainuia urnula*/ngata in riparian forest and scrub on the banks of the Waikawa Stream.

(d) The likely presence of spotless crake in wetland habitats with dense vegetative cover in the Paruāuku Swamp, due to the known presence of this species elsewhere in the same wetland.

145. New Zealand dabchick was recorded at the pond at Property #461, and may be present on any areas of open water within the Ō2NL Project Area. As an interim assessment, Property #461 has been assessed as providing breeding habitat for this species, and consequently assessed as significant. The ecological value and significance of other open water habitats were reassessed following the Spring 2021 bird surveys (refer to Avifauna Technical Assessment in Appendix J.5).

146. Vegetation and habitats in the Ō2NL Project Area that are significant include:

(a) All areas of remnant indigenous forest (4.94 hectares, five vegetation and habitat types).

(b) Habitats for ornate skink or *Powelliphanta traversi* (3.57 hectares, nine vegetation and habitat types).

(c) The open water and wetland habitats at Property #461 due to the presence of New Zealand dabchick (0.33 hectare, two vegetation and habitat types).

(d) Woody vegetation that buffers the Ohau River or Waikawa Stream (1.33 hectares, six vegetation and habitat types).

(e) Habitats that provide a buffer or provide connectivity to other sites that are significant (1.21 ha hectares 7 vegetation and habitat types).

(f) All natural wetlands in the Greater Wellington Region (1.78 hectares, 22 vegetation and habitat types).

(g) All indigenous wetlands (0.75 hectare, nine vegetation and habitat types).

(h) Wetlands within the former extent of the Paruāuku Swamp which are likely to provide habitat for At Risk wetland birds (regardless of indigenous vs. exotic composition) (1.10 hectares,13 vegetation and habitat types).

147. Of the 89 vegetation and habitat types in the Ō2NL Project Area, 47 are significant, covering a total area of 15.73 hectares, out of the total project construction footprint of covers 364 hectares, which includes the areas listed above.

Table J.2: Assessment of statutory significance for terrestrial and wetland vegetation and habitat types for the Ō2NL Project Area.

Vegetation/Habitat Type			Area within Project designations (in bold if within construction footprint)	Horizons One Plan (Horizons 2014)		GWRC Regional Policy Statement
Vegetation/Habitat Type	Equivalent Vegetation Type Listed in Table F.1 in Schedule F and Threat Classification Horizons One Plan	Equivalent Terrestrial Ecosystem Type Listed in Forest Ecosystems of the Wellington Region and Their Threat Classification (Greater Wellington Regional Council 2018)		Schedule F	Policy 13-5	Policy 23
ITF1 - Tawa forest	Hardwood/broadleaved species forest or treeland Threatened	NA	1.79 ha	Significant (Table F.2(a):(i)(a))	Significant (a)(i)(A)	NA
ITF2 - Tawa-kohekohe forest remnants	NA	MF6, Kohekohe, tawa forest Endangered	2.62 ha	NA	NA	Significant (a)(i), (b), (c)
ITF3 - Kohekohe-tītoki-karamū forest	Riparian margin At Risk	NA	0.03 ha	Significant (Table F.2(a):(v))	Significant (a)(iii)(B)	NA
ITF4 - Māhoe forest and scrub	Does not represent any of the forest definitions outlined in Schedule F Not Threatened	NA	**0.27 ha** 0.03 ha	Not significant	Not significant	NA
ITF5 - Puka-kōhūhū forest	NA	Does not represent any of the forest types outlined in Forest Ecosystems of the Wellington Region (GWRC 2018) Not Threatened	0.64 ha	NA	NA	Significant (d)(i)
ITF6 - Tarata-rewarewa forest	NA	Does not represent any of the forest types outlined in Forest Ecosystems of the Wellington Region (GWRC 2018) Not Threatened	**0.4 ha** 0.04 ha	NA	NA	Not significant
ITF7 - Tītoki forest	Indigenous forest or scrub containing *Powelliphanta* land snails At Risk	NA	0.20 ha	Significant (Table F.2(a):(iv))	Significant (a)(ii)(A)	NA
ITS1, ITS1d - Māhoe-karamū scrub	Does not represent any of the scrub definitions outlined in Schedule F Not Threatened	NA	ITS1 **0.53 ha** 0.18 ha ITS1d **1.47 ha** 0.37 ha	Not significant	Not significant	NA
ITT01 - Kāmahi-kānuka treeland	Does not represent any of the treeland definitions outlined in Schedule F Not Threatened	NA	0.01 ha	Not significant	Not significant	NA
ITT02 - Karaka-tawa treeland	Does not represent any of the treeland definitions outlined in Schedule F (due to abundance of karaka) Not Threatened	NA	**0.16 ha**	Not significant	Not significant	NA
ITT03, ITT03d - Planted indigenous treeland	Does not represent any of the treeland definitions outlined in Schedule F Not Threatened	0.01 ha (42) is in the Greater Wellington Region and does not represent any of the forest types outlined in Forest Ecosystems of the Wellington Region (GWRC 2018) Not Threatened	ITT03 **0.03 ha** 0.32 ha ITT03d 0.12 ha	Not significant	Not significant	Not significant
ITT04 - Tī kōuka treeland	Does not represent any of the treeland definitions outlined in Schedule F Not Threatened	NA	**0.01 ha**	Not significant	Not significant	NA
ITT05 - Tītoki treeland	Hardwood/broadleaved species forest or treeland. Threatened	NA	**0.001 ha** 0.003 ha	Not significant	Not significant	NA
ITT06 - Tītoki-hīnau-maire treeland	Hardwood/broadleaved species forest or treeland. Threatened	NA	**0.03 ha**	Not significant	Not significant	NA

Vegetation/Habitat Type			Area within Project designations (in bold if within construction footprint)	Horizons One Plan (Horizons 2014)		GWRC Regional Policy Statement
Vegetation/Habitat Type	Equivalent Vegetation Type Listed in Table F.1 in Schedule F and Threat Classification Horizons One Plan	Equivalent Terrestrial Ecosystem Type Listed in Forest Ecosystems of the Wellington Region and Their Threat Classification (Greater Wellington Regional Council 2018)		Schedule F	Policy 13-5	Policy 23
ITT07 - Tawa-tītoki treeland	Hardwood/broadleaved species forest or treeland. Threatened	NA	0.71 ha	Not significant	Significant (a)(i)(A)	NA
ITFn01 - Kiokio fernland	NA	Does not represent any of the terrestrial ecosystem types outlined in Forest Ecosystems of the Wellington Region (GWRC 2018) Not Threatened	**0.03 ha**	NA	NA	Not significant
MTF1 - Māhoe-barberry-*Muehlenbeckia australis* forest and scrub	Does not represent any of the forest and scrub definitions outlined in Schedule F Not Threatened	NA	**0.09 ha**	Not significant	Not significant	NA
MTF2 - Māhoe-sweet cherry scrub and forest	Does not represent any of the forest and scrub definitions outlined in Schedule F Not Threatened	NA	**0.03 ha** 0.14 ha	Not significant	Not significant	NA
MTF3 - False acacia-tītoki-cherry forest	Does not represent any of the forest definitions outlined in Schedule F Not Threatened	NA	0.35 ha	Not significant	Significant (a)(ii)(A)	NA
MTF4 - Crack willow-māhoe forest/scrub	Riparian margin At Risk	NA	0.08 ha	Significant (Table F.2(a):(v))	Significant (a)(iii)(B)	NA
MTF5 - Mixed indigenous-exotic planted forest	Does not represent any of the forest definitions outlined in Schedule F Not Threatened	Does not represent any of the terrestrial ecosystem types outlined in Forest Ecosystems of the Wellington Region (GWRC 2018) Not Threatened	**0.52 ha** 1.24 ha	Not significant	Not significant	Not significant
MTF6 - Karaka-māhoe-kawakawa forest and scrub	Indigenous forest or scrub containing *Powelliphanta* land snails At Risk	NA	0.07 ha	Significant (Table F.2(a):(iv))	Significant (a)(ii)(A)	NA
MTF6d - Karaka-māhoe-kawakawa forest and scrub (desktop only)	Does not represent any of the forest definitions outlined in Schedule F Not Threatened	NA	**0.47 ha** 0.20 ha	Not Significant	Not Significant	NA
MTF7 - Tītoki-karaka forest	Indigenous forest or scrub containing *Powelliphanta* land snails At-risk	NA	0.15 ha	Significant (Table F.2(a):(iv))	Significant (a)(ii)(A)	NA
MTF8 - Tītoki-false acacia-poataniwha-karaka forest	Does not represent any of the forest definitions outlined in Schedule F Not Threatened	NA	0.34 ha	Not significant	Significant (a)(ii)(A)	NA
MTS1 - Māhoe-karo scrub with emergent pine	NA	NA	0.37 ha	NA	NA	Significant (d)(i)
MTS2 - Barberry scrub with emergent tōtara	Does not represent any of the scrub definitions outlined in Schedule F Not Threatened	NA	**0.07 ha**	Not significant	Not significant	NA
MTS3 - Barberry-Blackberry-*Muehlenbeckia australis*-greater bindweed-(māhoe) scrub	Does not represent any of the scrub definitions outlined in Schedule F Not Threatened	NA	**0.09 ha** 0.001 ha	Not significant	Not significant	NA
MTS4 - Māhoe-mamaku-blackberry-barberry scrub	Does not represent any of the scrub definitions outlined in Schedule F Not Threatened	NA	**0.06 ha**	Not significant	Not significant	NA
ETF1 - Crack willow forest/scrub (riparian with Wainuia land snails)	Riparian margin At Risk	NA	**0.40 ha** 0.73 ha	Significant (Table F.2(a):(v))	Significant (a)(iii)(B)	NA
ETF2 - Eucalyptus forest	Does not represent any of the scrub definitions outlined in Schedule F Not Threatened	NA	**0.30 ha** 0.78 ha	Not significant	Not significant	NA

Vegetation/Habitat Type			Area within Project designations (in bold if within construction footprint)	Horizons One Plan (Horizons 2014)		GWRC Regional Policy Statement
Vegetation/Habitat Type	Equivalent Vegetation Type Listed in Table F.1 in Schedule F and Threat Classification Horizons One Plan	Equivalent Terrestrial Ecosystem Type Listed in Forest Ecosystems of the Wellington Region and Their Threat Classification (Greater Wellington Regional Council 2018)		Schedule F	Policy 13-5	Policy 23
ETF3 - Radiata pine forest	Does not represent any of the scrub definitions outlined in Schedule F Not Threatened	NA	**0.21 ha** **2.75 ha**	Not significant	Not significant	NA
ETF3 - Radiata pine forest (riparian)	Riparian margin At Risk	NA	0.05 ha	Significant (Table F.2(a):(v))	Significant (a)(iii)(B)	NA
ETF4, ETF4d - Exotic treeland and forest	Does not represent any of the scrub definitions outlined in Schedule F Not Threatened	Does not represent any of the terrestrial ecosystem types outlined in Forest Ecosystems of the Wellington Region (GWRC 2018) Not Threatened	ETF4 **5.90 ha** 3.85 ha ETF4d 06.65 ha	Not significant	Not significant	Not significant
ETF5 - Sweet cherry forest	Does not represent any of the forest definitions outlined in Schedule F Not Threatened	NA	0.05 ha	Not significant	Significant (a)(ii)(A)	NA
ETF6 - Redwood forest	Does not represent any of the forest definitions outlined in Schedule F Not Threatened	NA	0.31 ha	Not significant	Significant (a)(ii)(A)	NA
ETF7 - False acacia-karaka forest	Does not represent any of the forest definitions outlined in Schedule F Not Threatened	NA	1.24 ha	Not significant	Significant (a)(ii)(A)	NA
ETF8 - Macrocarpa-radiata pine-false acacia forest	Does not represent any of the forest definitions outlined in Schedule F Not Threatened	NA	1.00 ha	Not significant	Significant (a)(ii)(A)	NA
ETG1 - Rank grassland	Does not represent any of the forest definitions outlined in Schedule F Not Threatened	NA	**0.48 ha** 0.40 ha	Not significant	Not significant	NA
ETS1 - Crack willow-brush wattle-tree lucerne scrub	Riparian margin At Risk	NA	0.17 ha	Significant (Table F.2(a):(v))	Significant (a)(iii)(B)	NA
ETS2 - Gorse scrub	Riparian margin At Risk	NA	**0.01 ha** 0.09 ha	Significant (Table F.2(a):(v))	Significant (a)(iii)(B)	NA
ETS3 - Gorse-pampas shrubland	Does not represent any of the forest definitions outlined in Schedule F Not Threatened	NA	0.26 ha	Not significant	Not significant	NA
ETV1 - Blackberry vineland	Does not represent any of the forest definitions outlined in Schedule F Not Threatened	Does not represent any of the terrestrial ecosystem types outlined in Forest Ecosystems of the Wellington Region (GWRC 2018) Not Threatened	**0.93 ha** 0.39 ha	Not significant	Not significant	Not significant
IWFn1 - Bracken-whekī fernland on valley floor (Paruauku Swamp)	NA	NA	**0.03 ha**	NA	NA	Significant (a)(i), (b), (d)(i)
IWRe1 - Raupō reedland on valley floor	Swamp and marsh wetland Threatened	NA	**0.12 ha**	Significant (Table F.2(a):(viii))	Significant (a)(i)(A), (a)(ii)(A)	NA
IWSe1 - *Isolepis prolifera* sedgeland on the valley floor	Swamp and marsh wetland Threatened	NA	**0.02 ha** 0.002 ha	Not significant	Significant (a)(i)(A)	NA
IWSe1-SPG, IWSe1d-SPG - *Isolepis prolifera* sedgeland within a seepage wetland	Seepage and spring wetland Rare	NA	IWSe1-SPG **0.08 ha** 0.10 ha IWSe1d-SPG 0.12 ha	The 0.18 ha and 0.10 ha areas of seepage and spring wetland is significant (Table F.2(a):(xi))	Significant (a)(i)(A), (a)(ii)(A), (a)(ii)(E)	NA
IWSe2 - *Isolepis prolifera*-kiokio-spike sedge sedgeland on valley floor	Swamp and marsh wetland Threatened	NA	**0.11 ha**	Significant (Table F.2(a):(viii))	Significant (a)(i)(A)	NA

Vegetation/Habitat Type			Area within Project designations (in bold if within construction footprint)	Horizons One Plan (Horizons 2014)		GWRC Regional Policy Statement
Vegetation/Habitat Type	**Equivalent Vegetation Type Listed in Table F.1 in Schedule F and Threat Classification Horizons One Plan**	**Equivalent Terrestrial Ecosystem Type Listed in Forest Ecosystems of the Wellington Region and Their Threat Classification (Greater Wellington Regional Council 2018)**		**Schedule F**	**Policy 13-5**	**Policy 23**
IWSe3 - Rautahi sedgeland on valley floor (Paruauku Swamp)	NA	NA	**0.07 ha** 0.02 ha	NA	NA	Significant (a)(i), (b)
IWSe4 - *Isolepis prolifera-Juncus planifolius* sedgeland on valley floor (Paruauku Swamp)	NA	NA	0.001 ha	NA	NA	Significant (a)(i), (b), (d)(i)
IWSe5 - Kiokio-spike sedge-kāpūngāwhā sedgeland on valley floor (Paruauku Swamp)	NA	NA	**0.04 ha** 0.01 ha	NA	NA	Significant (a)(i), (b), (d)(i)
MWFn1 - Kiokio-spike sedge-Yorkshire fog fernland on valley floor (Paruauku Swamp)	NA	NA	**0.07 ha** 0.01 ha	NA	NA	Significant (a)(i), (d)(i)
MWSe1 - SPG, MWSe1-SPGd - *Isolepis prolifera*-soft rush sedgeland within a seepage wetland	NA	NA	MWSe1-SPG **0.04 ha** 0.01 ha MWSe1-SPGd 0.02 ha	NA	NA	Significant (a)(i), (b)
MWSe2 - *Isolepis prolifera*-floating sweet grass sedgeland on valley floor	Swamp and marsh wetland Threatened	NA	**0.01 ha** 0.02 ha	Not significant	Significant (a)(i)(A)	NA
MWSe3 - *Isolepis prolifera*-Mercer grass sedgeland in oxbow wetland	Does not represent any of the wetland definitions outlined in Schedule F Not Threatened	NA	**0.09 ha**	Not significant	Not significant	NA
MWSe3 - *Isolepis prolifera*-Mercer grass sedgeland on valley floor	Does not represent any of the wetland definitions outlined in Schedule F Not Threatened	NA	**0.01 ha**	Not significant	Not significant	NA
MWSe4 - Pūrei-spike sedge-Yorkshire fog sedgeland on valley floor (Paruauku Swamp)	NA	NA	**0.006 ha**	NA	NA	Significant (a)(i), (b)
MWG1 - Yorkshire fog-*Isolepis prolifera*-spike sedge grassland on valley floor	Does not represent any of the wetland definitions outlined in Schedule F Not Threatened	NA	**0.02 ha**	Not significant	Not significant	NA
MWG1d - Mixed wetland species grassland on valley floor	Does not represent any of the wetland definitions outlined in Schedule F Not Threatened	NA	**0.39 ha** 0.37 ha	Not significant	Not significant	Significant (a)(i), (b)
MWG2 - Yorkshire fog-spike sedge grassland on valley floor (Paruauku Swamp)	NA	NA	**0.19 ha** 0.13 ha	NA	NA	Significant (a)(i), (b)
MWG3 - Yorkshire fog-*Isolepis prolifera* grassland on valley floor	Does not represent any of the wetland definitions outlined in Schedule F Not Threatened	NA	**0.02 ha** 0.11 ha	Not significant	Not significant	NA
MWV1 - Blackberry-spike sedge vineland on valley floor	Does not represent any of the wetland definitions outlined in Schedule F Not Threatened	NA	**0.02 ha**	Not significant	Not significant	NA
MWRs1 - Soft rush/Yorkshire fog-spike sedge rushland (Paruauku Swamp)	NA	NA	**0.01 ha**	NA	NA	Significant (a)(i), (b)
EWF1 - Crack willow forest on valley floor (Paruauku Swamp)	NA	NA	**0.01 ha** 0.02 ha	NA	NA	Significant (a)(i), (b), (d)(i)
EWG1 - Floating sweet grass grassland on valley floor	Does not represent any of the wetland habitat definitions outlined in Schedule F Not Threatened	NA	**0.03 ha** 0.03 ha	Not significant	Not significant	NA
EWG2 - Mercer grass grassland on valley floor	Does not represent any of the wetland habitat definitions outlined in Schedule F Not Threatened	NA	**0.11 ha**	Not significant	Not significant	NA

Vegetation/Habitat Type			Area within Project designations (in bold if within construction footprint)	Horizons One Plan (Horizons 2014)		GWRC Regional Policy Statement
Vegetation/Habitat Type	**Equivalent Vegetation Type Listed in Table F.1 in Schedule F and Threat Classification Horizons One Plan**	**Equivalent Terrestrial Ecosystem Type Listed in Forest Ecosystems of the Wellington Region and Their Threat Classification (Greater Wellington Regional Council 2018)**		**Schedule F**	**Policy 13-5**	**Policy 23**
EWG3 - Blue sweetgrass-creeping buttercup grassland on valley floor	Does not represent any of the wetland habitat definitions outlined in Schedule F Not Threatened	NA	0.01 ha	Not significant	Not significant	NA
EWG4 - Mercer grass-water pepper grassland on valley floor	NA	NA	0.05 ha	NA	NA	Significant (a)(i), (b)
EWG5 - Yorkshire fog-creeping buttercup grassland on valley floor	NA	NA	0.01 ha	NA	NA	Significant (a)(i), (b)
EWG6 - Yorkshire fog-creeping buttercup-Mercer grass grassland on valley floor	Does not represent any of the wetland habitat definitions outlined in Schedule F Not Threatened	NA	**0.04 ha** 0.03 ha	Not significant	Not significant	NA
EWG7 - Creeping bent grassland on valley floor	Does not represent any of the wetland habitat definitions outlined in Schedule F Not Threatened	NA	**0.08 ha** 0.02 ha	Not significant	Not significant	NA
EWG8 - Soft rush/Yorkshire fog-creeping buttercup grassland on valley floor	Does not represent any of the wetland habitat definitions outlined in Schedule F Not Threatened	NA	**0.02 ha** 0.008 ha	Not significant	Not significant	NA
EWG9 - Mercer grass-open water grassland on valley floor	Does not represent any of the wetland habitat definitions outlined in Schedule F Not Threatened	NA	**0.002 ha** 0.02 ha	Not significant	Not significant	NA
EWG1d - Exotic grassland in wetland on valley floor	Does not represent any of the wetland habitat definitions outlined in Schedule F Not Threatened	NA	**0.09 ha** 0.04 ha	Not significant	Not significant	NA
MWH1 - Water celery-kikuyu-*Isolepis prolifera* herbfield on valley floor	Does not represent any of the wetland habitat definitions outlined in Schedule F Not Threatened	NA	**0.01 ha** 0.002 ha	Not significant	Not significant	NA
EWH1 - Creeping buttercup herbfield on valley floor (Paruauku Swamp)	NA	NA	**0.01 ha** 0.06 ha	NA	NA	Significant (a)(i), (b)
EWH1d - Creeping buttercup herbfield on valley floor	Does not represent any of the wetland habitat definitions outlined in Schedule F Not Threatened	NA	**0.05 ha** 0.73 ha	Not significant	Not significant	NA
EWH2 - Creeping buttercup-water pepper herbfield on valley floor	Does not represent any of the wetland habitat definitions outlined in Schedule F Not Threatened	NA	**0.05 ha** 0.05 ha	Not significant	Not significant	NA
EWH3 - Water celery herbfield on valley floor (Paruauku Swamp)	NA	NA	**0.35 ha** 0.17 ha	Not significant	Not significant	Significant (a)(i), (b)
EWH4 - Herbfields dominated by water celery on valley floors	Does not represent any of the wetland habitat definitions outlined in Schedule F Not Threatened	NA	**0.06 ha**	Not significant	Not significant	NA
EWH5 - Water pepper herbfield on valley floor (Paruauku Swamp)	NA	NA	**0.07 ha** 0.003 ha	Not significant	Not significant	Significant (a)(i), (b)
EWH6 - Herbfield dominated by water pepper herbfield on valley floors	Does not represent any of the wetland habitat definitions outlined in Schedule F Not Threatened	NA	0.03 ha	Not significant	Not significant	Significant (a)(i), (b)
EWH7 - Water pepper-Mercer grass herbfield on valley floor	Does not represent any of the wetland habitat definitions outlined in Schedule F Not Threatened	NA	**0.01 ha**	Not significant	Not significant	NA

Vegetation/Habitat Type			Area within Project designations (in bold if within construction footprint)	Horizons One Plan (Horizons 2014)		GWRC Regional Policy Statement
Vegetation/Habitat Type	**Equivalent Vegetation Type Listed in Table F.1 in Schedule F and Threat Classification Horizons One Plan**	**Equivalent Terrestrial Ecosystem Type Listed in Forest Ecosystems of the Wellington Region and Their Threat Classification (Greater Wellington Regional Council 2018)**		**Schedule F**	**Policy 13-5**	**Policy 23**
EWH8 - Broadleaved fleabane/Yorkshire fog herbfield on valley floor (Paruauku Swamp)	NA	NA	**0.004 ha** 0.006 ha	NA	NA	Significant (a)(i), (b)
EWH9, EWH9d - Exotic dominant wetland on valley floor	Does not represent any of the wetland habitat definitions outlined in Schedule F Not Threatened	NA	EWH9 **0.41 ha** 0.03 ha EWH9d 0.32 ha	Not significant	Not significant	NA
EWH10, EWH10d - Soft rush/creeping buttercup-Yorkshire fog-Mercer grass herbfield on valley floor	Does not represent any of the wetland habitat definitions outlined in Schedule F Not Threatened	NA	EWH10 **0.05 ha** 0.01 ha EWH10d **0.01 ha** 0.11 ha	Not significant	Not significant	Significant (a)(i), (b)
EWRs1, EWRs1d - Soft rush rushland on valley floor	Does not represent any of the wetland habitat definitions outlined in Schedule F Not Threatened	NA	EWRs1 **0.05 ha** 0.07 ha EWRs1d **0.004 ha** 1.48 ha	Not significant	Not significant	NA
EWRs2 - Soft rush-creeping buttercup-Yorkshire fog rushland on valley floor (Paruauku Swamp)	NA	NA	**0.007 ha**	NA	NA	Significant (a)(i), (b)
EWRs3 - Soft rush-Yorkshire fog rushland (Paruauku Swamp)	NA	NA	**0.03 ha** 0.13 ha	NA	NA	Significant (a)(i), (b)
OW - Open water with New Zealand dabchick	Does not represent any of the habitat definitions outlined in Schedule F Not Threatened	NA	**0.21 ha**	NA	Significant (a)(ii)(A)	NA
OW - Open water	Does not represent any of the habitat definitions outlined in Schedule F Not Threatened	NA	**0.12 ha** 0.62 ha	Not significant	Not significant	Not significant
TG1 - Gravelfield	Does not represent any of the habitat definitions outlined in Schedule F Not Threatened	NA	**0.37 ha** 0.80 ha	Not significant	Significant (a)(i)(A), (a)(iii)(A), (a)(ii)(B)	NA
EHG - House, gardens and farm buildings	Does not represent any of the habitat definitions outlined in Schedule F Not Threatened	Does not represent any of the terrestrial ecosystem types outlined in Forest Ecosystems of the Wellington Region (GWRC 2018) Not Threatened	**12.33 ha** 10.39 ha	Not significant	Not significant	Not significant
ETP - Cropping pasture	Does not represent any of the habitat definitions outlined in Schedule F Not Threatened	Does not represent any of the terrestrial ecosystem types outlined in Forest Ecosystems of the Wellington Region (GWRC 2018) Not Threatened	**312.79 ha**	Not significant	Not significant	Not significant
RRR - River/road/rail	Does not represent any of the habitat definitions outlined in Schedule F Not Threatened	Does not represent any of the terrestrial ecosystem types outlined in Forest Ecosystems of the Wellington Region (GWRC 2018) Not Threatened	**7.37 ha** 4.52 ha	Not significant	Not significant	Not significant
QRY – Quarry	Does not represent any of the habitat definitions outlined in Schedule F Not Threatened	Does not represent any of the terrestrial ecosystem types outlined in Forest Ecosystems of the Wellington Region (GWRC 2018) Not Threatened	**0.09 ha** 0.78 ha	Not significant	Not significant	Not significant

PROJECT SHAPING AND AVOIDING AND MINIMISING EFFECTS

Assessment of highway options

148. The avoidance of adverse ecological effects for the Ō2NL Project has been an iterative process.

149. The alternatives study area was bounded by the sensitive dunes and estuaries, and in the east, the foothills of the ranges. Information was obtained to identify key constraints, and three overall corridors (eastern, central, and western) were identified (refer to Part E of Volume II which provides a Consideration of Alternatives Summary). Multi-criteria analysis was undertaken to evaluate sections of each of the corridors, and four options were selected for further investigation; all four of these more specific route corridors lay to the east of Levin.

150. The selected highway corridor is the preferred one on ecological grounds: it avoids all mature indigenous forest remnants (ITF1 and ITF 2) and one area of old growth indigenous treeland (ITT07) in the project area (refer to the Ecology Drawings in Volume III - Drawings).

151. The selected corridor also avoids Te Waiaruhe Swamp, the largest wetland in close proximity to the Project construction footprint, although numerous small wetlands of varying ecological value cannot be avoided without shifting the corridor further to the east. This is not a viable alternative given the constraints of landscape features such as the Poroporo Range and Otarere Hill.

Refinement of preferred highway design

152. Habitats within the proposed designations were identified, mapped, and assessed for ecological value and significance. Multiple iterations of the preferred highway were then overlaid on this habitat maps to identify areas where additional avoidance of effects could be sought.

153. Further alterations to the design of the preferred alignment have resulted in the avoidance of all mature indigenous forest remnants and high-value tawa-tītoki treeland, including areas of mature indigenous forest that were avoided on request (such as tawa-kohekohe forest on the Staples Block, Property #42). The footprint of the proposed materials supply site (no.34a) on the Spiers property (#519) has also been revised to avoid the wetland that extends along the gully floor. Furthermore, the construction buffer has been

narrowed to avoid most snail habitat that buffers the northern side of the Waikawa Stream.

154. The ecological effects of the Project, including the area of vegetation loss, have been updated based on the latest design (refer to Table J.3).

155. This iterative refinement process has influenced both the final form of the Ō2NL Project designations, and the Ō2NL Project construction footprint (within the designations).

ASSESSMENT OF EFFECTS

Overview

156. The potential effects of the Ō2NL Project on terrestrial and wetland habitats during construction include:

(a) loss of indigenous and exotic vegetation and their associated habitat values for indigenous fauna;

(b) changes in the hydrology or flood regime of natural areas;

(c) sedimentation of wetland habitats;

(d) temporary disturbance of fauna (eg, by light, vibration, movement and/or noise);

(i) dust effects on indigenous vegetation and flora;

(ii) injury to and/or mortality of indigenous birds;

(iii) injury to and/or mortality of indigenous lizards; and

(iv) injury to and/or mortality of indigenous invertebrates.

157. The ongoing operational adverse effects of the Ō2NL Project on terrestrial and wetland ecology include:

(a) increase in edge effects for vegetation and habitats retained;

(b) increase in abundance of pest plants and/or pest animals in habitats retained;

(c) reduced ecological connectivity between natural areas, with potential adverse effects on populations of less-mobile species;

(d) effects of road lighting on indigenous habitats and fauna; and

(e) road kill of indigenous fauna.

158. Each of these effects is described and assessed in detail below. The magnitude of each effect is defined as outlined in the EcIAG and the level of the effects is assessed.

159. A summary table (Table J.3) is provided at the end of this section to illustrate the timeframe, magnitude, and value of the affected ecological feature, and overall level of each of these effects.

Loss of terrestrial and wetland habitats

160. The Ō2NL Project construction footprint covers 3.48 hectares of terrestrial habitats dominated by **indigenous** species, including:

(a) Indigenous treeland (0.23 hectare)

(b) Māhoe-dominant forest and scrub (2.85 hectares)

(c) Planted indigenous forest (0.40 hectare)

161. Other terrestrial vegetation types that are dominated by exotic species cover 8.6 hectares of the Ō2NL Project construction footprint (2.4%), including blackberry vineland (0.9 hectare), rank grassland (0.5 hectare), gorse scrub and gorse-pampas shrubland (0.01 hectare), crack willow (*Salix* x *fragilis*) forest and scrub (0.4 hectare), exotic forest and treeland (6.8 hectares).

162. A further 0.8 hectare of terrestrial habitat comprises mixed indigenous exotic forest and scrub.

163. Wetlands and open water cover a total of 3.84 hectares in the Ō2NL Project construction footprint, including:

(a) Indigenous wetlands (0.37 hectare)

(b) Mixed indigenous exotic wetlands (0.83 hectare)

(c) Exotic-dominated wetlands (2.3 hectares)

(d) Open water (0.34 hectare)

164. With the exception of open water habitats and marginal vegetation associated with farm ponds, the wetlands within the footprint meet the NPSFM definition for natural wetlands. The majority of the wetlands are present on wet valley floors and alluvial flats, and are intermittently to

permanently wet, with a suite of wetland obligate species. There are also wetlands within the Ō2NL Project construction footprint (Property #519) that are hillslope seepages. These wetlands occur on slopes and are fed by groundwater. The Ō2NL Project construction footprint also includes wetlands that are present in stream oxbows.

165. In addition to the habitats within the Ō2NL Project construction footprint, a further 258 hectares of habitats **beyond** the Ō2NL Project construction footprint but **within** the Ō2NL Project designations were identified, mapped, and described. These habitats are included in the assessment so that potential adverse effects (other than direct habitat loss) could be considered.

166. In this assessment, it is assumed that all vegetation and habitats within the Ō2NL Project construction footprint will be lost as a result of construction of the Ō2NL Project. The direct loss of terrestrial indigenous vegetation and habitats, and some exotic vegetation and habitats, will reduce the extent of habitat available for indigenous biodiversity in the Ō2NL Project Area. The areas of terrestrial woody vegetation (ie, forest, treeland, and scrub) in the Ō2NL Project construction footprint are relatively small, modified areas of mixed indigenous-exotic habitats, but all occur on Acutely Threatened Land Environments with less than 10% indigenous cover remaining (at a national level).

167. The Ō2NL Project will generate spoil that will require disposal. A long list of 177 potential spoil sites were subject to a multi-criteria assessment (MCA) process to manage and minimise effects, which is documented in Volume II of the application. Following the MCA, the number of spoil sites was subsequently shortlisted to 92, 11 of which were identified as having potential adverse effects on adjacent wetlands (eg, direct loss or encroaching within ten metres of wetland habitats). A further refinement of the spoil site locations and boundaries resulted in the avoidance of all terrestrial and wetland habitats, noting that most of the sites are located within the Ō2NL Project construction footprint.

168. Four material supply sites have been identified to provide suitable bulk earth fill for construction of road and bridge embankments. The selection of these sites was subject to an assessment process to manage and minimise effects, which is documented in Volume II of the application. None of the proposed material supply sites have a direct adverse impact on terrestrial vegetation and wetlands.

169. There is one location, however, where the proposed material supply site is in close proximity to a gully seepage wetland at property #519 (Site 34A Koputaroa). The original boundary of this spoil site was refined to extend the setback from the wetland. It is entirely within pasture and is unlikely to have any adverse effects on wetland hydrology given it is not within the sub-catchment that feeds seepages on the gully floor and on the southern gully face.

170. Nine laydown areas have been identified within the Ō2NL Project construction footprint. All laydown areas will be situated in areas dominated by exotic grassland, which means adverse effects on terrestrial and wetland habitats will be avoided. It is noted that the boundaries of two laydown areas (properties #463 and 199) were revised to avoid area of exotic-dominated natural wetlands.

171. The effects of terrestrial habitat loss on indigenous fauna are assessed further below with regards to birds, bats, lizards, and invertebrates (Table J.3).

172. The direct loss of 3.53 hectares of wetland habitat (excluding open water habitats) will result in changes in hydrology for receiving environments downstream such as reduced buffering of flow for streams and wetlands immediately downstream of the area of wetland loss. This is the key adverse effect for most of the wetland loss as most of the wetlands in the footprint are grazed, exotic-dominated wetlands of relatively low ecological value. At two locations, wetland loss within the footprint will result in the removal of indigenous wetland vegetation of high ecological value. These wetlands are partially protected from grazing (either due to deeper water, or a low intensity grazing regime), and their loss will result in the removal of habitats that are representative of the former wetlands of the Manawatū Plains Ecological District.

173. The effects of wetland loss on indigenous fauna are further addressed below.

Changes in the hydrology of natural areas

174. Construction of the highway has the potential to alter the hydrology of areas upstream, downstream, or adjacent to, the preferred alignment.

175. Analysis of surface water and ground water flows in relation to the Ō2NL Project was undertaken and is detailed in the Hydrogeology and Groundwater (Technical Assessment G). This involved assessing the

hydrological regime and sensitivity of 69 wetland and forest fragments and varying water sources along the alignment. A detailed analysis of the proposed highway alignment, both vertical and lateral, identified nine wetlands and forest remnants that are connected to groundwater and within a zone where road cuts may intercept and reduce groundwater levels. The expected hydrological effects on each wetland are detailed in Appendix G.1.6 to Technical Assessment G (Hydrogeology and Groundwater).

176. The potential reduction of groundwater flows into the wetlands was assessed as 'Low' for wetlands 12 and 58; 'Moderate' for wetlands 13, 18, and 19; and 'High' for wetlands 67, 70, 71, and 72. All affected wetlands are mapped in the Ecology plans in Volume III – Drawings.

177. Taking a conservative approach, wetland groundwater flow effects assessed as 'Moderate' and 'High' in Appendix G.1.6 are assumed to be lost and will need to be addressed by offsetting (seven wetlands in total comprising a combined area of 0.33 hectare). The extent of loss for each individual wetlands and the measures by which the residual impacts will be addressed are discussed in Table J.3.

Sedimentation of wetland habitats

178. Earthworks and/or vegetation removal upstream or directly adjacent to wetland habitats pose a risk that wetlands receive additional sediment input. This could result in declines in water quality (see Technical Assessment H (Water Quality), or at worst, infilling and a transition to more terrestrial environments. If significant sedimentation of wetlands occurs, this is likely to result in changes in species composition, including increases in abundance of pest plants. (Note that measures to managed the potential effects of sedimentation are described in the Erosion and Sediment Control Plan ("**ESCP**") provided in Appendix Four to Volume II).

Temporary and ongoing disturbance of fauna

179. Noise and vibration - Technical Assessment B (Noise and Vibration), Traffic - Technical Assessment A (Transport), and lighting (Design Construction Report ("**DCR**"), Appendix 4 to Volume II) during construction may all result in the temporary and ongoing disturbance of sensitive fauna. The effects of temporary disturbance are likely to be greatest where construction activities occur directly adjacent to higher value habitats that are to be retained.

180. Temporary disturbance may reduce or prevent the use of habitats for bird nesting during the construction period and may result in changes to lizard and invertebrate behaviours (home range, movement, reproduction, and foraging) and physiological state. This effect is likely to be greatest on the boundary of the construction footprint with indigenous habitats, and dissipate over the first 100 metres of the adjoining habitat.

181. Post-construction, these effects will be reduced to the level caused by the ongoing use of the highway.

Dust effects on indigenous vegetation and flora

182. If not appropriately managed, construction activities can generate dust (such as from earthworks and storage and use of construction material) that could have temporary adverse effects on adjacent indigenous habitats. Heavy dust loads on foliage can reduce photosynthesis, and lead to declines in plant health, particularly if dust levels are high for prolonged periods (Kameswaran *et al*. 2019). Technical Assessment C (Air Quality) reports on the actual and potential effects of dust during construction and proposes a process to manage these to acceptable nuisance levels.

Injury to and/or mortality of indigenous birds

183. Vegetation removal within forests, riverbeds, or wetlands can cause injury to and/or mortality of indigenous birds. Birds are generally most vulnerable to these effects during breeding season.

184. Traffic-related mortalities may occur where birds fly over the road during low light, poor weather conditions, or at night. Birds of prey, such as kāhu (*Circus approximans*) and karearea (*Falco novaeseelandiae ferox*), may not perceive the threat of oncoming vehicles. There is also anecdotal evidence to suggest that kererū (*Hemiphaga novaeseelandiae*) have a daily migration route across the proposed highway (James Lambie and Lindsay Poutama, pers. comms.), which means they are vulnerable to collisions with vehicles when flying east to west from the foothills of the Tararua Range. The placement of roadside stormwater ponds may also increase the risk of bird strike of species which cannot gain flight altitude due to the close proximity of the road to the waterbody.

Injury to and/or mortality of indigenous lizards

185. Vegetation removal and earthworks during construction of the Ō2NL Project is likely to result in the injury or death of some lizards. Lizards are less mobile and their first response is to "hide" when disturbed, and therefore become injured or killed when clearance occurs.

186. This impact can be locally and or regionally significant, due to high abundances that lizards can reach in some habitat types.

Injury to and/or mortality of indigenous invertebrates

187. Vegetation removal during the construction of the Ō2NL Project is likely to result in the injury or death of some terrestrial invertebrates. In particular, *Wainuia urnula*/ngata individuals within crack willow forest/scrub habitat on property #158 (a known population) are likely to be disturbed and/or killed during vegetation clearance.

188. Activities associated with road construction can lead to soil compaction, which may reduce the presence of terrestrial invertebrate habitat through potential increased run off and decreased soil porosity. This may also result in direct mortality to ground dwelling invertebrates.

189. Numerous common invertebrate species are also likely to be directly impacted by habitat removal, including Lepidoptera (moths and butterflies) and Coleoptera (beetles).

Increase in edge effects for vegetation and habitats retained

190. Removal of forest or scrub vegetation results in an increase in edge effects for adjacent vegetation that is retained. Edge effects can include increases in light, wind, and associated desiccation of habitats, which in turn are often associated with biotic changes such as increases in pest animals, reduced habitat quality for invertebrates that prefer moist conditions, and/or changes to vegetation structure and composition.

191. A review of edge effects in New Zealand forests concluded that they are likely to extend 50-100 metres into the forest habitats (Norton 2002). All areas of woody indigenous vegetation within or partly within the Ō2NL Project area are less than 50 metres in width at their narrowest point (for example, the forest remnant at Property #40). As such, all forest, scrub and treeland habitat affected by the Ō2NL Project comprises edge habitat. The

Ō2NL Project will therefore not result in any interior areas of forest and scrub becoming edge habitat. However, vegetation clearance will further exacerbate existing edge effects at some locations.

Increase in abundance of pest plants and or pest animals

192. Construction can result in the arrival of new pest species to a site (eg, through earthwork machinery acting as vectors), and the facilitation of pest establishment (by providing bare surfaces for colonisation). The effects of construction on pest abundance can also persist into the operational phase. If areas subject to earthworks are not adequately rehabilitated with topsoil and plantings, pest plants can become abundant on roadsides, with adverse effects on these habitats. Pest plants on roadsides can also have an adverse effect on adjacent indigenous habitats (retained through project shaping or restored to offset habitat loss), or exotic habitats that are beneficial to indigenous fauna (such as lizards), by acting as a source of propagules. Key pest plant species that could increase in abundance along the highway edges, with associated adverse effects on ecological values, include pampas (*Cortaderia* spp.), radiata pine (*Pinus radiata*), gorse, barberry (*Berberis glaucocarpa*), blackberry and tutsan (*Hypericum androsaemum*).

193. It is likely that increased numbers of predatory mammals and birds will use the new road as a corridor and this may impact on lizard populations as a result.

Reduced ecological connectivity between natural areas, with potential adverse effects on populations of non-mobile species

194. Due to a high level of avoidance of indigenous forest and scrub habitats by the preferred alignment, the potential effects on ecological connectivity primarily relate to how the change from pasture or cropping habitats to road surfaces could alter the movement of species within the vicinity of the Ō2NL Project Area. Most of the indigenous species present in the Ō2NL Project Area that can cross areas of pasture or cropping land (ie, common mobile bird species by flying) are also likely to cross the proposed highway in a similar manner.

195. The potential for movement of less mobile species across pasture gaps (such as ornate skink crossing the 110 metres of pasture between forest habitats at Property #465 and #479, or *Powelliphanta traversi*, if this species is present

here) is less well understood. At times between grazing, when the intervening grass may grow long, movement of fauna between the remnants may occur. Permanent slivers of rough grassland (ie, farm track and road verges) are also likely to act as corridors for dispersal and genetic interchange between subpopulations. If these species do cross pasture between forest remnants, and stop doing so if the intervening land use changes to a road surface, the highway may further isolate small populations of some invertebrate species. This may then increase the risk of localised population extinction.

Effects of road lighting on indigenous habitats and fauna

196. Lighting of roads can have adverse effects on fauna species. The nature of these effects is primarily determined by the extent, type, and duration of lighting, and the vulnerability of the adjacent habitats or fauna to artificial lighting. Artificial lighting can cause changes to habitat use by some species (ie, attraction to or avoidance of lit areas) and can also cause mortality of fauna such as flying invertebrates, if the lighting used generates hot surfaces or by attraction to the road with consequent vehicle collisions.

Road kill of, or injury to, indigenous fauna

197. Direct mortality of flying terrestrial invertebrates is likely to occur through collisions with vehicles using the road following completion of the Ō2NL Project. Research has shown that mortality can be high within invertebrate groups crossing roads, with increasing impacts on populations with high traffic volumes (Muñoz *et al*., 2015).

198. Less likely, but not unknown, are the risk of lizards being infrequently killed on roads as they bask on or cross roads.

MEASURES TO REMEDY OR MITIGATE ACTUAL OR POTENTIAL ADVERSE ECOLOGICAL EFFECTS

199. An Ecology Management Plan ("**EMP**") will be prepared once resource consents are granted and in advance of construction. The scope of this management plan and its preparation process is provided in the proposed resource consent conditions attached as Appendix Seven to Volume II.

200. The EMP will provide a detailed outline of avoidance and minimisation measures, and include sub-plans for vegetation clearance (including vegetation salvage), avifauna, lizards, and terrestrial invertebrates. The key

mitigation measures to reduce the level of adverse ecological effects are outlined below, and further detailed in Table J.3.

201. The EMP will also include a detailed plan for the restoration of habitats to address the offsetting and/or compensation of residual adverse ecological effects. All mitigation measures that are proposed to reduce adverse ecological effects, and taken into consideration for the assessment of the overall level of effect, need to be covered by the designation and/or consent conditions and the (separate) Wildlife Act 1953 permitting requirements for the Ō2NL Project.

202. For ecosystems and habitats, the key minimisation measures to be included in the EMP (or other management plans), and considered in the assessment of the Magnitude of Effects in Table J.3 are as follows:

(a) Clear physical marking of the extent of vegetation clearance (ie, with fencing) to minimise impacts on indigenous vegetation and habitats retained (including, for example, the prevention of the use of these areas as site access or laydown areas). Note that this measure is included in the DCR (Appendix Four to Volume II).

(b) Salvage and reuse of high value vegetation (ie, logs, canopy epiphytes) or soils (ie, peaty wetland soils, forest soils) in adjacent areas of ecological restoration.

(c) Remedial restoration of indigenous vegetation and wetland habitats where these cannot be avoided by construction, and are temporarily removed or modified within the construction buffer.

(d) Pest plant control, where appropriate, to address disturbance effects on adjacent areas of habitat that will be retained.

(e) Ensuring that adequate sediment and erosion control measures are in place to minimise adverse effects of sedimentation, especially in wetland habitats. Note that measures are described in the Erosion and Sediment Control Plan ("**ESCP**") provided in Appendix Four to Volume II.

(f) Monitoring the settlement of construction dust on indigenous vegetation that will be retained, and where necessary, implementing additional dust suppression and control measures. Note that this measure is addressed in Air Quality - Technical Assessment C and provided for in the proposed conditions (Appendix Seven to Volume II).

(g) The use of low-noise road seal and other noise reduction methods (such as noise walls) where needed to address potential effects on high value bird habitats. This measure is described in Technical Assessment B (Noise).

(h) With the exception of the seven wetlands identified as at 'Moderate' and 'High' risk of reduced groundwater in-flows (refer above), ensure that earthworks do not materially alter the existing hydrology and flooding regime of indigenous vegetation and/or wetlands that will be retained, unless this has been assessed as beneficial for that habitat (ie, restoration of former hydrological conditions that have since been altered) (refer to Technical Assessment G (Hydrogeology and Groundwater). **Dr Jack McConchie** (Author of Technical Assessment G) has also advised that monitoring the potential effects of any groundwater drawdown will not be necessary, given that construction and earthworks will have an overall negligible hydrological effect across the Ō2NL Project Area.

(i) Effects on three indigenous-dominated wetland types located at properties #19 and #21 will be mitigated by undertaking **direct transfer** at the point of impact. The vegetation types are rautahi sedgeland (IWSe3, 0.07 hectare), bracken-whekī fernland (IWFn1, 0.03 hectare), and kiokio-spike sedge-kāpūngāwhā sedgeland (IWSe5, 0.04 hectare).

203. For effects on fauna species, including threatened species, the key minimisation measures to be included in the EMP, and considered in the assessment of the Magnitude and Level of Effects in Table J.3, are as follows:

(a) Avoidance of identified fauna habitat where possible.

(b) Where needed and practicable, the establishment of alternative habitats close to the footprint prior to construction, to provide continuity of habitats at locations where Threatened or At Risk fauna affected by the road are present.

(c) Management of vegetation clearance and earthworks at key locations to minimise harm to nesting birds and lizards.

(d) Salvage of lizards and land snails at key sites in the construction footprint to minimise mortality of individuals. A Lizard Management Plan ("**LMP**") and Snail Management Plan ("**SMP**") will be required and will be developed as part of the EMP. The LMP and SMP will describe the following:

(i) identification of specific search sites and target habitat types;

(ii) search methodology and minimum search effort;

(iii) identification of designated relocation sites;

(iv) pre-release habitat enhancement at relocation sites;

(v) pest control at relocation sites;

(vi) habitat enhancement monitoring programme;

(vii) post-release lizard population monitoring programme (if lizards are released into a predator-free location); and

(viii) adaptive management (ie, where contingency action may be needed if lizard numbers do not respond positively to pest-control and habitat enhancement); and

(ix) reporting of outcomes.

204. Addressing permanent habitat loss through establishment of new habitat prior to and during construction. Habitats with vegetation including rough grasslands and shrublands, and rocklands suitable for lizards should be created to complement existing habitat remnants through ecological restoration plans. This habitat creation should be guided by the EMP and is required to restore habitat that is lost within the Ō2NL Project Area.

205. Addressing modification of remaining habitat by minimising habitat fragmentation and isolation through suitable engineering and landscaping planning, including ecological restoration plans. These actions are required to maximise potential habitat availability and connectivity for less mobile fauna, such as lizards.

206. The EMP will include detailed measures to manage pest plant and pest animal species, and should be implemented during construction and for up to two years once the road is operational.

207. Ecological mitigation measures for fauna will require monitoring, where the outcomes of mitigation activities (relocation outcomes, habitat enhancement and connectivity, pest management, wildlife passes) are investigated and reported. Those mitigation activities include:

(a) Maximising habitat connectivity for less mobile (ie, non-flying) fauna species by ensuring connectivity of riparian vegetation and habitats on the banks of streams and rivers crossed by bridges.

(b) Assess any opportunities to maintain habitat connectivity for terrestrial species across the highway, where this is feasible and of significant ecological benefit.

(c) Maximising habitat quality in remaining habitats through pest plant and pest animal control within key habitats.

(d) Planting buffer vegetation on the edge of retained habitats to minimise potential microclimatic changes resulting from edge effects.

(e) Planting buffer vegetation on the edge of the following retained habitats to minimise the potential effects of dust deposition: tawa forest (ITF1), tawa-kohekohe forest (ITF2); puka-kōhūhū forest / planted indigenous forest (ITF5); and tawa-tītoki treeland (ITT07)

(f) Minimising effects on fauna by restricting lighting of the highway to key locations such as major intersections and roundabouts, noting that there could be a small number of new lights included on new and/or upgraded local roads. The approach to lighting is described in the DCR (Appendix Four to Volume II).

(g) Minimising the potential for vehicle collisions for avifauna by:

(i) Planting the margins of the highway with species that do not provide significant sources of nectar or fruit for birds.

(ii) Where stormwater treatment devices, existing wetlands, or forest remnants occur immediately adjacent to the road, designing the plantings so that the vegetation between this habitat and the highway is both tall and dense. These measures will encourage birds to cross the highway at a safe height above vehicles, or to divert their flight paths away from the road. This taller vegetation can be set back from the road margin for road maintenance and health and safety requirements.

(iii) Where needed, the use of fences or other barriers. These could be temporary until planted vegetation reaches heights that encourage birds to take elevated flight paths.

208. An Authority under the Wildlife Act 1953 is required from the Department of Conservation in order to undertake any works that affect indigenous fauna populations, including both impact and mitigation activities. This is a separate statutory process.

Table J.3: Habitat types, ecological values, extent within O2NL Project Area, predicted area of loss, magnitude of effect, and level of effect for the Ō2NL Project Area

Vegetation Structural Class/ Vegetation Type[5]	Code	Ecological Value	Extent of removal	Potential Impacts	Magnitude of Effect in absence of effects management	Level of Effect in absence of effects management	Avoidance and Mitigation Measures	Magnitude of Effect (after Avoidance and Mitigation)	Level of Effect (after Avoidance and Mitigation)
Indigenous Forest									
Tawa forest	ITF1	Very High	**0.00 ha**	Adverse effects of road noise on fauna. Deposition of construction dust on foliage.	Low	Low	The Project construction footprint has avoided the entire site. Use of low-noise roading surface adjacent to remnant. Establish indigenous vegetation as a buffer to the remnant. Monitor dust and implement dust suppression measures if required.	Negligible	Very Low
Tawa-kohekohe forest	ITF2	High	**0.00 ha**	Adverse effects of road noise on fauna. Potential for adjacent cut to lower water table and decrease soil moisture, with associated adverse effects on fauna and compositional changes for the vegetation. Potential for vehicle collisions for birds crossing between forest remnants on either side of the highway. Deposition of construction dust on foliage.	Low	Low	The Project construction footprint has avoided the entire site. Assess groundwater table and options for maintaining existing hydrology (if the groundwater table is high). Note that hydrology team has confirmed that adverse effects on groundwater and surface flows will be avoided. Use of low-noise roading surface adjacent to remnant. Establish indigenous vegetation as a buffer to the remnants. Implement dust suppression measures.	Negligible (based on hydrological analysis that shows no adverse effects on ground water and surface water flows)	Very Low
Tītoki forest	ITF7	High	**0.00 ha**	Potential drawdown of groundwater due to road cut and a corresponding decrease in forest health, and quality of fauna habitat (ornate skink, other lizards, and *Powelliphanta* spp., if present). Increase in road noise. Deposition of construction dust on foliage.	Low	Low	Establish indigenous vegetation as a buffer to the remnant (note that a sufficient buffer will be provided as part of the proposed offset planting adjacent to the site). Undertake pest plant and pest animal control until forest restoration has succeeded in creating new ornate skink habitat and population is sustainable. Supplement soil moisture, if required, with treated road runoff, implement dust suppression measures, design plantings to encourage wildlife passage and flight at greater height across roads. Note that hydrology team has confirmed that adverse effects on groundwater and surface flows will be avoided.	Negligible (based on hydrological analysis that shows no adverse effects on ground water and surface water flows)	Very Low
Kohekohe-tītoki-karamū forest	ITF3	Moderate	**0.00 ha**	Increase in road noise, deposition of construction dust on foliage, potential for disturbance of lizards and *Wainuia* land snails.	Low	Low	Use of low-noise roading surface on bridge. Only outer dripline ($4m^2$) within construction buffer so avoids any felling of kohekohe or titoki trees. Physical delineation to ensure no clearance or trampling of habitat. Dust suppression measures.	Very Low	Very Low

[5] This includes vegetation types and habitat types such as rock outcrops, which may not have a cover of indigenous vegetation.

Vegetation Structural Class/ Vegetation Type[5]	Code	Ecological Value	Extent of removal	Potential Impacts	Magnitude of Effect in absence of effects management	Level of Effect in absence of effects management	Avoidance and Mitigation Measures	Magnitude of Effect (after Avoidance and Mitigation)	Level of Effect (after Avoidance and Mitigation)
Māhoe forest and scrub	ITF4	Moderate	**0.27 ha**	Loss of 90% of vegetation.	Very High	High	Physical delineation to ensure no clearance or trampling of habitat to be retained. Transfer of cut trunks to any adjacent areas of indigenous plantings. Timing of habitat loss to occur outside of the breeding season for forest birds (August-February inclusive) and or pre-clearance nest surveys. Lizard salvage.	Moderate	Moderate
				Reduced connectivity of habitats via forest and scrub (ie, loss of stepping stone habitats). Effects on nesting birds.	Low	Low		Low	Low
				Increase in edge effects and peripheral damage to vegetation during construction.	Low	Low		Negligible	Very low
Planted indigenous forest	ITF5	Moderate	**0.00 ha**	Deposition of construction dust on foliage. Peripheral damage to vegetation during construction	Low	Low	Establish indigenous vegetation as a buffer. Implement dust suppression measures. Physical delineation to ensure no clearance or trampling of habitat that is to be retained.	Negligible	Very low
Planted indigenous forest	ITF6	Moderate	**0.40 ha**	Loss of 100% of vegetation.	Very High	High	Establish linkage plantings between forests at Property #39 and #42. Transfer of cut trunks to any adjacent areas of indigenous plantings for linkage purposes. Timing of habitat loss to occur outside of the breeding season for forest birds (August-February inclusive) and or pre-clearance nest surveys. Lizard salvage.	High	Moderate
				Reduced connectivity of habitats via forest and scrub (ie, loss of stepping stone habitats). Effects on nesting birds.	Low	Low		Moderate	Moderate
Indigenous Treeland									
Tawa-tītoki treeland	ITT07	High	**0.00 ha**	Deposition of construction dust on foliage	Low	Low	The Project construction footprint has avoided the entire site. Establish indigenous vegetation as a buffer. Implement dust suppression measures.	Negligible	Very Low
Kāmahi-kānuka treeland	ITT01	Moderate	**0.004 ha**	Loss of 25% of vegetation.	Low	Low	Implement dust suppression measures. Timing of habitat loss to occur outside of the breeding season for forest birds (August-February inclusive) and or pre-clearance nest surveys.	Low	Low
				Deposition of construction dust on foliage. Effects on nesting birds.	Low	Low		Negligible	Very Low
Tītoki-hīnau-maire treeland	ITT06	Moderate	**0.03 ha**	Loss of 100% of vegetation.	Very High	High	Transfer of cut trunks to any adjacent areas of indigenous plantings. Timing of habitat loss to occur outside of the breeding season for forest birds (August-February inclusive) and / or pre-clearance nest surveys.	High	Moderate
				Reduced connectivity of habitats via forest and scrub "stepping stones". Effects on nesting birds.	Low	Low		Low	Low
Karaka-tawa treeland	ITT02	Moderate	**0.16 ha**	Loss of 100% of vegetation.	High	Moderate	Restoration of indigenous vegetation removed within the construction buffer, exclude livestock and plant indigenous forest species to protect and enhance adjacent areas of treeland to be retained. Transfer of cut trunks to any adjacent areas of indigenous plantings.	High	Moderate
				Reduced connectivity of habitats via forest and scrub "stepping stones". Effects on nesting birds.	Moderate	Moderate		Low	Low

Vegetation Structural Class/ Vegetation Type[5]	Code	Ecological Value	Extent of removal	Potential Impacts	Magnitude of Effect in absence of effects management	Level of Effect in absence of effects management	Avoidance and Mitigation Measures	Magnitude of Effect (after Avoidance and Mitigation)	Level of Effect (after Avoidance and Mitigation)
Indigenous treeland (only one tree species present)	ITT04, ITT05	Low	**0.01 ha**	Loss of 100% of vegetation.	Moderate	Low	Exclude livestock and plant indigenous forest species to protect and enhance adjacent areas of forest to be retained. Transfer of cut trunks to any adjacent areas of indigenous plantings. Timing of habitat loss to occur outside of the breeding season for forest birds (Aug-February inclusive) and/or pre-clearance nest surveys	Moderate	Low
				Reduced connectivity of habitats via forest and scrub "stepping stones". Effects on nesting birds.	Low	Very Low		Negligible	Very low
Indigenous treeland (planted)	ITT03, ITT03d	Low	**0.03 ha**	Loss of 12.5% of vegetation.	Low	Very Low	N/A	Negligible	Very Low
				Reduced connectivity of habitats via forest and scrub "stepping stones".	Low	Very Low			
Indigenous scrub									
Māhoe-karamū scrub	ITS1, ITS1d	Moderate	**2.05 ha**	Loss of 50% of vegetation.	Moderate	Moderate	Exclude livestock and plant indigenous forest species to protect and enhance adjacent areas of forest to be retained. Transfer of cut trunks to any adjacent areas of indigenous plantings. Timing of habitat loss to occur outside of the breeding season for forest birds (Aug-February inclusive) and/or pre-clearance nest surveys. Lizard salvage.	Moderate	Moderate
				Reduced connectivity of habitats via forest and scrub "stepping stones". Potential for disturbance, potential for injury or mortality of birds, arboreal geckos and terrestrial skinks if present.	Low	Low		Negligible	Very low
Mixed indigenous-exotic Scrub									
Barberry scrub with indigenous species in canopy	MTS2, MTS3	Moderate	**0.16 ha**	Loss of 100% of vegetation.	High	Moderate	Use of low-noise roading surface adjacent to remnant, implement dust suppression measures. Timing of habitat loss to occur outside of the breeding season for forest birds (Aug-February inclusive) and/or pre-clearance nest surveys. Exclude livestock, undertake pest plant control, and plant indigenous forest species to protect and enhance adjacent areas of forest to be retained. Transfer of cut trunks to any adjacent areas of indigenous plantings	High	Moderate
				Reduced connectivity of habitats via forest and scrub "stepping stones". Increase in road noise, deposition of construction dust on foliage.	Low	Low		Negligible	Very low
Māhoe-karo scrub with emergent radiata pine	MTS1	Moderate	**0.00 ha**	Deposition of construction dust on foliage. Peripheral damage to vegetation during construction.	Low	Low	Implement dust suppression measures. Physical delineation to ensure no clearance or trampling of habitat to be retained.	Negligible	Very Low
Māhoe-mamaku-blackberry-barberry scrub	MTS4	Moderate	**0.06 ha**	Loss of 100% of vegetation.	High	Moderate	Timing of habitat loss to occur outside of the breeding season for forest birds (Aug-February inclusive) and/or pre-clearance nest surveys. Lizard salvage.	High	Moderate
				Potential for disturbance, injury or mortality of birds and terrestrial skinks.	Low	Low		Negligible	Very Low
Mixed indigenous-exotic forest and or scrub									
Māhoe-barberry-*Muehlenbeckia australis* forest and scrub	MTF1	Moderate	**0.09 ha**	Loss of 100% of vegetation.	High	Moderate	Timing of habitat loss to occur outside of the breeding season for forest birds (Aug-February inclusive) and/or pre-clearance nest surveys. Transfer of cut trunks to any adjacent areas of indigenous plantings.	High	Moderate
				Reduced connectivity of habitats via forest and scrub "stepping stones". Potential for disturbance, injury and/or mortality of birds.	Low	Low		Negligible	Very Low

Vegetation Structural Class/ Vegetation Type[5]	Code	Ecological Value	Extent of removal	Potential Impacts	Magnitude of Effect in absence of effects management	Level of Effect in absence of effects management	Avoidance and Mitigation Measures	Magnitude of Effect (after Avoidance and Mitigation)	Level of Effect (after Avoidance and Mitigation)
Mixed indigenous-exotic forest (Arapaepae Bush)	MTF3, MTF6, MTF7, MTF8	Moderate	**0.00 ha**	Potential drawdown of groundwater due to road cut and a corresponding decrease in forest health, and quality of fauna habitat (ornate skink, other lizards, and *Powelliphanta* spp., if present). Increase in road noise. Deposition of construction dust on foliage.	Low	Low	Establish indigenous vegetation as a buffer to the remnant (note that a sufficient buffer will be provided as part of the proposed offset planting adjacent to the site). Undertake pest plant and pest animal control until forest restoration has succeeded in creating new ornate skink habitat and population is sustainable. Supplement soil moisture, if required, with treated road runoff, implement dust suppression measures, design plantings to encourage wildlife passage and flight at greater height across roads. Note that hydrology team has confirmed that adverse effects on groundwater and surface flows will be avoided.	Negligible (based on hydrological analysis that shows no adverse effects on ground water and surface water flows)	Very Low
Crack willow-māhoe forest and scrub (Ōhau River)	MTF4	Moderate	**0.00 ha**	Deposition of construction dust on foliage. Peripheral damage to vegetation during construction.	Low	Low	Implement dust suppression measures. Physical delineation to ensure no clearance or trampling of habitat to be retained. Remedial works to restore riparian vegetation within construction footprint. Establish indigenous vegetation to buffer and extend habitat retained.	Negligible	Very Low
Māhoe-sweet cherry forest and scrub	MTF2	Low	**0.03 ha**	Loss of 18% of vegetation.	Moderate	Low	Implement dust suppression measures.	Moderate	Low
				Deposition of construction dust on foliage Potential for disturbance, injury and/or mortality of birds.	Low	Very Low	Physical delineation to ensure no clearance or trampling of habitat to be retained. Timing of habitat loss to occur outside of the breeding season for forest birds (Aug-February inclusive) and/or pre-clearance nest surveys.	Negligible	Very low
Karaka-māhoe-kawakawa forest and scrub (desktop only)	MTF6d	Moderate	**0.47 ha**	Loss of 71% of vegetation.	High	Moderate	Implement dust suppression measures.	High	Moderate
				Deposition of construction dust on foliage. Potential for disturbance, injury and/or mortality of birds.	Low	Low	Timing of habitat loss to occur outside of the breeding season for forest birds (Aug-February inclusive) and/or pre-clearance nest surveys.	Negligible	Very low
Mixed indigenous-exotic forest (planted)	MTF5	Low	**0.52 ha**	Loss of 30% of vegetation.	Moderate	Low	Implement dust suppression measures.	Moderate	Low
				Deposition of construction dust on foliage. Potential for disturbance, injury and/or mortality of birds.	Low	Very Low	Physical delineation to ensure no clearance or trampling of habitat to be retained. Timing of habitat loss to occur outside of the breeding season for forest birds (Aug-February inclusive) and/or pre-clearance nest surveys.	Negligible	Very low
Indigenous Wetland									
Kiokio fernland	ITFn01	Moderate	**0.01 ha**	Loss of 100% of vegetation. Loss of buffering for wetland habitats retained.	Very High	High	Transfer of wetland soils and vegetation (direct transfer) to adjacent wetland restoration areas supplemented with additional wetland planting).	Low to Very Low (based on ability to successfully undertake direct transfer of vegetation)	Low to Very Low

Vegetation Structural Class/ Vegetation Type[5]	Code	Ecological Value	Extent of removal	Potential Impacts	Magnitude of Effect in absence of effects management	Level of Effect in absence of effects management	Avoidance and Mitigation Measures	Magnitude of Effect (after Avoidance and Mitigation)	Level of Effect (after Avoidance and Mitigation)
Bracken-whekī fernland	IWFn1	High	**0.03 ha**	Loss of 100% of vegetation.	Very High	Very High	Transfer of wetland soils and vegetation (direct transfer) to adjacent wetland restoration areas supplemented with additional wetland planting. Timing of habitat loss to occur outside of the breeding season for wetland birds (Aug-March inclusive) and/or pre-clearance nest surveys. Lizard survey then determine need for salvage programme	Low to Very Low (based on ability to successfully undertake direct transfer of vegetation)	Low to Very Low
				Reduced connectivity of wetland habitats for species that require dense wetland vegetation, potential for disturbance, injury or mortality of birds and terrestrial skinks.	Low	Low		Negligible	Very low
Raupō reedland	IWRe1	High	**0.12 ha**	Loss of 100% of vegetation.	Very High	Very High	Timing of habitat loss to occur outside of the breeding season for wetland birds (Aug-March inclusive) and/or pre-clearance nest surveys.	Very High	Very High
				Reduced connectivity of habitats via wetland "stepping stones". Potential for disturbance, injury and/or mortality of spotless crake and/or marsh crake.	High	Very High		Moderate	High
Isolepis prolifera sedgeland on the valley floor	IWSe1	Moderate	**0.02 ha**	Loss of 100% of vegetation.	High	Moderate	Restoration of wetland vegetation removed within the construction buffer. Physical delineation to ensure no clearance or trampling of adjacent wetland habitats beyond the footprint of work.	High	Moderate
				Reduced connectivity of habitats via wetland "stepping stones".	Moderate	Moderate		Moderate	Moderate
Isolepis prolifera sedgeland within a seepage wetland	IWSe1-SPG (W67), IWSe1d-SPG	Moderate	**0.09 ha** (of which **W67** comprises **0.1 ha**)	Loss of 25% of vegetation.	Moderate	Moderate	Restoration of wetland vegetation removed within the construction buffer. Physical delineation to ensure no clearance or trampling of adjacent wetland habitats beyond the footprint of work.	Moderate	Moderate
				Reduced connectivity of habitats via wetland "stepping stones".	Low	Low		Low	Low
				Potential drainage and or modification due to adjacent earthworks causing a drawdown of groundwater levels.	Moderate	Moderate	Hydrology team has confirmed assessed that there will be a high likelihood of reduced groundwater wetland 67.	Moderate	Moderate
Isolepis prolifera-kiokio-spike sedge sedgeland on valley floor	IWSe2	Moderate	**0.11 ha**	Loss of 100% of vegetation.	High	Moderate	Physical delineation to ensure no clearance or trampling of adjacent wetland habitats beyond the footprint of work. Transfer of wetland soils and vegetation (direct transfer) to adjacent wetland restoration areas supplemented with additional wetland planting.	Low	Low
				Reduced connectivity of habitats via wetland "stepping stones".	Moderate	Moderate			
Indigenous sedgeland on valley floor (Paruauku Swamp)	IWSe3, IWSe4, IWSe5	Moderate	**0.07 ha**	Loss of 67% of vegetation.	High	Moderate	Physical delineation to ensure no clearance or trampling of adjacent wetland habitats beyond the footprint of work. Transfer of wetland soils and vegetation (direct transfer) to adjacent wetland restoration areas supplemented with additional wetland planting.	Low	Low
				Reduced connectivity of wetland habitats for species that require dense wetland vegetation	Moderate	Low			
Mixed indigenous-exotic wetland									
Kiokio-spike sedge-Yorkshire fog fernland	MWFn1	Moderate	**0.07 ha**	Loss of 88% of vegetation.	High	Moderate	Physical delineation to ensure no clearance or trampling of adjacent wetland habitats beyond the footprint of work. Transfer of wetland soils and vegetation (direct transfer) to adjacent wetland restoration areas supplemented with additional wetland planting. Restoration of wetland vegetation removed within the construction buffer. Control of sediments entering wetland.	Low to Very Low (based on ability to successfully undertake direct transfer of vegetation)	Low to Very Low
				Reduced viability of small area of wetland habitat retained, potential for disturbance, injury and/or mortality of birds and terrestrial skinks.	High	Moderate			

Vegetation Structural Class/ Vegetation Type[5]	Code	Ecological Value	Extent of removal	Potential Impacts	Magnitude of Effect in absence of effects management	Level of Effect in absence of effects management	Avoidance and Mitigation Measures	Magnitude of Effect (after Avoidance and Mitigation)	Level of Effect (after Avoidance and Mitigation)
Isolepis prolifera-soft rush sedgeland within a seepage wetland	MWSe1-SPG (W70), MWSe1-SPGd (W71)	Moderate	**0.07 ha** (of which **W70** comprises **0.01 ha** and **W71** comprises **0.02 ha**)	Loss of 94% of vegetation.	Moderate	Moderate	Physical delineation to ensure no clearance or trampling of adjacent wetland habitats beyond the footprint of work. Transfer of wetland soils and vegetation (direct transfer) to adjacent wetland restoration areas supplemented with additional wetland planting. Restoration of wetland vegetation removed within the construction buffer. Control of sediments entering wetland.	Moderate	Moderate
				Potential drainage and or modification due to adjacent earthworks causing a drawdown of groundwater levels.	Moderate	Moderate	Hydrology team has assessed that there will be a high likelihood of reduced groundwater flows into wetlands 70 and 71.	Moderate	Moderate
Grazed wetlands dominated by *Isolepis prolifera*, Yorkshire fog and/or spike sedge; wetlands assessed by desktop exercise	MWG1, MWG1d, MWSe2, MWSe3	Moderate	**0.51 ha**	Loss of 57% of vegetation.	Moderate	Moderate	Physical delineation to ensure no clearance or trampling of adjacent wetland habitats. Restoration of wetland habitats modified within the construction buffer.	Moderate	Moderate
				Reduced connectivity of habitats via wetland "stepping stones".	Moderate	Moderate		Moderate	Low
Blackberry-spike sedge vineland	MWV1	Moderate	**0.02 ha**	Loss of 100% of vegetation.	High	Moderate	Physical delineation to ensure no clearance or trampling. Timing of habitat loss to occur outside of the breeding season for wetland birds (Aug-March inclusive) and/or pre-clearance nest surveys	High	Moderate
				Reduced connectivity of habitats for wetland species. Potential for disturbance, injury and/or mortality of birds.	Moderate	Moderate		Moderate	Moderate
Pūrei-spike sedge-Yorkshire fog sedgeland on valley floor (Paruauku Swamp)	MWSe4	Moderate	**0.01 ha**	Loss of 100% of vegetation.	High	Moderate	Undertake restoration planting to offset residual loss of vegetation. Restoration of indigenous wetland vegetation removed within the construction buffer. Physical delineation to ensure no clearance or trampling of adjacent wetland habitats beyond the footprint of work. Transfer of wetland soils and vegetation (direct transfer) to adjacent wetland restoration areas.	Low to Very Low (based on ability to successfully undertake direct transfer of vegetation)	Low to Very Low
				Reduced connectivity of wetland habitats for species that require dense wetland vegetation. Increase in road noise, deposition of construction dust on foliage. Potential for disturbance, injury and/or mortality of birds.	Moderate	Moderate		Low	Low
Yorkshire fog-spike sedge grassland on valley floor (Paruauku Swamp and Te Waiaruhe Swamp)	MWG2, MWG3 (W58)	Moderate	**0.21 ha**	Loss of 59% of vegetation.	Moderate	Moderate	Restoration of indigenous wetland vegetation removed within the construction buffer. Physical delineation to ensure no clearance or trampling of adjacent wetland habitats beyond the footprint of work. Lizard survey then determine need for salvage programme. Timing of habitat loss to occur outside of the breeding season for wetland birds (Aug-March inclusive) and/or pre-clearance nest surveys.	Moderate	Moderate
				Reduced connectivity of habitats for wetland species. Potential for disturbance, injury or mortality of birds and terrestrial skinks if rough grassland present.	Low	Low		Negligible	Very low
				Potential drainage and or modification due to adjacent earthworks causing a drawdown of groundwater levels.	Negligible	Very low	Hydrology team has assessed that there will be a low likelihood of reduced groundwater flows into wetland 58, which forms part of the upper reaches of Te Waiaruhe Swamp.	Negligible	Very low
	MWRs1	Moderate	**0.01 ha**	Loss of 100% of vegetation.	High	Moderate		High	Moderate

Vegetation Structural Class/ Vegetation Type[5]	Code	Ecological Value	Extent of removal	Potential Impacts	Magnitude of Effect in absence of effects management	Level of Effect in absence of effects management	Avoidance and Mitigation Measures	Magnitude of Effect (after Avoidance and Mitigation)	Level of Effect (after Avoidance and Mitigation)
Soft rush/Yorkshire fog-spike sedge rushland (Paruauku Swamp)				Potential for disturbance, injury or mortality of birds and terrestrial skinks if rough grassland present.	Low	Low	Timing of habitat loss to occur outside of the breeding season for wetland birds (Aug-March inclusive) and/or pre-clearance nest surveys. Lizard survey then determine need for salvage programme	Negligible	Very low
Exotic Wetland									
Crack willow forest on valley floor (Paruauku Swamp)	EWF1	Moderate	**0.01 ha**	Loss of 33% of vegetation	Moderate	Moderate	Control of sediments entering wetland.	Moderate	Moderate
				Potential changes to hydrology and flood regime. Potential for disturbance, injury and/or mortality of birds.	Low	Low	Restoration of indigenous wetland vegetation removed within the construction buffer. Assess potential positive or adverse effects of embankment *c.*80 metres downstream. Timing of habitat loss to occur outside of the breeding season for wetland birds (Aug-March inclusive) and/or pre-clearance nest surveys. Hydrology team has confirmed that adverse effects on groundwater and surface flows will be avoided**.**	Negligible	Very Low
Water celery-kikuyu-*Isolepis prolifera* herbfield on valley floor	MWH1	Moderate	**0.01 ha**	Loss of 100% of vegetation.	Moderate	Moderate	Timing of habitat loss to occur outside of the breeding season for wetland birds (Aug-March inclusive) and/or pre-clearance nest surveys. Restoration of indigenous wetland vegetation removed within the construction buffer.	Moderate	Moderate
				Reduced connectivity of habitats for wetland species. Potential for disturbance, injury and/or mortality of birds.	Low	Low		Negligible	Very Low
Wetlands dominated by exotic grasses	EWG1-9 (includes W12 and W13), EWG1d	Low	**0.75 ha** (of which **W12** comprises **0.01 ha** and **W13** comprises **0.05 ha**)	Loss of 45% of vegetation.	Moderate	Low	Physical delineation to ensure no clearance or trampling of adjacent wetland habitats. Restoration of wetland habitats removed within the construction buffer. Hydrology team has assessed that there will be a low likelihood of reduced groundwater flows into wetland 12 and a moderate likelihood of reduced groundwater flows into wetland 13.	Moderate	Low
				Potential drainage and or modification due to adjacent earthworks causing a drawdown of groundwater levels.	Moderate for W13 and Low for W12	Low for W13 and Very low of W12		Moderate for W13 and Low for W12	Low for W13 and Very low of W12
Wetlands dominated by exotic herbs (Paruauku Swamp)	EWH1, EWH3, EWH5 EWH6 (includes W18 and W19) EWH8	Moderate	**0.50 ha** (of which **W18** comprises **0.003 ha** and **W19** comprises **0.03 ha**)	Loss of 78% of vegetation.	Moderate	Moderate	Physical delineation to ensure no clearance or trampling of adjacent wetland habitats. Timing of habitat loss to occur outside of the breeding season for wetland birds (Aug-March inclusive) and/or pre-clearance nest surveys Restoration of wetland habitats removed within the construction buffer.	Moderate	Moderate
				Reduced connectivity of wetland habitat and reduced buffering to adjacent wetlands.	Moderate	Moderate		Low	Low
				Potential drainage and or modification due to adjacent earthworks causing a drawdown of groundwater levels.	Moderate	Moderate	Hydrology team has assessed that there will be a moderate likelihood of reduced groundwater flows into wetlands 18 and 19.	Moderate	Moderate
Wetlands dominated by exotic herbs (other)	EWH1d, EWH2, EWH4, EWH9-10, EWH9d, EWH10d (W72)	Low	**0.86** ha (of which **W72** comprises **0.12 ha**)	Loss of 57% of vegetation.	Moderate	Low	Physical delineation to ensure no clearance or trampling of adjacent wetland habitats. Timing of habitat loss to occur outside of the breeding season for wetland birds (Aug-March inclusive) and/or pre-clearance nest surveys. Restoration of wetland habitats removed within the construction buffer.	Moderate	Low
				Reduced connectivity of wetland habitat and reduced buffering to adjacent wetlands.	Moderate	Low		Low	Very low
				Potential drainage and or modification due to adjacent earthworks causing a drawdown of groundwater levels.	Moderate	Moderate	Hydrology team has assessed that there will be a high likelihood of reduced groundwater flows into wetland 72.	Moderate	Moderate

Vegetation Structural Class/ Vegetation Type[5]	Code	Ecological Value	Extent of removal	Potential Impacts	Magnitude of Effect in absence of effects management	Level of Effect in absence of effects management	Avoidance and Mitigation Measures	Magnitude of Effect (after Avoidance and Mitigation)	Level of Effect (after Avoidance and Mitigation)
Wetlands dominated by exotic rushes (Paruauku Swamp)	EWRs2 EWRs3	Moderate	**0.04 ha**	Loss of 100% of vegetation Moderate	High	Moderate	Physical delineation to ensure no clearance or trampling of adjacent wetland habitats. Timing of habitat loss to occur outside of the breeding season for wetland birds (Aug-March inclusive) and or pre-clearance nest surveys.	High	Moderate
				Reduced connectivity of habitats for wetland species. Potential for disturbance, injury and/or mortality of birds.	Moderate	Moderate		Low	Low
Wetlands dominated by exotic rushes (other)	EWRs1, EWRs1d	Low	**0.05 ha**	Loss of 100% of vegetation.	High	Low	Physical delineation to ensure no clearance or trampling of adjacent wetland habitats. Timing of habitat loss to occur outside of the breeding season for wetland birds (Aug-March inclusive) and/or pre-clearance nest surveys	High	Low
				Reduced connectivity of habitats for wetland species. Potential for disturbance, injury and/or mortality of birds.	Moderate	Low		Low	Very low
Open water	OW	Moderate	**0.34 ha**	Loss of 44% of open water habitat.	Moderate	Moderate	Timing of habitat loss to occur outside of the breeding season for wetland birds (Aug-March inclusive) and/or pre-clearance nest surveys.	Moderate	Moderate
				Reduced connectivity of habitats for open water species. Potential for disturbance, injury and/or mortality of birds.	Moderate	Moderate		Low	Low
Gravelfield									
Gravelfield	TG1	Moderate	**0.37 ha**	Potential changes to hydrology and flood regime due to bridge support structures, shading of river bed.	Moderate	Moderate	Design bridge supports to minimise effects on river bed morphology.	Low	TBC
Exotic Forest and Treeland									
Crack willow forest/scrub (riparian)	ETF1	Low	**0.40 ha**	Loss of vegetation along a Schedule F river (35% of total vegetation type)	Moderate	Low	Physical delineation to ensure no clearance or trampling of adjacent habitat retained. Remedial works to restore riparian vegetation within construction footprint (Ōhau River). Timing of habitat loss to occur outside of the breeding season for wetland birds (Aug-March inclusive) and/or pre-clearance nest surveys.	Moderate	Low
				Loss of riparian buffering (Ōhau River). Potential for disturbance, injury and/or mortality of birds.	Low	Very low		Negligible	Very Low
Exotic forest at Arapaepae (habitat for ornate skink and possibly *Powelliphanta* spp.)	ETF5, ETF6, ETF7, ETF8	Moderate	**0.00 ha**	Potential drawdown of groundwater due to road cut and a corresponding decrease in forest health, and quality of fauna habitat. Increase in deposition of construction dust on foliage.	Low	Low	Hydrology team has confirmed that adverse effects on groundwater and surface flows will be avoided**.** Implement dust suppression measures.	Negligible	Very Low
Eucalyptus forest	ETF2	Low	**0.30 ha**	NA					
Radiata pine forest (riparian)	ETF3	Low	**0.20 ha**	NA			NA		
Radiata pine forest	ETF3	Low	**0.24 ha**	Potential for disturbance, injury or mortality of birds and lizards, however, low likelihood.	Low	Very Low	Physical delineation to ensure no clearance or trampling of adjacent habitat retained. Timing of habitat loss to occur outside of the breeding season for forest birds (Aug-February inclusive) and/or pre-clearance nest surveys. Lizard survey then determine inclusion in salvage programme.	Negligible	Very Low
Exotic treeland and forest (other)	ETF4, ETF4d, ETF1	Low	**5.90 ha**	Estimated loss of exotic treeland and forest containing indigenous vegetation is 0.68 ha	Moderate	Low	Physical delineation to ensure no clearance of adjacent indigenous trees to be retained.	Moderate	Low

Vegetation Structural Class/ Vegetation Type[5]	Code	Ecological Value	Extent of removal	Potential Impacts	Magnitude of Effect in absence of effects management	Level of Effect in absence of effects management	Avoidance and Mitigation Measures	Magnitude of Effect (after Avoidance and Mitigation)	Level of Effect (after Avoidance and Mitigation)
				Potential for Loss of woody vegetation "stepping stones" for indigenous fauna, and in particular forest birds.	Moderate	Low	Timing of habitat loss to occur outside of the breeding season for forest birds (Aug-February inclusive) and/or pre-clearance nest surveys. Woody vegetation planted alongside the road for landscape purposes.	Low	Very low
Exotic Scrub									
Crack willow-brush wattle-tree lucerne scrub	ETS1	Moderate	**0.00 ha**	NA			NA		
Scrub dominated by gorse	ETS2, ETS3	Low	**0.01 ha**	Loss of 5% of vegetation.	Negligible	Very Low	NA		
Exotic vineland									
Blackberry vineland	ETV1	Low	**0.93 ha**	NA			NA		
Houses and gardens									
House, gardens and farm buildings	EHG	Negligible	**12.3 ha**	NA			NA		
Pasture and Cropping									
Pasture and Cropping land	ETP	Negligible	**328.4 ha**	NA			NA		
Rank grassland	ETG1	Low	**0.48 ha**	Loss of riparian buffering along Waikawa Stream and Ōhau River (both Schedule F watercourses).	Moderate	Low	Remedial works to restore riparian vegetation within construction footprint.	Negligible	Very Low
Roads									
Road, Rail, Rivers	RRR	Negligible	**7.37 ha**	NA			NA		
Quarry	QRY	Negligible	**0.1 ha**	NA			NA		

RESIDUAL ADVERSE ECOLOGICAL EFFECTS

209. Most of the Ō2NL Project construction footprint encompasses cropping or pasture land or, to a much lesser extent, woody exotic vegetation of low ecological value (ie, radiata pine forest, gorse scrub, crack willow forest, planted exotic treeland). Consequently, the levels of residual ecological effects on the majority of habitats within the footprint of the Ō2NL Project (with mitigation) are Negligible, Very Low or Low (Table J.3).

Indigenous forest, treeland and scrub habitats

210. The Ō2NL Project construction footprint has avoided all direct effects (ie, clearance) on indigenous forest, treeland, and scrub of High or Very High value. As a consequence of this avoidance, together with mitigation measures such as dust suppression and plantings to buffer these habitats from the adjacent highway, the overall level of effects for High or Very High value forest and treeland habitats after mitigation measures are implemented is Very Low.

211. There was initially concern over the potential residual hydrological effects on tītoki forest (ITF7) of High ecological value. The dependence of this forest remnant on groundwater is unknown, and the habitat may be located beside a road cutting. However, advice provided by Dr McConchie (and as reported in Technical Assessment G (Hydrogeology and Groundwater) indicated that there are highly unlikely to be adverse effects on groundwater and surface flow along the alignment. This particular area of forest is referenced as 'Object Identifier 36' in Appendix G.1.6 to Technical Report G and has been assessed as having no risk of reduced groundwater in-flows. The level of ecological effect of the road on tītoki forest and contiguous vegetation types has therefore been assessed as Very Low.

212. Selection of a preferred alignment that avoids High and Very High value forest habitats has resulted in the selection of a route that inevitably passes through adjacent terrestrial habitats of Low to Moderate ecological value. That is to say, in order to avoid forest remnants on either side of the highway, the footprint includes intervening areas of lower value indigenous treeland and scrub habitats. In most of these cases, small areas of indigenous treeland or scrub, or planted areas of indigenous forest of Low to Moderate value, are partly or completely removed by works within the Ō2NL Project construction footprint. Opportunities to minimise adverse ecological effects

for these features are limited, and the removal of these terrestrial habitats results in Very Low, Low, or Moderate residual effects. It is anticipated that offsetting activities to address the residual loss of these vegetation types will result in a Net Gain in biodiversity. Offsetting measures are discussed later in this assessment.

Mixed indigenous-exotic forest and scrub

213. The residual effects of the Ō2NL Project for four mixed indigenous exotic forest and scrub habitats was assessed as Very Low or Low (prior to offsetting). These four habitats are of Low to Moderate value and lie partly within the Ō2NL Project construction footprint.

214. The residual effects on māhoe-barberry-*Muehlenbeckia australis* forest and scrub was assessed as Moderate to High as the scrub included mature pukatea trees and is entirely within the Ō2NL Project construction footprint.

215. The residual effects were assessed as Low for one area of mixed indigenous-exotic forest Arapaeapae Bush of Moderate ecological value. This vegetation type provides habitat for an At Risk lizard (ornate skink), and potentially *Powelliphanta traversi.* Both of these species are reliant on moist habitats, and the habitats are located adjacent to a road cutting.

216. As discussed above, it is not anticipated that the Ō2NL Project will adversely affect groundwater within these habitats.

Exotic terrestrial vegetation

217. Residual effects for exotic forest within Arapaepae Bush was assessed as Low due to potential changes in groundwater levels and soil moisture, and the barrier effect of the highway on fauna, noting that this is habitat for ornate skink and potentially *Powelliphanta traversi.*

218. The residual effects for all other exotic terrestrial vegetation are Very Low or Low.

Wetland habitats

219. The O2NL Project construction footprint includes 3.47 hectares of wetland habitats of Low to High ecological value. This extent is exclusive of open water habitat in ponds (0.34 hectare).

220. Most of the wetlands within the Ō2NL Project Area are small, and within or partly within the Ō2NL Project construction footprint. As such, the most common scenario is complete removal of each area of habitat, and opportunities to minimise adverse effects on remaining habitat are therefore limited.

221. Approximately 0.37 hectare of indigenous wetland habitat lies within or partly within the Ō2NL Project construction footprint. The residual effects for these wetland areas were assessed as Very High for two wetlands of High ecological value, and further discussed in the 'Limits to Offsetting' section below:

(a) Raupō reedland (0.12 hectare, 0.12 hectare of loss)

(b) Bracken-whekī fernland (0.03 hectare, 0.03 hectare of loss)

222. The residual adverse effects for the remaining areas of indigenous wetland are Moderate.

223. For areas of mixed indigenous exotic wetlands (totalling 0.80 hectare) within the route, all of which are of Moderate ecological value, the level of residual effects is Moderate.

224. The level of residual effects for exotic dominated wetlands (totalling 2.3 hectares) within the route are Low to Moderate.

Birds

225. The level of residual effects for birds after minimisation measures have been applied range from Very Low to Moderate (refer to Avifauna Technical Assessment in Appendix J.5).

226. The residual effects on puweto/spotless crake and koitareke/marsh crake are Low, after minimisation measures have been applied, noting measures to establish raupō reedland in close proximity to the impact site at Property #519, together with supplementary wetland planting, are considered likely to benefit local crake populations.

227. The residual effects on Australasian bittern have been assessed as Moderate for mortality during vegetation clearance, reduction in habitat connectivity, mortality due to vehicle collisions, and disturbance by noise.

228. The residual effects on birds of river habitats were assessed as Low to Moderate.

229. The residual adverse effects for all other bird species were assessed as Very Low to Low.

Terrestrial invertebrates

230. Following the implementation of effects minimisation actions, it is expected that the level of residual effects on terrestrial invertebrates will be Negligible to Moderate (refer to Invertebrates Technical Assessment in Appendix J.7). Moderate effects relate to:

(a) Direct mortality of *Wainuia urnula* (land snail) during vegetation clearance. While a SMP is proposed to salvage snails in key habitats, the highly cryptic nature of this species means that there is a high likelihood some individuals will not be found and relocated.

(b) Reduction of habitat connectivity and exacerbated edge effects for *Powelliphanta* spp. (giant land snails).

(c) Increased predation pressure on *Powelliphanta* spp. as a result of heightened pest animal presence.

Lizards

231. The level of residual effects for lizards is assessed range from Negligible (for mortality or injury on roads) to Moderate (for the reduction of habitat connectivity through fragmentation and introduction of new barriers) (refer to Lizards Technical Assessment in Appendix J.6). This assessment is on the basis that:

(a) Lizard salvage and relocation programmes tend not to capture all individuals within any population at targeted salvage sites. This is because lizards are highly cryptic and can be difficult to detect. This will result in injuries to and death of a significant number of lizards. As there are a number of potential sites with lizards present within the Ō2NL Project Area, the effect will be cumulative over the entire alignment.

(b) It is not possible to cover all sites that contain potential lizard populations during a lizard salvage programme.

(c) Reduced habitat connectivity due to the development of a new barrier and a wide highway.

(d) Increased predator pressure as a result of increased pest animal presence (both mammalian and avian).

Bats

232. While there is potential bat roosting habitat within the Ō2NL Project Area, no bats were detected during the survey carried out in March 2021. The survey effort used complies with the Department of Conservation protocols for surveys in areas where bats have not been previously recorded. A lack of bat detections indicates that bats are not using the available habitat in the area. As such, there are not expected to be any residual effects on indigenous bats within the Ō2NL Project Area.

BIODIVERSITY OFFSETTING AND COMPENSATION MEASURES

Introduction

233. I have referred to the following publications in order to design a robust and well-developed offset and compensation response for the Ō2NL Project:

(a) Guidance on Good Practice Biodiversity Offsetting in New Zealand (Department of Conservation 2014);

(b) Business and Biodiversity Offsets Programme (BBOP). 2009. Principles on Biodiversity Offsets. BBOP, Washington, D.C. (Forest Trends 2009);

(c) A biodiversity offsets accounting model for New Zealand: User manual (Maseyk *et al*. 2015);

(d) Biodiversity Offsetting under the Resource Management Act (Maseyk *et al*. 2018); and

(e) Discounting for Biodiversity Offsets (Denne and Bon-Smith 2011).

234. Biodiversity offsets are defined as:

> *"Measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development after appropriate prevention and mitigation measures have been taken"* (Forest Trends 2009).

235. The goal of biodiversity offsets is to:

> *"….to achieve No Net Loss and preferably a Net Gain of biodiversity on the ground with respect to species composition, habitat structure, ecosystem function and people's use and cultural values associated with biodiversity"* (Forest Trends 2009).

236. Biodiversity offsets are not mitigation as they do not occur at the point of impact but are undertaken elsewhere to create a positive effect.

237. Environmental compensation differs from biodiversity offsetting in that it is not necessarily designed to demonstrate a No Net Loss outcome. As such, compensation carries the greatest risk for biodiversity outcomes and is the last resort in the effects management hierarchy (Maseyk *et al*. 2018).

238. The two main approaches most often used to achieve biodiversity gains at an offset site are: (i) <u>enhancement</u> of an existing habitat to improve its condition (improving ecosystem function and resilience) and (ii) <u>creation</u> of habitat through new plantings (increasing ecosystem extent, and over time, improving ecosystem function).

239. Exchanging area for condition is *"… designed to achieve no net loss [and] may focus on improving the condition of biodiversity through activities such as pest control, through creating new habitat or through averting loss",* whereas habitat creation *"…typically involves restoration plantings of species that form early stages of succession towards a desired final habitat"* (Department of Conservation 2014).

Biodiversity Offset and Accounting Model

240. The Biodiversity Offset and Accounting Model ("**BOAM**") presented in the Guidance on Good Practice Biodiversity Offsetting in New Zealand was used in calculating biodiversity offsets for the Project. The BOAM is similar to the approach used by the Stream Ecological Valuation (SEV) method to address the loss of aquatic habitats. The SEV method is described and applied in the assessment prepared by **Dr Alex James** (Technical Assessment K (Freshwater Ecology)).

241. In summary, the BOAM:

(a) Accounts only for 'like for like' biodiversity trades aimed at demonstrating No Net Loss (the model does not address 'like for unlike' exchanges);

(b) Relies on three hierarchical levels to categorise biodiversity (biodiversity types, biodiversity components, and biodiversity attributes);

(c) Calculates net present biodiversity value ("**NPBV**") or individual biodiversity attributes and an average NPBV across the range of attributes representing a biodiversity component;

(d) Uses NPBV to estimate whether No Net Loss is achieved in the exchange (with project level No Net Loss being demonstrated when all components demonstrate No Net Loss) for individual biodiversity attributes and average NPBV across the range of attributes representing a biodiversity component; note, this can mean net loss for some attributes, so long as there is no net loss of average NPBV.

(e) Incorporates the use of a discount rate; and

(f) Adjusts for uncertainty of success regarding the proposed offset actions.

242. The robustness of the BOAM outputs depends on the quality of the inputs (such as field data, assumptions used, and level of confidence) and the decisions to place attributes into biodiversity components. Data or assumptions that are incorrect can result in the BOAM producing ‘false positives’, whereby No Net Loss or Net Gain has been erroneously demonstrated when in fact the opposite may be true.

243. In this regard, I have discussed our approach to the BOAMs with Mr James Lambie (Horizons), particularly with respect to the biodiversity components and biodiversity attributes to be used as inputs into the models for terrestrial, wetland, and open water habitats. As suggested by Mr Lambie, I have incorporated biodiversity attributes for fauna resources into the BOAMs for terrestrial habitats. It is noted that the addition of fauna resources has generally resulted in an increase in the amount of offset required for each affected habitat type (compared with previous iterations of the BOAMs, which did not include fauna resources).

244. The biodiversity attributes are listed below and are generally in line with those used in recent large infrastructure projects such as Te Ahu a Turanga: Manawatū Tararua Highway Project:

(a) Canopy (percent cover, height, diameter at breast height, basal area);

(b) Diversity (number of plant species in the canopy, sub-canopy, understorey / ground tier, and epiphytes and lianes);

(c) Understorey and ground tier (percent cover);

(d) Fauna resources (canopy epiphytes, fruit, percent cover of leaf litter and coarse woody debris, and foraging habitat for wetland bird species); and

(e) Wetland bird species (number of wetland bird species, number of spotless crake, and number of marsh crake).

245. In the BOAM for Open Water habitat, I have used the following biodiversity components and biodiversity attributes:

(a) Habitat provision (percent cover of open water, marginal vegetation, and islands, and proportion of total shoreline which is indented);

(b) Diversity of indigenous birds (number of 'Not Threatened' species, number of 'Threatened' bird species, and number of 'At Risk' bird species); and

(c) Diversity of indigenous fish (number of 'Not Threatened' species, numbers of 'Threatened' species, and number of 'At Risk' species).

246. Attributes such as canopy height, canopy cover, plant species diversity, number of epiphytes, and cover of understorey / ground tier vegetation, leaf litter, and coarse woody debris were measured in the field (at selected impact sites) using standard RECCE methodology. Where observed in the field, wetland bird and waterfowl species were included in the BOAMs for raupō reedland and open water habitat. For example, spotless crake was confirmed as present in raupō reedland (Property #493), while eight bird species, including one 'Threatened' and two 'At Risk' species, were recorded in a pond at Property #461).

(a) I have measured the value of each attribute to a benchmark (reference) value relevant to the biodiversity element being measured. Benchmark values are *"either directly measured (from a high-quality reference site) or defensibly estimated (by consensus of suitably qualified experts)"* (Maseyk *et al.* 2016). I have provided justifications for the benchmark values used in my assessment in Appendix J.10.

(b) A ‘discount rate’ has been applied to the BOAMs to account for the time-lag between biodiversity losses due to development and biodiversity gains due to an offset. Discount rates typically range between 0 and 4%, although it has been suggested that a rate of approximately 1% should be applied to offset proposals in New Zealand (Denne and Bond-Smith 2011).

(c) I have applied a more conservative discount rate of 3%, which is in line with BOAMs applied to recent large-scale road projects such as Te Ahu a Turanga (Manawatū Tararua Highway Project) and Te Ara o Te Ata (Mt Messenger Bypass).

Principles of biodiversity offsetting

247. Biodiversity offsetting is based on a number of widely accepted principles that provide a critical checklist of project design considerations of a well-developed and well-applied offset to be considered in consenting process (Maseyk *et al*. 2018).

248. Eleven core principles were developed by the Business and Biodiversity Offsets Programme (BBOP) to help developers, conservation groups, communities, governments and financial institutions that wish to consider and develop best practice related to biodiversity offsets.

249. Maseyk *et al*. (2018) described the first six principles as *"having particular applicability to the use of biodiversity offsetting in consent decision making under the RMA, as they cover key concepts not captured elsewhere."* The remaining five principles should be given consideration when designing an offset package, *"but their application is more prescribed or circumscribed by the RMA, and apply to a broader range of circumstances than solely biodiversity offsetting."*

250. The 11 principles are listed and explained below:

(1) **Limits to offsetting** – proposals for offsetting or compensation should be avoided if the residual effects cannot be addressed due to the irreplaceability or vulnerability of the biodiversity affected;

(2) **No Net Loss and preferably a Net Gain** - the goal of a biodiversity offset is a measurable outcome that can reasonably be expected to result in No Net Loss, and preferably a Net Gain of biodiversity;

(3) **Landscape context** - the design of a biodiversity offset should consider the landscape context of both the impact site and the offset site, taking into account interactions between species, habitats, and ecosystems, spatial connections, and system functionality;

(4) **Additionality** - a biodiversity offset must achieve gains in biodiversity above and beyond gains that would have occurred anyway in the absence of the offset;

(5) **Permanence** - The biodiversity benefits at an offset site should be managed to secure outcomes that last at least as long as the impacts and preferably in perpetuity. This may require legal mechanisms such as covenants as well as long-term monitoring and management;

(6) **Ecological equivalence** - describes the degree to which the biodiversity gain attributable to an offset is balanced with the biodiversity losses due to development across type, space, and time. Assessing ecological equivalence requires the biodiversity at both the impact and the offset site to be described and measured to quantify losses and gains, ie, by using a Biodiversity Offset Accounting Model;

(7) **Adherence to the mitigation hierarchy** - in an RMA context, offsets should only be contemplated after steps to avoid, remedy, or mitigate adverse effects have sequentially been exhausted, and thus applies only to residual biodiversity impacts;

(8) **Stakeholder participation** – stakeholders such as the public, local iwi, local government, and the Department of Conservation should be consulted early in the process so that they can play an effective role in the design and implementation of an offset proposal;

(9) **Transparency** - the design and implementation of a biodiversity offset, and communication of its results to the public, should be undertaken in a transparent and timely manner;

(10) **Science and Traditional Knowledge** - the design and implementation of a biodiversity offset should be a documented process informed by science, including an appropriate consideration of traditional knowledge (ie, consideration of Mātauranga Māori and Te Ao Māori); and

(11) **Equity** - sharing among stakeholders of the rights and responsibilities, risks and rewards associated with a project and offset in a fair and balanced way, respecting legal and customary arrangements.

Applying biodiversity offsetting and compensation to the Project

251. For the Ō2NL Project, all residual adverse effects assessed as Low, Moderate, High, or Very High have been addressed by biodiversity offset or compensation measures. By setting the threshold of residual effects to be addressed at this level, additional ecological management will be undertaken to address the effects of:

(a) All clearance of indigenous-dominant forest, scrub, and fernland vegetation of natural origin (ie, not planted) (4.33 hectares);

(b) All clearance of mixed indigenous-exotic and exotic-dominant scrub of natural origin (1.2 hectares);

(c) Loss of raupō reedland (0.12 hectare), *Isolepis prolifer*-dominated wetlands (0.10 hectare), exotic-dominant wetlands (2.3 hectares), and mixed exotic-indigenous wetlands (0.83 hectare);

(d) Indirect (non-clearance) effects on High value indigenous forest habitats;

(e) Indirect effects on exotic forest within Arapaepae Bush that is High value due to the presence of 'Threatened' or 'At Risk' fauna;

(f) Effects on birds, including pūweto, Australasian bittern, and birds of river habitats;

(g) Effects on indigenous lizards; and

(h) Effects on the land snails *Wainuia urnula*, and if they are present, *Powelliphanta traversi*.

252. In addition to the offsetting to address residual adverse effects of Low or greater, other residual effects should be addressed by biodiversity offsetting to address the cumulative loss of habitat, or regional plan requirements, including effects on:

(a) all significant habitats per GWRC and One Plan policy documents;

(b) exotic dominated wetlands that are of Low ecological value and not assessed as Significant;

(c) planted indigenous forest and treeland; and

(d) woody riparian vegetation buffering Schedule F rivers under the One Plan.

253. All impacted habitats within the part of the Ō2NL Project Area in the Wellington Region are within the Manawatū Plains Ecological District. These habitats will be offset in the Manawatū Plains Ecological District, thus satisfying Schedule G2 of the NRP. Higher value indigenous-dominated wetlands in the Wellington Region part of the Project will be mitigated via direct transfer, thus precluding the need for statutory offsetting requirements under the NRP.

254. There are three very small exotic-dominated wetlands (EW10, EWG8, and MWG1d) and one small area of open water (OW) impacted by the Project that are located in the Tararua Ecological District, within the Manawatū-Whanganui Region (chainage 28200 to 28500). It is proposed to undertake offsetting for these habitats in the Te Ripo O Hinemata wetland in the Manawatū Plains Ecological District. The three impacted wetlands occur in the same type of landscape and land form as many of the other wetlands within the Project Area as well as that of the proposed offsetting site (ie, characterised by drained and modified alluvial flats and shallow basins with little to no indigenous vegetation). The proposed offset meets the test of Policy 13-4(d)(iii) of the One Plan in that the impact and offset sites are "generally in the same ecologically relevant habitat".

255. It is also acknowledged that almost all of the vegetation within the Tararua Ecological District occurs in the Tararua Range and foothills, and the small area where the ecological district boundary overlaps the Project designation is more characteristic of the Manawatū Plains Ecological District in terms of vegetation, topography, and extent of modification.

256. To simplify the offsetting and compensation process, I have grouped the terrestrial and wetland vegetation types into broad categories listed in tables J.4a and J.4b below. The BOAMs for each category are provided in Appendix J.9. Benchmark values and justification, and offset assumptions, are provided in Appendix J.10.

Table J.4a: Categories for terrestrial vegetation types.

Terrestrial vegetation type[1]	Area to be removed (ha)[2]
Exotic forest and treeland (indigenous component only)	0.68
Exotic riparian scrub, forest, and vineland	0.40
Mixed indigenous-exotic forest and scrub	0.80
Indigenous treeland	0.23
Planted indigenous forest	0.40
Māhoe-dominant scrub and forest	2.85
Total	**5.36**

1. Indigenous treeland has not been included in offsetting models. Individual trees of a certain size will be replaced using specified planting ratios as discussed below.
2. Area located within the O2NL construction footprint and assumed to be removed.

Table J.4b: Categories for wetland vegetation types.

Wetland vegetation type	Area to be removed (ha)[4]
Indigenous-dominant fernland[3]	0.07
Exotic-dominant wetland[1]	2.30
Raupō reedland[2]	0.12
Isolepis prolifer dominated wetlands[1]	0.11
Mixed exotic-indigenous wetlands[1]	0.83
Rautahi sedgeland wetlands[1]	0.07
Open water[2]	0.34
Total	**3.84**

1. Combined for offsetting purposes.
2. Offsetting to be undertaken for individual habitat types.
3. Will be addressed through mitigation near point of impact (via direct transfer).
4. Area located within the O2NL Project construction footprint and assumed to be removed.

Offsetting loss of māhoe-dominant forest and scrub

257. Offsetting data for māhoe-dominant forest and scrub was collected from three sites: ITS1 (Property #461), ITF4 (Property #493), and MTS4 (Property #151).

258. The loss of māhoe-dominant forest and scrub will be offset by undertaking revegetation planting into pasture. It is important to note that the aim of the proposed restoration planting is not just to offset the loss of māhoe-dominant forest and scrub by establishing a larger area of an equivalent habitat type. The intention is to also create the type of high-value forest that once would have been common on the Manawatū Plains, hence the use of Keeble's Bush as a reference site for benchmark values. Keeble's Bush is located

approximately 34 kilometres northeast of Levin and is "*widely considered to be the best remnant of lowland podocarp forest in the Manawatu*".[6]

259. The offset model demonstrates that at least **4.1 hectares** of restoration planting is required to offset the loss of māhoe-dominant forest and scrub.

260. Key offset planting areas include: (i) *c.*2.96 hectares of flat pasture immediately north of Arapaepae Bush and (ii) grazed gully faces at Property #519. If required, additional planting will be undertaken in existing pasture at Manakau Heights, which is within the designation (refer to Terrestrial Ecology Draft Maps in Volume III).

Offsetting loss of mixed indigenous-exotic forest and scrub, planted indigenous forest, exotic forest and treeland, and riparian forest, scrub and vineland

261. The loss of most of the affected terrestrial habitats is proposed to be offset via restoration planting, derived via the applications of the O2NL Project-specific BOAMs.

262. Data for mixed indigenous-exotic forest and scrub was collected from five sites: MTF1, MTS2, and MTF4 (Property #212), MTF5 (Property #47), and MTF5 (Property #40). Data for planted indigenous forest was collected from one site: ITF6 (Property #40). Data for exotic riparian forest, scrub and vineland was collected at three sites: ETS1 and ETF1 (both on Property #158) and ETF1 (Property #209).

263. Data for exotic forest and treeland was collected at two sites: ETF4# (Property #493) and ETF4d (Property #31). A desktop analysis was undertaken for remaining areas of exotic forest and treeland in order to estimate potential areas of indigenous vegetation. Areas that were clearly exotic (eg, shelter belts, gardens, and pine blocks) were excluded. Areas that likely supported some indigenous sub-canopy and understorey vegetation were included in the BOAM.

264. Benchmark values for attributes such as canopy, height, diversity, and cover of indigenous understorey and ground tier vegetation are the same as those used in the māhoe-dominant forest and scrub offset model (ie, based on the

[6]https://www.massey.ac.nz/massey/fms/Agricultural%20Services/Keebles%20Farm/Keebles%20Bush%20summary%20Oct09.pdf

Keeble' Bush species list). The dominant canopy species were used to calculate current and predicted basal areas.

265. Offset planting to address the loss of exotic **riparian vegetation** is proposed to be undertaken on the northern banks of the Ohau River, slightly to the east of the proposed bridge (refer to Volume III - Drawings). If offset planting does not occur in this location, alternative planting sites include the northern banks of the Waikawa Stream and open pasture at Manakau Heights (refer to landscape planting drawings in Volume III - Drawings).

266. Given that offset planting for the loss of māhoe-dominant forest and scrub will require all available pasture to the north of Arapaepae Bush, other options to address the loss of mixed indigenous-exotic forest and scrub and planted indigenous forest need to be considered. These options include planting the grazed gully faces at Property #519 and open pasture at Manakau Heights (refer to landscape planting drawings in Volume III).

267. The BOAMs demonstrate that at least:

    (a) 1.7 hectares of restoration planting is required to offset the loss of 0.80 hectare of mixed indigenous-exotic forest and scrub;

    (b) at least 0.67 hectare is required to offset the loss of 0.40 hectare of planted indigenous forest;

    (c) at least 0.68 hectare is required to offset the loss of 0.68 hectare of indigenous vegetation within exotic forest and treeland; and

    (d) and at least 0.42 hectare is required to offset the loss of 0.40 hectare of exotic riparian forest, scrub and vineland.

Offsetting loss of indigenous treeland

268. Offsetting data for indigenous treeland was collected from three sites: ITT01 (Property #55), ITT03 (Property #42), and ITT01 (Property #55).

269. The loss of indigenous trees with diameters over 10 centimetres that occur in very small, isolated areas of indigenous treeland are proposed to be offset by undertaking **replacement planting** of individual trees at specific ratios, rather than offsetting by area. I consider this is a more conservative approach whereby all individual trees are accounted for, as opposed to offsetting by area alone, which in my view is likely to result in a lower quantum of offset planting. This approach also accounts for the size and ages of each tree.

270. The replacement ratios per diameter size class are presented in Table J.5a below. It is accepted that there is no scientific precedent for replacement ratios in New Zealand, hence a highly conservative approach (compared to typical replacement ratios) has been adopted. That approach better acknowledges the age of the trees that will be removed and the time it will take for the replacement trees to reach maturity. I have applied higher ratio replacement ratios to tree species that are generally longer-lived, taller canopy species, which occur naturally in the Project area but are not common. Māhoe, tarata and kāpuka/broadleaf are relatively common within the Project area and it is noted that the majority of the latter two species are likely to have been planted.

Table J.5a Tree replacement ratios based on diameter size classes.

Diameter (DBH)	Replacement ratio
Tītoki, hinau, white maire, kamahi, totara, pukatea, rewarewa	
10-20 cm	10 to 1
21-35 cm	20 to 1
36-49 cm	30 to 1
50+ cm	50 to 1
Māhoe, tarata, kāpuka/broadleaf	
10-20 cm	5 to 1
21-35 cm	10 to 1

271. It is proposed to undertake replacement planting within three areas of degraded mixed indigenous-exotic forest and wetland habitats: Arapaepae Bush, the gully wetland at the Property #519, and Te Ripo O Hinemata wetland at Koputaroa.[7] Plant species that are not indigenous to the region (eg, pōhutukawa, kauri) were not considered for replacement. The species, number, and proposed locations of the replacement trees are listed in Table J.5b. Following a preliminary review by Mr Lambie, total replacement numbers were adjusted to allow for a 10% failure rate.

Table J.5b Schedule of indigenous trees to be replaced using replacement ratios

Tree species	No. of replacement trees	Arapaepae Bush	Property #519 (gully floor)	Te Ripo o Hinemata wetland
Hinau	55	55		
Kamahi	22	22		

[7] Local iwi have varying and rich mātauranga as to the origins of the name ‘Koputaroa’. Muaūpoko acknowledge the name of the swamp near Koputaroa Stream as ‘Koputaroa’, while the stream itself is known as Te Awa a te Tau. Ngāti Raukawa use a slightly different spelling: ‘Koputoroa’, named for the albatross (toroa).

Tree species	No. of replacement trees	Arapaepae Bush	Property #519 (gully floor)	Te Ripo o Hinemata wetland
Kāpuka/broadleaf	16	16		
Māhoe	11	11		
Tarata	22	22		
Titoki	88	88		
Tōtara	22	22		
Pukatea	198		99	99
Rewarewa	22	22		
White maire	30	30		
Total	**486**	**288**	**+9999**	**99**

ADDRESSING LOSS OF WETLAND EXTENT AND OPEN WATER HABITAT

Introduction

272. A two-pronged approach is proposed to address the loss of natural wetland extent within the Ō2NL Project construction footprint and thus address:

(a) NPS-FM Policy 6 ("*no further loss of extent of natural inland wetlands, their values are protected, and their restoration is promoted*"); and

(b) NPS-FM clause 3.22 (including the application of the effects management hierarchy in respect of the loss of extent or values of natural inland wetlands associated with specific infrastructure).

273. Prior to the commencement of construction works, it is proposed to use compensation to achieve a Net Gain of wetland condition **or value** (as opposed to **extent**), which will involve undertaking restoration activities at two key sites: Property #519 and Te Ripo O Hinemata wetland at Koputaroa, approximately six kilometres northeast of Levin. More detail is provided on these sites below.

274. In addition, the loss of wetland extent and open water habitat will be addressed through the rehabilitation of up to three proposed material supply sites. Three sites have been identified near / adjacent to the Waikawa Stream and Ohau River (refer to Natural Character Drawings in Volume III - Drawings). The amount of material excavated from each material supply site will depend on the final design and its cut fill balance, but at this stage it is assumed that the Ō2NL Project will need material available from each site so that the open water legacy outcomes described in the Cultural and

Environmental Design Framework ("**CEDF**") (Appendix Three to Volume II) can be developed.[8]

275. The reason I have applied 'compensation' to addressing the effects of wetland loss instead of 'offsetting' is because the offset principle of No Net Loss is unable to be achieved, at least in the short term (ie, within 5-8 years). It is noted that No Net Loss for wetlands will be achieved in the medium term (ie, within ten years) by rehabilitating the materials supply sites (as discussed in the next paragraph).

276. The outcome – or 'legacy statement' of the rehabilitated material supply sites - will comprise large areas of planted wetland vegetation, using species that are typical of alluvial and riverine habitats, together with extensive areas of open water. It is intended that the rehabilitated sites will provide opportunities for public access, recreation, mahinga kai, and rongoā (including options for interpretation), as well as support a wide range of indigenous fauna and flora species. In this regard, the rehabilitation of the materials supply sites adheres to the core Project principle of **creating an enduring community legacy**, whilst also promoting the core value of **kaitiakitanga** (environmental stewardship).

277. It is estimated that excavation works within the material supply sites would commence within the first six months of the Ō2NL Project construction. All sites would be operational for at least two earthwork seasons (that is, two years) but potentially longer. Based on the construction programme provided in the DCR (Appendix Four to Volume II) it is estimated that works to rehabilitate the sites will commence at least 12 months prior to the completion of the Ō2NL Project, as bulk earthworks should be completed by then.

278. Even though there is confidence that significantly larger areas of wetland and open water habitats will be created than those lost during construction works, biodiversity compensation for wetland habitat is proposed at other sites to:

(a) address the 'lag period' between the commencement of excavation works and completion of restoration works in the material supply sites; and

[8] Final design of the rehabilitated Material Supply Sites will be provided in the Outline Plan process (provided for in s.176A of the RMA) will be in accordance with the design principles provided in the CEDF (Appendix Three to Volume II). The material supply sites will be rehabilitated following completion of the bulk earthworks.

(b) provide positive ecological outcomes in the short term.

279. Similarly, given the known habitat values of existing areas of open water habitat within the Ō2NL Project construction footprint, a BOAM for open water habitat has also been provided.

280. A summary of the residual impacts for each affected habitat type, together with measures to offset or compensate those effects is present in Table J.7. An assessment of the Magnitude and Level of Effect following offsetting and compensation is also included.

Loss of open water habitat

281. The areas of impacted open water are characterised by very small manmade (or induced) ponds, of which at least one dries up during the summer (Property #461).

282. It is intended to offset the loss of 0.34 hectare of open water by rehabilitating at least one of the three materials supply sites. The proposed stormwater ponds are likely to provide useful foraging habitat for some species of waterfowl and wetland birds in the interim, noting that approximately 17 stormwater ponds will be constructed along the highway (chainage 10,500 to chainage 29,700).

283. For the purposes of biodiversity offsetting, I have selected the largest material supply site, on the northern terrace of the Ohau River.

284. Paruāuku Swamp (*c*.11.4 hectares), approximately 10 kilometres to the southwest of the proposed material supply sites, was used as a Benchmark for area and provision of habitat for birds, given it has a good mix of open water and littoral habitat types. Species lists of indigenous birds recorded from Lake Horowhenua and Papaitonga were used as a Benchmark for species diversity and number of 'Threatened', 'At Risk', and 'Not Threatened' bird species present. Species that were considered unlikely to visit the proposed offset site (for example, migrant waders such as wrybills and red knot) were excluded from the list.

285. A species list of indigenous fish recorded from Lake Horowhenua by Tempero (2013) was used as a Benchmark for species diversity and number of 'Threatened', 'At Risk', and 'Not Threatened' fish species present. Species diversity of indigenous fish within the impact areas is restricted to shortfin eel,

based on freshwater survey data collected along within the Ō2NL Project Area by **Dr Alex James**.

286. The offset model demonstrates that at least **0.48 hectare** of open water creation is required to offset the loss of ponds along the alignment (refer to the BOAM in Appendix J.9). The proposed rehabilitation of the materials supply site north of the Ohau River will result in approximately **seven hectares** of open water and wetland habitat, which is highly likely to result in a Net Gain of biodiversity.

Loss of raupō reedland

287. It is proposed to undertake a direct transfer of raupō rhizomes and indigenous sedges (where accessible) from the impact site at Property #493 and plant them on a wet gully floor at Property #519. While this proposed action could be regarded as mitigation, an offsetting approach has been used given that additional species are proposed to be planted (over and above what already exists at the impact site).

288. The intention is to establish a larger area of raupō reedland at the offset site and plant a buffer of swamp forest species such as kahikatea, swamp maire, pukatea, tī kōuka, manuka, and harakeke on gully floor margins and side seepages. This area of planting will connect with Natural Character plantings further downstream (refer to Natural Character Drawings in Volume III - Drawings).

289. A benchmark of 18 indigenous species was used to inform plant species diversity in the offsetting model, which is informed by numerous surveys of raupō-dominant wetlands I have undertaken around the North Island. These species are listed in Table J.6 together with notes with regards to planting at the offset site.

290. The BOAM demonstrates that at least **0.25 hectare** of restoration is required to offset the loss of raupō reedland (refer to the BOAM in Appendix J.9). The proposed direct transfer of raupō reedland, together with supplementary planting, will cover a minimum area of **0.5 hectare**, which is highly likely to result in a Net Gain of biodiversity.

Table J.6: Benchmark plant species used in the offset model for raupō-dominant wetlands.

Species	To be transferred to offset site	To be planted at offset site	Already present at offset site	Likely to establish naturally
Raupō	ü			ü
Carex geminata		ü		
Carex secta	ü	ü		
Carex virgata	ü	ü		
Coprosma propinqua var. *propinqua*		ü		
Cyperus ustulatus		ü		
Isolepis prolifer		ü	ü	
Pink bindweed		ü		ü
Swamp millet				ü
Harakeke		ü		
Mānuka		ü		
Hiya distans				ü
Machaerina rubiginosa				ü
Whekī		ü		
Tī kōuka		ü		
Kahikatea		ü		
Swamp maire		ü		
Pukatea		ü	ü	

Loss of combined wetlands

291. The impact areas for three broad wetland types were combined to produce an overall area of 3.31 hectares, noting these do not include the three indigenous wetland types to be **mitigated** by direct transfer at properties #19 and #21. The combined wetland types are listed below:

(a) Exotic-dominated wetlands;

(b) *Isolepis prolifer*-dominated wetlands;

(c) Mixed exotic-indigenous wetlands;

(d) Rautahi sedgeland.

292. With regards to benchmark values, it can be speculative as to what a comparable reference site may be for degraded exotic dominated wetlands within an agricultural landscape with very little indigenous wetland habitat remaining. A literature review was therefore undertaken in order to better understand what plant species and assemblages unmodified wetland

habitats on the Manawatū Plains might have supported. The key references include:

(a) Species list for Blakes Swamp, Koputaroa;[9]

(b) Vascular plants and vegetation of Makerua Swamp Wildlife Management Reserve, Tokomaru;[10]; and

(c) Plant checklist for wetlands near Awahuri and Longburn, two Manawatū wetlands with fluctuating water levels and surrounded by pasture.[11]

293. The species lists were reviewed and refined to remove diminutive and uncommon indigenous herb species, and instead focus on more commonly occurring species that provide vegetative structure and habitat complexity, as well as habitat resources for wetland fauna species. These species largely comprise woody tree and shrub species, sedge and rush species, ferns, and monocots such as raupō and harakeke. A total of 36 benchmark species were selected.

294. The BOAM demonstrates that at least **4.65 hectares** of wetland restoration is required to compensate for the loss of combined wetland habitat. The proposed reinstatement of the hydrological regime, and subsequent planting and pest plant control across approximately **9 hectares** of the Te Ripo O Hinemata wetland is highly likely to result in a Net Gain of biodiversity.

Limits to offsetting

295. None of the adverse residual effects of the Ō2NL Project are beyond the limits of offsetting, and, in general, the feasilbility for offsetting for all habitats is considered to be ‘High’ as per Pilgim *et al.* (2013), given that:

(a) no mature indigenous forest will be lost;

(b) no originally rare ecosystems will be adversely affected;

(c) no ‘Threatened’ fauna or flora species will be directly impacted, and

(d) most of the affected vegetation types are highly modified and/or contain a substantial exotic component.

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[9] https://www.nzpcn.org.nz/publications/plant-lists/plant-lists-by-region/blakes-swamp-koputaroa-blks/
[10] https://www.nzpcn.org.nz/site/assets/files/0/12/443/wanganui_plant_list_29_makerua_swamp-_tokomaru.pdf
[11] https://www.nzpcn.org.nz/publications/documents/plant-checklist-for-wetlands-near-awahuri-and-longburn-two-Manawatū-wetlands-with-fluctuating-water-levels-and-surrounded-by/

296. There are also very good opportunities to restore existing habitats close to the Project construction footprint that have been degraded by stock, drainage, and pest plants.

297. The loss of wetlands, however, warrants further discussion. It is acknowledged that wetlands have been greatly reduced in extent in the Wellington and Manawatū-Whanganui regions, with *c.*700 hectares (<3%) remaining in Manawatū[12] and *c*.3,500 hectares (<.3%) remaining in Wellington.[13] Based on the limited amount of wetland vegetation remaining in the two regions, it is appropriate to assess the vulnerability status of wetlands as ‘Critically Endangered’ (in a regional context) as per the International Union (IUCN) threat rankings used by Pilgrim *et al*. (2013).

298. In a regional context, the ‘Magnitude of Effects’ of wetland loss will be ‘Negligible’ given that only *c*.1.35 hectares and *c*.1.71 hectares will be impacted in the Wellington and Manawatū-Whanganui regions respectively (ie, loss of wetland habitat will be <0.01% of the existing extent in both regions).

299. None of the habitats affected within the Project construction footprint are irreplaceable, although it is worth noting here that the least common indigenous wetland types present (raupō reedland, rautahi sedgeland, bracken-whekī fernland, and kiokio-spike sedge-kāpūngāwhā sedgeland) will essentially be reinstated by undertaking the direct transfer of plant material to appropriate recipient sites. Adverse effects on wetlands can be addressed by mitigation and compensation measures in the short term (ie, 5-8 years). Offsetting the residual effects of loss of wetland extent will be addressed by the creation of wetland habitat in the medium term (ie, within 10 years).

300. A Net Gain is considered very likely to be achieved for all affected habitat types.

Performance standards for BOAM and compensation models outcome monitoring

301. Performance standards will be used to ensure that the predicted outputs of the BOAM and compensation models are validated. This will be achieved by

[12] Horizons Regional Council: State of the Environment 2019.
[13] https://www.gw.govt.nz/environment/our-natural-environment/our-unique-ecosystem-types/wetlands/wetlands-in-our-region/; https://www.wetlandtrust.org.nz/wp-content/uploads/2020/06/Wellington-Wetlands-to-Visit_2020.pdf

regularly monitoring planted areas and checking key performance indicators such as canopy closure, plant species diversity, and plant survival rates.

302. Performance standards for terrestrial and wetland restoration planting and the establishment of indigenous wetland habitat via direct transfer include the following:

(a) Ninety percent canopy cover after eight years;

(b) Pasture grasses and light-demanding exotic plant species suppressed to levels at which they can no longer compete with planted indigenous species; and

(c) Ninety percent survival rate of replacement trees (ie, trees planted to offset the loss of indigenous treeland throughout the Ō2NL Project Area) after eight years.

303. Compared with vegetation-specific attributes such as canopy cover and cover of understorey and ground cover species, it is more likely that attributes for fauna resources will take decades until they reach at stage at which they provide benefits to indigenous birds, lizards, and invertebrates.

304. In the BOAMs for terrestrial habit types, I have used a timeframe of 25-35 years at which the predicted offset measurements for fauna resources would be attained. It is important to reiterate, however, that no old growth indigenous vegetation (which typically contains abundant fauna resources) will be lost as a result of the Project. Furthermore, the impacted terrestrial habitats provide little in the way of fauna resources, ie, they are relatively young, degraded areas of vegetation that generally lack typical forest structure. Performance standards for terrestrial revegetation should therefore reflect the offset measurements for key vegetation-based attributes such as vegetation canopy cover and diversity being achieved over a shorter timeframe (ie, eight years).

Table J.7: Magnitude and level of effects before and after measures proposed for offsetting and compensation.

Vegetation Structural Class/ Vegetation T ype	Code	Ecological Value	Extent of removal	Potential Impacts	Magnitude of Effect in absence of effects manageme nt	Level of Effect in absence of effects managemen t	Avoidance, Mitigation, Offsetting and Compensation Measures	Magnitude of Effect (after Avoidance, Mitigation, Offsetting and Compensation Measures)	Level of Effect (after Avoidance, Mitigation, Offsetting and Compensation Measures)
Woody terrestrial vegetation									
Planted indigenous forest	ITF6	Moderate	0.40 ha	Direct loss of vegetation. Effects on nesting birds. Reduced connectivity of habitats via forest and scrub "stepping stones".	Low to Very High	Low to High	**Undertaking offset planting in open pasture to address residual effects of vegetation loss.** Establish linkage plantings between forests at Property #39 and #42. Transfer of cut trunks to any adjacent areas of indigenous plantings for linkage purposes. Timing of habitat loss to occur outside of the breeding season for forest birds (August-February inclusive) and /or pre-clearance nest surveys. Lizard salvage of areas cleared.	Positive (based on a 20-35[14]-year timeframe) Moderate	Net Gain

[14] Attributes such as canopy epiphytes and fruiting kohekohe trees are expected to provide resources to indigenous fauna at 35 years, noting that most attributes such as canopy cover and diversity will attain their predicted values after 20-25 years.

Vegetation Structural Class/ Vegetation T ype	Code	Ecological Value	Extent of removal	Potential Impacts	Magnitude of Effect in absence of effects manageme nt	Level of Effect in absence of effects managemen t	Avoidance, Mitigation, Offsetting and Compensation Measures	Magnitude of Effect (after Avoidance, Mitigation, Offsetting and Compensation Measures)	Level of Effect (after Avoidance, Mitigation, Offsetting and Compensation Measures)
Indigenous treeland	ITT01 ITT06 ITT02 ITT04 ITT05 ITT03 ITT03d	Low to Moderate	0.23 ha	Direct loss of mature indigenous treeland. Deposition of construction dust on foliage. Effects on nesting birds. Reduced connectivity of habitats via forest and scrub "stepping stones".	Low to Very high	Low to Moderate	**Undertake replacement planting at three sites to residual loss of mature indigenous trees.** Implement dust suppression measures. Exclude livestock and plant indigenous forest species to protect and enhance adjacent areas of forest to be retained. Transfer of cut trunks to any adjacent areas of indigenous plantings. Timing of habitat loss to occur outside of the breeding season for forest birds (Aug-February inclusive) and/or pre-clearance nest surveys	Positive (based on a 20-35-year timeframe)	Net Gain

Vegetation Structural Class/ Vegetation T ype	Code	Ecological Value	Extent of removal	Potential Impacts	Magnitude of Effect in absence of effects manageme nt	Level of Effect in absence of effects managemen t	Avoidance, Mitigation, Offsetting and Compensation Measures	Magnitude of Effect (after Avoidance, Mitigation, Offsetting and Compensation Measures)	Level of Effect (after Avoidance, Mitigation, Offsetting and Compensation Measures)
Māhoe dominant indigenous forest and scrub	ITF4 ITS1 ITS1d MTS4 MTF6d	Moderate	2.85	Direct loss of terrestrial vegetation. Reduced connectivity of habitats via forest and scrub "stepping stones". Potential for disturbance, potential for injury or mortality of birds, arboreal geckos and terrestrial skinks if present. Loss of 100% of vegetation. Potential for disturbance, injury or mortality of birds and terrestrial skinks. Deposition of construction dust on foliage.	Low to High	Low to Moderate	**Undertaking offset planting in open pasture to address residual effects of vegetation loss.** Physical delineation to ensure no clearance or trampling of habitat to be retained. Exclude livestock and plant indigenous forest species to protect and enhance adjacent areas of forest to be retained. Transfer of cut trunks to any adjacent areas of indigenous plantings. Timing of habitat loss to occur outside of the breeding season for forest birds (Aug-February inclusive) and/or pre-clearance nest surveys. Lizard salvage of areas cleared. Implement dust suppression measures.	Positive (based on 20-35-year timeframe)	Net Gain

Vegetation Structural Class/ Vegetation T ype	Code	Ecological Value	Extent of removal	Potential Impacts	Magnitude of Effect in absence of effects manageme nt	Level of Effect in absence of effects managemen t	Avoidance, Mitigation, Offsetting and Compensation Measures	Magnitude of Effect (after Avoidance, Mitigation, Offsetting and Compensation Measures)	Level of Effect (after Avoidance, Mitigation, Offsetting and Compensation Measures)
Mixed indigenous-exotic forest and scrub	MTS2 MTS3 MTF1 MTF2 MTF5	Low to Moderate	0.80 ha	Direct loss of terrestrial vegetation. Reduced connectivity of habitats via forest and scrub "stepping stones". Potential for disturbance, potential for injury or mortality of birds, arboreal geckos and terrestrial skinks if present. Loss of 100% of vegetation. Potential for disturbance, injury or mortality of birds and terrestrial skinks. Deposition of construction dust on foliage.	Low to High	Very low to Moderate	**Undertaking offset planting in open pasture to address residual effects of vegetation loss.** Physical delineation to ensure no clearance or trampling of habitat to be retained. Exclude livestock and plant indigenous forest species to protect and enhance adjacent areas of forest to be retained. Transfer of cut trunks to any adjacent areas of indigenous plantings. Timing of habitat loss to occur outside of the breeding season for forest birds (Aug-February inclusive) and/or pre-clearance nest surveys. Lizard salvage area of areas cleared. Implement dust suppression measures.	Positive (based on 25-35-year timeframe)	Net Gain

Vegetation Structural Class/ Vegetation T ype	Code	Ecological Value	Extent of removal	Potential Impacts	Magnitude of Effect in absence of effects manageme nt	Level of Effect in absence of effects managemen t	Avoidance, Mitigation, Offsetting and Compensation Measures	Magnitude of Effect (after Avoidance, Mitigation, Offsetting and Compensation Measures)	Level of Effect (after Avoidance, Mitigation, Offsetting and Compensation Measures)
Exotic forest, scrub and vineland (riparian)	ETF1	Low	0.40 ha	Loss of woody vegetation along a Schedule F river. Loss of riparian buffering (Ōhau River). Potential for disturbance, injury and/or mortality of birds.	Low to Moderate	Very low to Low	**Undertaking offset planting in open pasture bordering the Ohau River in order to address residual effects of vegetation loss.** Physical delineation to ensure no clearance or trampling of adjacent habitat retained. Remedial works to restore riparian vegetation within construction footprint (Ohau River). Timing of habitat loss to occur outside of the breeding season for wetland birds (Aug-March inclusive) and/or pre-clearance nest surveys.	Positive (based on 25-35-year timeframe)	Net Gain

Vegetation Structural Class/ Vegetation T ype	Code	Ecological Value	Extent of removal	Potential Impacts	Magnitude of Effect in absence of effects manageme nt	Level of Effect in absence of effects managemen t	Avoidance, Mitigation, Offsetting and Compensation Measures	Magnitude of Effect (after Avoidance, Mitigation, Offsetting and Compensation Measures)	Level of Effect (after Avoidance, Mitigation, Offsetting and Compensation Measures)
Exotic treeland and forest (other)	ETF4 ETF4d	Low	5.90 ha	Estimated loss of exotic treeland and forest containing indigenous vegetation is **0.68 ha**. Potential for Loss of woody vegetation "stepping stones" for indigenous fauna, and in particular forest birds.	Moderate	Low	**Undertaking offset planting in open pasture to address residual effects of vegetation loss.** Physical delineation to ensure no clearance of adjacent indigenous trees to be retained. Timing of habitat loss to occur outside of the breeding season for forest birds (Aug-February inclusive) and/or pre-clearance nest surveys.	Positive (based on 20-year timeframe)	Net Gain
Wetlands									

Vegetation Structural Class/ Vegetation T ype	Code	Ecological Value	Extent of removal	Potential Impacts	Magnitude of Effect in absence of effects manageme nt	Level of Effect in absence of effects managemen t	Avoidance, Mitigation, Offsetting and Compensation Measures	Magnitude of Effect (after Avoidance, Mitigation, Offsetting and Compensation Measures)	Level of Effect (after Avoidance, Mitigation, Offsetting and Compensation Measures)
Raupō reedland	IWRe1	High	**0.12 ha**	Direct loss of high value wetland habitat. Reduced connectivity of habitats via wetland "stepping stones". Potential for disturbance, injury and/or mortality of spotless crake and/or marsh crake.	High to Very High	Very High	**Undertake restoration planting at Property #519 to compensate for residual loss of wetland values.** **Loss of wetland extent will be addressed through the rehabilitation of the material supply sites.** Timing of habitat loss to occur outside of the breeding season for wetland birds (Aug-March inclusive) and/or pre-clearance nest surveys.	Positive (based on 8-year timeframe)	Net Gain
***Isolepis prolifer* dominated wetlands**	IWSe1 IWSe1-SPG IWSe1d-SPG IWSe2 (W67)	Moderate	**0.09 ha**	Direct loss of wetland habitat. Reduced connectivity of habitats via wetland "stepping stones". Potential drainage and or modification due to adjacent earthworks causing a drawdown of groundwater levels.	Low to High	Low to Moderate	**Undertake restoration works at Te Ripo O Hinemata wetland to compensate for loss of wetland values.** **Loss of wetland extent will be addressed through the rehabilitation of the material supply sites.** Restoration of wetland vegetation removed within the construction buffer. Physical delineation to ensure no clearance or trampling of adjacent wetland habitats beyond the footprint of work.	Positive (based on 8-year timeframe)	Net Gain

Vegetation Structural Class/ Vegetation T ype	Code	Ecological Value	Extent of removal	Potential Impacts	Magnitude of Effect in absence of effects manageme nt	Level of Effect in absence of effects managemen t	Avoidance, Mitigation, Offsetting and Compensation Measures	Magnitude of Effect (after Avoidance, Mitigation, Offsetting and Compensation Measures)	Level of Effect (after Avoidance, Mitigation, Offsetting and Compensation Measures)
Mixed exotic-indigenous wetlands	MWSe1-SPG (W70) MWSe1-SPGd (W71) MWG1 MWG1d MWSe2 MWSe3 MWV1 MWSe4 MWG2 MWG3 MWRs1	Moderate	**0.83 ha**	Direct loss of wetland habitat. Potential drainage and or modification due to adjacent earthworks causing a drawdown of groundwater levels. Reduced connectivity of habitats for wetland species. Potential for disturbance, injury and/or mortality of birds.	Low to Moderate	Low to Moderate	**Undertake restoration works in Te Ripo O Hinemata wetland to compensate for loss of wetland values.** **Loss of wetland extent will be addressed through the rehabilitation of the material supply sites (or direct transfer, if possible).** Physical delineation to ensure no clearance or trampling of adjacent wetland habitats beyond the footprint of work. Restoration of wetland vegetation removed within the construction buffer. Control of sediments entering wetland. Hydrology team has confirmed that adverse effects on groundwater and surface flows will be avoided**.**	Positive (based on 8-year timeframe)	Net Gain

Vegetation Structural Class/ Vegetation T ype	Code	Ecological Value	Extent of removal	Potential Impacts	Magnitude of Effect in absence of effects manageme nt	Level of Effect in absence of effects managemen t	Avoidance, Mitigation, Offsetting and Compensation Measures	Magnitude of Effect (after Avoidance, Mitigation, Offsetting and Compensation Measures)	Level of Effect (after Avoidance, Mitigation, Offsetting and Compensation Measures)
Exotic dominant wetlands	EWF1 MWH1 EWG1-9 (includes W12 and W13) EWG1d EWH1 EWH3 EWH5 EWH6 (W18, W19) EWH8 EWH1d EWH2 EWH4 EWH9-10 EWH9d EWH10d EWRs2 EWRs3 EWRs1 EWRs1d	Low-Moderate	**2.26**	Direct loss of wetland habitat. Potential changes to hydrology and flood regime. Reduced connectivity of wetland habitat and reduced buffering to adjacent wetlands Potential for disturbance, injury and/or mortality of birds.	Low to High	Very low to Moderate	**Undertake restoration works in Te Ripo O Hinemata wetland to compensate for residual loss of wetland values.** **Loss of wetland extent will be addressed through the rehabilitation of the material supply sites.** Restoration of indigenous wetland vegetation removed within the construction buffer. Timing of habitat loss to occur outside of the breeding season for wetland birds (Aug-March inclusive) and/or pre-clearance nest surveys. Control of sediments entering wetland. Physical delineation to ensure no clearance or trampling of adjacent wetland habitats. Restoration of wetland habitats removed within the construction buffer. Hydrology team has confirmed that adverse effects on groundwater and surface flows will be avoided**.**	Positive (based on 10-year timeframe)	Net Gain

Vegetation Structural Class/ Vegetation T ype	Code	Ecological Value	Extent of removal	Potential Impacts	Magnitude of Effect in absence of effects manageme nt	Level of Effect in absence of effects managemen t	Avoidance, Mitigation, Offsetting and Compensation Measures	Magnitude of Effect (after Avoidance, Mitigation, Offsetting and Compensation Measures)	Level of Effect (after Avoidance, Mitigation, Offsetting and Compensation Measures)
Open water	OW	Moderate	**0.34 ha**	Loss of open water habitat. Reduced connectivity of habitats for open water species. Potential for disturbance, injury and/or mortality of birds.	Moderate	Moderate	**Loss of extent will be addressed creating much larger areas of open water in the rehabilitated material supply sites.** Timing of habitat loss to occur outside of the breeding season for wetland birds (Aug-March inclusive) and/or pre-clearance nest surveys.	Positive (based on 10-year timeframe)	Net Gain

COMPENSATION MEASURES TO ENHANCE INDIGENOUS LIZARD VALUES

305. It is acknowledged that the completed roading project will act as a permanent barrier to the dispersal and migration of indigenous skink species such as ornate skink and northern grass skink. It is also accepted that mitigation measures alone (such as lizard salvage and relocation) will not fully address the adverse effects on lizards such as injury, mortality, and habitat loss.

306. Options for enhancing the existing populations of ornate and grass skinks, together with other less mobile fauna such as land snails, have been discussed with Dr Trent Bell (Lead Herpetologist, Wildland Consultants), Mr James Lambie (Ecologist, Horizons), Siobhan Karaitiana (representative of Muaūpoko Tribal Authority), and Les Moran (Herpetologist, Department of Conservation). There is general agreement between the relevant experts that constructing a predator-proof fence around an existing forest remnant within or close to the Ō2NL Project Area would deliver a sustainable positive outcome for indigenous skinks and land snails (including individuals that have been relocated from impacted habitats), together with a wide range of indigenous bird, invertebrate, and plant species.

307. In my view, the effects of the Project on lizards would be suitably addressed if Waka Kotahi to take responsibility for constructing the predator-proof fence and establish any necessary physical infrastructure within the protected area, undertake the eradication of pest animals following the completion of the fence, and to carry out initial monitoring for pest animal incursions for a maximum period of two years. The focus of pest monitoring would be on mice (*Mus musculus*), which are adept at breaching fences. Those requirements should be reflected in conditions and the EMP, which, following implementation, will result in a net gain in ecological values for indigenous lizards and other fauna species. Other stakeholders would then be well placed to take on responsibility for any ongoing monitoring and contingency pest control, and maintenance of the fence, in perpetuity.

308. A forested site protected by a predator-proof fence would be an optimal location to which skinks and land snails could be relocated during the fauna salvage operations.

309. Research undertaken by Nelson *et al*. (2016) at Zealandia Sanctuary in Wellington City demonstrated an increase in ornate skink numbers where mice were excluded or contained to very low levels (~10 mice per 100 trap

nights) in consecutive years. Similar research undertaken by Reardon *et al.* (2012) in Otago found that pest-proof fences benefited populations of Otago skink (*Oligosoma otagense*) and grand skink (*O. grande*). There is strong evidence that indigenous biodiversity can significantly improve in fenced mainland islands following the removal of predatory mammals (for example, Tawharanui Sanctuary in Auckland and Sanctuary Mountain in Maungatatauri, Waikato), although much of the focus of monitoring has tended to focus on bird populations.

310. Two sites put have been identified as candidates for a fenced ‘wildlife sanctuary’: Waiopehu Scenic Reserve and Arapaepae Bush, both of which located within 1,500 metres of each other on Queen Street East and Arapaepae Road North (State Highway 57) respectively. Waiopehu Scenic Reserve (*c*.9 hectares) is a high-quality example of intact lowland forest dominated by mature tawa and titoki. While the presence of the ‘Threatened’ land snail species *Powelliphanta traversi* has been confirmed at the reserve, it is not currently known if indigenous lizards are present (although it is considered likely). Ornate skinks, however, have been recorded in Arapaepae Bush as well as in a nearby forest remnant at Property #479. It is noted that this remnant will be restored and expanded in size as part of the biodiversity offsetting programme. Following revegetation planting in pasture immediately north of the remnant, the total size of the site will be *c*.5.4 hectares (refer to Natural Character Drawings in Volume III - Drawings).

311. Constructing a predator-proof fence around Waiopehu Scenic Reserve will be the more challenging option, given that negotiations with neighbouring landowners will be required. That is, some neighbours would need to agree to sell or vest a small portion of their properties to facilitate a *c*.5-metre buffer along the perimeter of the reserve. The fact that Arapaepae Bush is entirely within the Ō2NL Project designation means that issues with adjacent landowners are avoided.

312. Whichever site is selected for the predator-proof fence, there will be an ongoing commitment required with regards to monitoring for pest incursions and maintaining the fence once Waka Kotahi has transferred responsibility to the nominated community group after two years. It should be emphasised that the construction of a predator-proof fence is not strictly needed by the Project (ie, it is over and above what is required to address the effects on indigenous lizards), but rather to ensure that a significant enduring benefit occurs.

313. In summary, taking into account the existing environment where pest animal control is either absent or very limited, I am confident that the construction of a predator-proof fence around either the Waiopehu Scenic Reserve or Arapaepae Bush would deliver a Net Gain for populations of ornate skinks,[15] northern grass skinks, and indigenous land snails, as well as a wide range of indigenous bird and invertebrate species.

CONCLUSIONS

314. The proposed designation covers 618 hectares, within which the Ō2NL Project construction footprint (road surface, earthworks, stormwater treatment devices, and construction buffer) covers 364 hectares. Ecological input during the earlier design phases resulted in all mature indigenous forest remnants being avoided by the Ō2NL Project construction footprint.

315. The loss of terrestrial habitats of Low to Moderate Ecological Value within the Project construction footprint results in residual adverse effects that range from Very Low to Moderate. The loss of wetland habitats within the footprint of the highway results in residual effects that range from Low (for exotic-dominated wetlands) to Very High (for indigenous wetlands of High ecological value).

316. Construction and operation of the highway will also have indirect effects where the road is in close proximity to habitats of high ecological value. These indirect effects, including settlement of dust during construction, noise, and the fragmentation of some fauna populations, are also considered in this assessment. For most habitats, indirect effects can be addressed by mitigation actions at the source and point of impact to result in residual effects that are Low to Moderate.

317. The Ō2NL Project has adhered to the mitigation hierarchy, resulting in the avoidance of all remnants of mature indigenous forests (ITF1, ITF2, and ITF7) and high value indigenous treeland (ITT07). The results of site investigations provide a high level of certainty that adverse effects on adjacent indigenous habitats (ie, outside of the Project construction footprint) will be suitably addressed with regards to effects such as groundwater

[15] Although ornate skinks have not been recorded at Waiopehu Scenic Reserve, ornate skinks that may be relocated to the site would benefit from the presence of a predator-proof fence, should the reserve be selected as the lizard enhancement site.

drawdown and edge effects. There will also be the potential to retain connectivity of vegetated habitats under the two major bridges.

318. After any further avoidance has been achieved, or shown not to be feasible, the residual effects of the Ō2NL Project on terrestrial and wetland ecology and indigenous fauna will be offset and compensated for through terrestrial revegetation, wetland restoration, and plant and animal pest management. The measures have been developed in collaboration with key stakeholders (DOC, Forest and Bird) and with our Iwi Partners, and using a BOAM to take a biodiversity offsetting approach to achieve a Net Gain for affected habitats and species.

319. Measures for mitigation, offsetting and compensation will be specified in a comprehensive Ecological Management Plan, which will provide the detail required to ensure the positive biodiversity outcomes described in this assessment.

320. The actions proposed to address residual effects on terrestrial ecology include the reversal of historical wetland loss, restoration of degraded wetland habitats by fencing and/or planting, plantings to extend and link isolated forest remnants, and the construction of a predator-proof fence around either the restored Arapaepae Bush or Waiopehu Scenic Reserve to enhance and protect indigenous lizards and land snails, together with more common indigenous fauna species. These actions are likely to occur at sites within the designations, and at other sites nearby on the Horowhenua Plains.

321. In my opinion, the proposed offset and compensation response adheres to the following principles of biodiversity offsetting:

(a) **Limits to offsetting** – no habitats within the Project construction footprint are considered irreplaceable, and the feasibility of offsetting all habitat types is considered to be high.

(b) **No Net Loss of biodiversity** – the BOAMs prepared for the Project achieve a Net Gain of indigenous biodiversity for all terrestrial habitat types (including fauna resources). The proposed restoration of wetland habitats at Property #519 and Te Ripo O Hinemata, together with the proposed rehabilitated material supply sites, will result in a net increase in wetland extent and condition.

(c) **Additionality** – the offset and compensation response would not otherwise be implemented in the absence of the Project. It is important to note that there has been the intention of the Manawatū Kukutauaki No. 3 Sec 2E5 Trust to fully restore Te Ripo O Hinemata wetland; however, a lack of resources has prevented this work from being undertaken.

(d) **Landscape context** - the offset and compensation response has been designed to augment and enhance existing forest remnants and large areas of degraded wetland habitat in close proximity to the Project construction footprint. The terrestrial offset and compensation response will align with the aquatic offset response and natural character plantings, helping to create linkages across a predominantly pastural landscape. Furthermore, the response will contribute to the enhancement and protection of threatened fauna at the national level (eg, ornate skinks, spotless crake).

(e) **Ecological equivalence (or like-for-like)** – with the proper implementation of the EMP, it is anticipated that the restored habitats and revegetated areas will achieve ecological equivalence or greater in the medium to long-term (10-25 years).

(f) **Permanence** – all terrestrial and two wetland offset sites will be located on land owned by Waka Kotahi. Te Ripo O Hinemata wetland is protected under the Kereru Conservation Covenant and will continue to be managed by the Manawatū Kukutauaki No. 3 Section 2E5 Trust. If Waiopehu Reserve is used as a compensation site for enhancing and protecting lizard values, the special status of that land satisfies the principle of permanence. A title instrument would likely need to be secured in order to appropriately provide for a predator-proof fence on private land surrounding the reserve.

(g) **Stakeholder participation** – input from a range of stakeholders, including Horizons, the Department of Conservation, Forest and Bird, and iwi have helped to shape the offset and compensation response. Notably, the applicant will be working with Ngāti Raukawa and Kereru Marae to progress the restoration of Te Ripo O Hinemata wetland, as well as the Muaūpoko Tribal Authority with respect to enhancing indigenous lizard populations affected by the Project.

322. The models developed for the offsetting and compensation package demonstrate that a net indigenous biodiversity gain can be achieved for terrestrial and wetland habitats. Moreover, the two-pronged approach of using mitigation and compensation (in the short term) and offsetting (in the medium term) to address residual effects on wetlands will result in a larger positive gain than would otherwise be required if wetland extent was replaced using a 1:1 ratio, ie, adopting a not net loss approach as per Policy 6 of the NPSFM. Fundamental to this is the creation of large areas of indigenous wetland vegetation and open water by rehabilitating the proposed materials supply sites.

323. In my opinion, if the offset and compensation proposal described in my assessment is appropriately implemented as per the consent conditions and the performance outcomes of an Ecological Management Plan, then the residual effects of the Project will be appropriately addressed, resulting in a Net Gain of indigenous biodiversity for terrestrial and wetland habitats, as well as for indigenous fauna species such as ornate skinks, forest and wetland birds, and land snails. In this respect, the proposed measures described in this assessment are considered to satisfy the following key statutory directives: Policy 6 of the NPSFM; Policy 13-3 and Policy 3-3 of the One Plan (Horizons); and Policy 37, Policy 38 and Policy 40(c) of the Natural Resources Plan – Appeals Version (Greater Wellington).

Nicholas Paul Goldwater
14 October 2022

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APPENDIX J.1

DESCRIPTION AND PHOTOGRAPHS OF TERRESTRIAL VEGETATION AND HABITATS WITHIN THE Ō2NL PROJECT AREA

APPENDIX J.2

LIST OF VASCULAR PLANT
SPECIES FOR THE
Ō2NL PROJECT AREA

INDIGENOUS SPECIES

Gymnosperms

Agathis australis	kauri
Dacrycarpus dacrydioides	kahikatea
Dacrydium cupressinum	rimu
Pectinopitys ferruginea	miro
Podocarpus laetus	Hall's tōtara
Podocarpus totara var. *totara*	tōtara
Prumnopitys taxifolia	mataī

Monocot. trees and shrubs

Cordyline australis	tī kōuka, cabbage tree
Rhopalostylis sapida	nīkau

Dicot. trees and shrubs

Alectryon excelsus subsp. *excelsus*	tītoki
Aristotelia serrata	makomako, wineberry
Beilschmiedia tawa	tawa
Coprosma grandifolia	kanono, raurēkau, raurākau, manono
Coprosma propinqua var. *propinqua*	mingimingi
Coprosma repens	taupata
Coprosma rhamnoides	
Coprosma robusta	karamū, kāramuramu
Coriaria arborea var. *arborea*	tutu
Corokia cotoneaster	korokio, korokio tāranga
Corynocarpus laevigatus	karaka
Dodonaea viscosa	akeake
Dysoxylum spectabile	kohekohe
Elaeocarpus dentatus	hīnau, whīnau
Fuscospora fusca	red beech, tawhairaunui
Fuscospora solandri	black beech
Geniostoma ligustrifolium var. *ligustrifolium*	hangehange
Griselinia littoralis	kāpuka
Griselinia lucida	puka
Hedycarya arborea	porokaiwhiri; pigeonwood
Hoheria sexstylosa	houhere, lacebark
Knightia excelsa	rewarewa
Kunzea robusta	kānuka
Laurelia novae-zelandiae	pukatea
Leptospermum scoparium agg.	mānuka
Lophomyrtus bullata[16]	ramarama
Melicope simplex	poataniwha
Melicytus ramiflorus subsp. *ramiflorus*	māhoe
Metrosideros excelsa	pōhutukawa
Metrosideros umbellata	southern rātā
Myrsine australis	māpou, matipou, māpau
Myrsine salicina	toro
Nestegis lanceolata	white maire, maire rauriki
Olearia traversiorum	Chatham Island akeake
Pennantia corymbosa	kaikōmako
Piper excelsum subsp. *excelsum*	kawakawa
Pittosporum crassifolium	karo
Pittosporum eugenioides	tarata; lemonwood
Pittosporum tenuifolium	kōhūhū, rautāhiri, rautāwhiri
Plagianthus regius subsp. *regius*	ribbonwood, mānatu
Pseudopanax arboreus	whauwhaupaku, puahou, five finger

[16] Planted

Pseudopanax crassifolius × *P. arboreus*	
Schefflera digitata	patē
Solanum aviculare var. *aviculare*	poroporo
Sophora tetraptera	kōwhai
Streblus heterophyllus	tūrepo
Veronica stricta var. *stricta*	koromiko, kōkōmuka
Vitex lucens	pūriri
Weinmannia racemosa	kāmahi

Dicot. lianes

Metrosideros perforata	aka
Muehlenbeckia australis	puka
Muehlenbeckia complexa	pōhuehue
Parsonsia heterophylla	akakaikiore

Ferns

Asplenium bulbiferum	mouku, hen and chicken fern
Asplenium flaccidum	makawe, ngā makawe o Raukatauri
Asplenium gracillimum	
Asplenium oblongifolium	huruhuru whenua
Asplenium polyodon	petako
Azolla rubra	Pacific azolla
Icarus filiforme	pānako
Cranfillia fluviatilis	kiwikiwi, kiwakiwa
Blechnum novae-zelandiae	kiokio
Cyathea dealbata	ponga, silver fern
Cyathea medullaris	mamaku
Cyathea smithii	kātote, soft tree fern
Deparia petersenii subsp. *congrua*	
Dicksonia squarrosa	whekī
Diplazium australe	
Histiopteris incisa	mātātā, water fern
Hypolepis ambigua	
Dendroconche scandens	mokimoki
Paesia scaberula	mātātā
Parapolystichum glabellum	smooth shield fern
Polystichum vestitum	pūniu, prickly shield fern
Pteridium esculentum	rārahu, bracken
Pteris macilenta	titipo, sweet fern
Pteris tremula	turawera, shaking brake
Pyrrosia elaeagnifolia	leather-leaf fern
Zealandia pustulata subsp. pustulata	kōwaowao, pāraharaha, hound's tongue fern

Orchids

Earina autumnalis	raupeka

Grasses

Chionochloa flavicans	
Microlaena stipoides	pātītī, meadow rice grass

Sedges

Carex geminata agg.	rautahi
Carex secta	pūrei, pūkio
Carex virgata	pūrei
Cyperus ustulatus f. *ustulatus*	toetoe upoko-tangata
Eleocharis acuta	spike sedge
Isolepis cernua	

Isolepis prolifera	
Isolepis reticularis	
Machaerina rubiginosa	
Schoenoplectus tabernaemontani	kāpūngāwhā

Rushes

Juncus edgariae	wi, wīwī
Juncus pallidus	wi, wīwī
Juncus planifolius	

Monocot. herbs (other than orchids, grasses, sedges, and rushes)

Arthropodium cirratum	rengarenga
Lemna disperma	karearea
Phormium tenax	harakeke, flax
Typha orientalis	raupō

Composite herbs

Leontodon saxatilis	hawkbit
Pseudognaphalium luteoalbum agg.	pukatea
Senecio bipinnatisectus	Australian fireweed

Dicot. herbs (other than composites)

Epilobium pallidiflorum	tawarewa
Galium sp.	
Galium trilobum	
Haloragis erecta subsp. *erecta*	toatoa
Hydrocotyle moschata	

NATURALISED AND EXOTIC SPECIES

Gymnosperms

Cryptomeria japonica	Japanese cedar
Cupressus macrocarpa	macrocarpa
Ginkgo biloba	Ginkgo, maidenhair tree
Pinus radiata	radiata pine
Pseudotsuga menziesii	Douglas fir
Sequoia sp.	redwood

Monocot. trees and shrubs

Alocasia brisbanensis	elephant's ears
Trachycarpus fortunei	Chinese windmill palm

Dicot. trees and shrubs

Acacia longifolia	Sydney golden wattle
Acacia melanoxylon	Tasmanian blackwood
Acer pseudoplatanus	sycamore maple
Alnus glutinosa	common alder
Banksia sp.	banksia
Berberis glaucocarpa	barberry
Buddleja davidii	buddleia
Camellia japonica	common camellia
Chamaecytisus palmensis	tree lucerne
Cotoneaster glaucophyllus	cotoneaster
Cytisus scoparius	broom
Elaeagnus ×reflexa	elaeagnus

Erica lusitanica	Spanish heath
Eucalyptus sp.	eucalyptus
Hydrangea macrophylla	hydrangea
Ilex aquifolium	holly
Juglans ailantifolia	Japanese walnut
Leptospermum laevigatum	coast tea tree
Leycesteria formosa	Himalayan honeysuckle
Ligustrum lucidum	tree privet
Liquidambar styraciflua	liquidambar
Lupinus arboreus	lupin
Magnolia sp.	
Olea europaea	Olive
Paraserianthes lophantha	brush wattle
Populus alba	white poplar
Populus sp.	
Prunus avium	sweet cherry
Prunus persica	peach tree, nectarine
Prunus sp.	ornamental cherry
Quercus palustris	pin oak
Quercus robur	English oak
Rhamnus alaternus	Italian evergreen buckthorn
Robinia pseudoacacia	false acacia, black locust, robinia
Rubus sp. (*R. fruticosus* agg.)	blackberry
Salix cinerea	grey willow
Salix ´fragilis	crack willow
Sambucus nigra	elder
Senecio angulatus	Cape ivy
Solanum pseudocapsicum	Jerusalem cherry
Ulex europaeus	gorse
Ulmus sp.	elm

Dicot. lianes

Calystegia silvatica	greater bindweed
Clematis vitalba	old man's beard
Delairea odorata	German ivy
Lonicera japonica	Japanese honeysuckle
Passiflora tarminiana	banana passionfruit
Passiflora tripartita	banana passionfruit
Vinca major	periwinkle

Grasses

Agrostis stolonifera	creeping bent
Anthoxanthum odoratum	sweet vernal
Cenchrus clandestinus	kikuyu grass
Cortaderia jubata	purple pampas
Cortaderia selloana	pampas
Dactylis glomerata	cocksfoot
Echinochloa crus-galli	barnyard grass
Ehrharta erecta	veldt grass
Glyceria declinata	blue sweetgrass
Glyceria fluitans	floating sweet grass
Glyceria maxima	reed sweetgrass
Holcus lanatus	Yorkshire fog
Lolium arundinaceum subsp. *arundinaceum*	tall fescue
Lolium perenne	rye grass
Paspalum dilatatum	paspalum
Paspalum distichum	Mercer grass

Rushes

Juncus articulatus	jointed rush

Juncus effusus var. *effusus*	soft rush, leafless rush
Juncus squarrosa	heath rush

Monocot. herbs (other than orchids, grasses, sedges, and rushes)

Agapanthus praecox	agapanthus
Canna indica	canna lily, Indian shoot
Crocosmia ×crocosmiiflora	montbretia
Hedychium flavescens	wild ginger, yellow ginger
Iris foetidissima	stinking iris
Libertia peregrinans[17]	
Tradescantia fluminensis	tradescantia
Zantedeschia aethiopica	arum lily

Composite herbs

Achillea millefolium	yarrow
Bidens frondosa	beggars' ticks
Carduus nutans	nodding thistle
Cirsium arvense	Californian thistle
Cirsium vulgare	Scotch thistle
Erigeron bonariensis	wavy-leaved fleabane
Erigeron canadensis	Canadian fleabane
Erigeron sumatrensis	broad-leaved fleabane
Helminthotheca echioides	oxtongue
Jacobaea vulgaris	ragwort
Senecio skirrhodon	gravel groundsel
Soliva sessilis	Onehunga weed

Dicot. herbs (other than composites)

Apium nodiflorum	water celery
Callitriche stagnalis	starwort
Cerastium fontanum subsp. *vulgare*	mouse-ear chickweed
Chenopodium murale	nettle-leaved fathen
Conium maculatum	hemlock
Daucus carota	wild carrot
Digitalis purpurea	foxglove
Epilobium ciliatum	tall willow herb
Euphorbia peplus	milkweed
Fumaria officinalis	fumitory
Galium palustre	marsh bedstraw
Lotus pedunculatus	lotus
Lotus suaveolens	hairy birdsfoot trefoil
Ludwigia palustris	water purslane
Lythrum hyssopifolia	hyssop loosestrife
Medicago sp.	
Myosotis laxa	water forget-me-not
Myosotis sylvatica	garden forget-me-not
Nasturtium officinale	watercress
Nymphaea alba	water lily
Orobanche minor	broomrape
Oxalis sp.	
Parentucellia viscosa	tarweed
Persicaria hydropiper	water pepper
Physalis peruviana	cape gooseberry
Phytolacca octandra	inkweed
Plantago lanceolata	narrow-leaved plantain
Plantago major	broad-leaved plantain
Ranunculus repens	creeping buttercup
Rorippa sylvestris	Creeping yellow cress

[17] Planted

Rumex acetosella	sheep’s sorrel
Rumex obtusifolius	broad-leaved dock
Silene gallica	catchfly
Solanum chenopodioides	velvety nightshade
Solanum erianthum	Velvet nightshade
Solanum nigrum	black nightshade
Stachys sylvatica	hedge woundwort
Stellaria media	chickweed
Symphyotrichum subulatum	
Trifolium pratense	red clover
Trifolium repens	white clover
Tropaeolum majus	garden nasturtium

APPENDIX J.3

TECHNICAL ASSESSMENT EFFECTS ON THREATENED PLANTS FOR THE Ō2NL PROJECT AREA

DESCRIPTION AND PHOTOGRAPHS OF TERRESTRIAL VEGETATION AND HABITATS WITHIN THE Ō2NL PROJECT AREA

Terrestrial and wetland vegetation and habitats

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TERRESTRIAL

ITF1 - Tawa forest on terraces and hillslopes

This vegetation type comprises forest remnants dominated by tawa (*Beilschmiedia tawa*) on Properties 163 and 287. These forest remnants are surrounded by pasture.

A mature forest remnant occurs at Property 287, with tawa trees common in the canopy and emergent rewarewa (*Knightia excelsa*). This forest remnant is currently outside of the possible highway designation. Other species recorded within this vegetation type include frequent māhoe (*Melicytus ramiflorus* subsp. *ramiflorus*), kawakawa (*Piper excelsum* subsp. *excelsum*), kōhūhū (*Pittosporum tenuifolium*), tītoki (*Alectryon excelsus* subsp. *excelsus*), hangehange (*Geniostoma ligustrifolium* var. *ligustrifolium*), porokaiwhiri (*Hedycarya arborea*). Pukatea (*Laurelia novae-zelandiae*), tōtara (*Podocarpus totara* var. *totara*) and nīkau (*Rhopalostylis sapida*) also occur occasionally. Some non-local indigenous species have been planted within this forest remnant, including pōhutukawa (*Metrosideros excelsa*), kauri (*Agathis australis*), and karaka (*Corynocarpus laevigatus*).

A small tawa forest remnant also occurs at Property 163, with a canopy comprising abundant tawa. Other species include frequent kohekohe (*Dysoxylum spectabile*), nīkau, karaka, kawakawa, and kanono (*Coprosma grandifolia*) within the understorey, and occasional tarata (*Pittosporum eugenioides*), whauwhaupaku (*Pseudopanax arboreus*), tōtara, māhoe, karamū (*Coprosma robusta*), rewarewa and kōhūhū. Some non-local indigenous species have been planted, particularly along the margins of this remnant, including kauri, and pōhutukawa. Exotic species include elder (*Sambucus nigra*), holly (*Ilex aquifolium*), and blackberry (*Rubus fruticosus* agg.). This forest remnant is largely outside of the possible highway designation.

Plate 1: Tawa forest remnant at Property 163. 13 April 2021.

ITF2 - Tawa- kohekohe forest on terraces and hillslopes

This vegetation type comprises remnants of tawa-kohekohe forest surrounded by pasture.

At Property 39, the existing SH1 runs along the northern boundary of a mature tawa-kohekohe forest remnant that is otherwise surrounded by pasture. This vegetation type includes a kohekohe canopy *c*.8-10 metres tall, with emergent tawa trees *c*.15-18 metres tall. Occasional mature rewarewa and pukatea trees are also emergent above the kohekohe canopy. Kōhūhū, kawakawa, karaka, tarata, and karamū occur frequently within the subcanopy. *Muehlenbeckia australis* and banana passionfruit (*Passiflora tripartita*) vines occur frequently along the forest margin. This forest remnant is surrounded by deer exclusion fencing.

At Property 42, there is a remnant of tawa-kohekohe forest. Kohekohe (*c*.15 metres tall) are abundant and tawa (*c*.20 metres tall) are common in the forest canopy. The tawa and kohekohe trees have Diameter at Breast Height (DBH) of *c*.50-60 centimetres, with the largest tawa tree measuring *c*.90 centimetres DBH. Pukatea, tītoki, rewarewa, and nīkau occur occasionally within the canopy and as emergent species. Kawakawa, māhoe, and kōhūhū occur frequently in the understorey and several fern species occur in the ground tier. This forest remnant is surrounded by deer exclusion fencing (Plate 1).

At Property 43, a remnant of tawa-kohekohe forest occurs adjacent to, but outside the proposed road designation. This forest remnant comprises a canopy of abundant tawa and kohekohe trees. Occasional pukatea, māhoe, porokaiwhiri, nīkau, and tītoki also occur within the canopy. Abundant kohekohe, māhoe, kawakawa, nīkau, karaka, and pukatea saplings occur within the understorey and ground tiers. This forest remnant is fenced, but likely has a history of grazing as it is missing the subcanopy tier and lacks the diversity of ground ferns, epiphytes, and rātā *Metrosideros* spp.) vines that would normally be expected. *Muehlenbeckia australis* is locally common and akakaikiore (*Parsonsia heterophylla*) occurs occasionally along the forest margin.

Plate 1: Tawa-kohekohe forest at Property 42. 26 March 2021.

TF3 - Kohekohe-tītoki-karamū forest on stream terrace

At Property 151, to the north of a tributary of the Manakau Stream, there is a very small area of kohekohe-tītoki-karamū- forest. This vegetation type includes one mature tītoki and one mature kohekohe. The tītoki is approximately nine metres tall and 79 centimetres DBH, and the kohekohe is approximately eight metres tall and 50 centimetres DBH.

The understorey and ground tiers feature abundant karamū and greater bindweed (*Calystegia sylvatica*), with frequent māhoe, mamaku (*Cyathea medullaris*), kawakawa, blackberry, and kohekohe.Occasional huruhuru whenua (*Asplenium oblongifolium*) and kōwaowao (*Zealandia pustulata* subsp. *pustulata*) also occur in the ground tier (Plate 2).

Plate 2: Kohekohe-tītoki-karamū forest at Property 151. 23 March 2021.

ITF4 - Māhoe forest and scrub on hillslopes and terrace risers

Areas of māhoe forest and scrub occur on Properties 167, 171, and 493.

At Property 493, this vegetation type comprises a canopy of abundant māhoe on a hillslope with frequent mamaku, ponga (*Cyathea dealbata*), whekī (*Dicksonia squarrosa*), and karamū. The understorey comprises sweet cherry (*Prunus avium*), with occasional kiwikiwi (*Cranfillia fluviatilis*), hangehange, kawakawa, and inkweed (*Phytolacca octandra*). Occasional banana passionfruit and *Muehlenbeckia australis* occur along the forest margins.

At Property 167, māhoe scrub occurs along a waterway with occasional tarata, kawakawa, kanono, barberry (*Berberis glaucocarpa*), poroporo (*Solanum aviculare* var. *aviculare*) and blackberry (Plate 3).

Plate 3: Māhoe forest and scrub at Property 167. 24 April 2021.

ITF5 - Puka-kōhūhū forest on hillslope

At Property 39, an area of restoration plantings contains a canopy of abundant puka (*Griselinia lucida*) and kōhūhū, with emergent rewarewa. A naturally regenerating subcanopy and understorey includes abundant kawakawa and kohekohe saplings. Saplings of other indigenous tree species are occasional to frequent, including māhoe, makomako (*Aristotelia serrata*), karaka, tītoki, tawa, and tarata. Mamaku, ponga, hangehange, kanono, *Coprosma rhamnoides*, kōwaowao, and nīkau also occur in the understorey.

Locally abundant mātātā (*Histiopteris incisa*) occurs in a light gap, and harakeke (*Phormium tenax*) is occasional around the pond at the bottom of the gully. Non-local and exotic species include occasional sweet cherry, pōhutukawa, and radiata pine. Banana passionfruit and *Muehlenbeckia australis* occur predominantly along the forest margins (Plate 4).

Plate 4: Puka-kōhūhū forest with emergent rewarewa at Property 39.

ITF6 - Tarata-rewarewa forest on hillslope

At Property 40, an area of tarata-rewarewa forest is likely the result of restoration plantings from the 1970's. Abundant tarata forms a *c*.5-6 metres tall canopy, with emergent rewarewa up to *c*.15 metres tall. Species in the understorey include frequent puka, kōhūhū, patē (*Schefflera digitata*), māhoe, kawakawa, makomako, mamaku, and karamū. Abundant māhoe and kohekohe saplings are regenerating in the ground tier. The Chatham Island akeake (*Olearia traversiorum*) is the only recorded species that is not indigenous to the southern North Island (Plate 5).

Plate 5: Tarata-rewarewa forest at Property 40. 23 March 2021.

ITF7 - Tītoki forest on terrace

Tītoki forest occurs in the western corner of the forest area at Property 465. Tītoki is abundant in the canopy, with occasional cherry (*Prunus* sp.), redwood (*Sequoia sempervirens*), karaka, and poataniwha (*Melicope simplex*). The understorey and ground tiers are sparse and dominated by leaf litter with occasional tradescantia (*Tradescantia fluminensis*) (Plate 6).

Plate 6: Tītoki forest at Property 465. 12 June 2021.

ITS1 - Māhoe-karamū scrub on stream scarp and hillslopes

Permission was not granted to access Property 207, so this site was assessed from a public vantage point. Māhoe-karamū scrub was observed along an escarpment, with a large tītoki tree and occasional kanono also visible. Pasture occurs above and below the escarpment. This vegetation type largely occurs outside the possible highway corridor.

At Properties 455, 459, 461, 472, 473, and 493, this vegetation type occurs adjacent to the railway and features a canopy approximately four metres tall. Other canopy species include occasional mamaku, tarata, cotoneaster (*Cotoneaster glaucophyllus*), and karaka. Frequent tree lucerne (*Chamaecytisus palmensis*), blackberry, Japanese honeysuckle (*Lonicera japonica*), puka, and barberry occur along the edges, and kiokio (*Blechnum novae-zelandiae*), mātātā, and bracken (*Pteridium esculentum*) occur occasionally in the understorey (Plate 7).

Plate 7: Māhoe-karamū scrub at Property 461. 26 March 2021.

ITT01 - Kāmahi-kānuka treeland on stream scarp

Frequent kāmahi (*Weinmannia racemosa*) and kānuka (*Kunzea robusta*) trees occur along a terrace scarp at Property 55. These trees are approximately four metres tall and occur over frequent Spanish heath (*Erica lusitanica*), gorse (*Ulex europaeus*), and barberry. Kāmahi trees have a DBH of approximately 40 centimetres

The ground tier features frequent bare earth with occasional mātātā, whekī, aka (*Metrosideros perforata*), cocksfoot (*Dactylis glomerata*), kiokio, kātote (*Cyathea smithii*), Himalayan honeysuckle (*Leycesteria formosa*), and kōwaowao. Pōhutukawa and tōtara saplings are also occasional in the ground tier (Plate 8).

Plate 8: Kāmahi and kānuka treeland along a scarp at Property 55. 24 March 2021.

ITT02 - Karaka-tawa treeland on terrace

At Property 61, areas of treeland dominated by karaka and tawa. These areas contain occasional porokaiwhiri, tī kōuka (*Cordyline australis*), radiata pine, sycamore (*Acer pseudoplatanus*), pūriri (*Vitex lucens*), and olive trees (*Olea europaea*). Barberry occurs occasionally and leather-leaf fern (*Pyrrosia elaeagnifolia*) is growing on some of these trees (Plate 9).

Plate 9: Karaka-tawa treeland at Property 61. 14 April 2021.

ITT03 - Planted indigenous treeland on terraces and hillslopes

This vegetation type is artificially established and occurs at Properties 42, 91, 307, and 459.

At Property 42, planted indigenous trees occur within small fenced areas, adjacent to a farm gate. These were presumably established for amenity purposes.

At Property 91, a small area of mānuka (*Leptospermum scoparium* agg.) and tōtara treeland occurs adjacent to the driveway.

At Property 307, this vegetation type comprised a small stand of southern rātā, miro (*Pectinopitys ferruginea*), tōtara, and rimu (*Dacrydium cupressinum*) trees.

At Property 459, planted tōtara trees with one kahikatea (*Dacrycarpus dacrydioides*) and one kauri tree occur with abundant *Muehlenbeckia australis*. Occasional regenerating māhoe, kawakawa, and hangehange occur in the understorey (Plate 10).

Plate 10: Planted indigenous treeland at Property 459. 23 April 2021.

ITT04 - Tī kōuka treeland on terrace

Three tī kōuka trees and one karaka tree occur over grazed pasture at Property 61 (Plate 11).

Plate 11: Tī kōuka treeland at Property 61. 14 April 2021.

ITT05 - Tītoki treeland on terrace

At Property 465, a single tītoki tree occurs over grazed pasture (Plate 12).

Plate 12: Tītoki tree within pasture at Property 465. 12 April 2021.

ITT06 - Tītoki-hīnau-maire treeland on terrace

At Property 465, one tītoki, one hīnau (*Elaeocarpus dentatus*), and one maire (*Nestegis lanceolata*) occur over pasture (Plate 14).

Plate 13: Tītoki-hīnau-maire treeland at Property 465. 12 April 2021.

ITT07 - Tawa-tītoki treeland on terrace

An area of treeland at Property 207, to the west of the preferred alignment, comprises a discontinuous canopy of tawa and tītoki. Other canopy tree species include occasional mānatu (*Plagianthus regius* subsp. *regius*), nīkau, and black beech (*Fuscospora solandri*). This area is grazed and the understorey comprises pasture grasses, tradescantia, thistles, inkweed, *Coprosma propinqua var. propinqua*, and barberry. Akakaikiore and *Muehlenbeckia australis* occur within the canopy, and leather-leaf fern occurs on the trunks and branches of the trees (Plate 14).

Plate 14: Tawa-tītoki treeland at Property 207. 20 May 2021.

ITFn01 - Kiokio fernland on hillslope

An area of kiokio fernland occurs at Property 19 near the base of a hillslope. This area includes abundant kiokio, locally common lace fern (*Paesia scaberula*), and occasional karamū, whekī, and creeping buttercup (*Ranunculus repens*) (Plate 15).

Plate 15: Kiokio fernland at Property 19. 27 May 2021.

MTF1 - Māhoe-barberry-*Muehlenbeckia australis* forest and scrub on stream scarp

Property 212 includes an area of forest and scrub on an old stream escarpment. The canopy comprises abundant māhoe and barberry trees and shrubs (*c.* 2-3 metres tall), with occasional emergent pukatea (*c.* six metres tall). *Muehlenbeckia australis* is also common within the canopy.

Porokaiwhiri, akakaikiore, tōtara, kawakawa, and māpou (*Myrsine australis*) occur occasionally in the understorey and river rocks are common within the ground tier (Plate 16).

Mature trees within this vegetation type include māhoe (*c.*33 centimetres DBH), pukatea (*c.*32-47 centimetres DBH), and porokaiwhiri (35 centimetres DBH).

Plate 16: Māhoe-barberry-*Muehlenbeckia australis* forest and scrub at Property 212. 22 March 2021.

MTF2 - Māhoe-sweet cherry scrub and forest on hillslope

Mixed indigenous-exotic vegetation occurs along a hillslope at Property 472. Māhoe and sweet cherry trees are common, with locally common tree lucerne and occasional karamū and radiata pine. Frequent *Muehlenbeckia australis* and occasional banana passionfruit also occur within the canopy (Plate 17). Inkweed, Australian fireweed (*Senecio bipinnatisectus*), blackberry, cape gooseberry (*Physalis peruviana*), and mātātā occur under the canopy.

Plate 17: Māhoe-sweet cherry scrub/forest at Property 472. 22 March 2021.

MTF3 - False acacia-tītoki-cherry forest on terrace

At Property 465, this vegetation type comprises abundant false acacia (*Robinia pseudoacacia*) and tītoki. Ornamental cherry is also common in the canopy. The understorey is sparse and includes abundant inkweed and tradescantia, with occasional kawakawa (Plate 18).

Plate 18: False acacia-tītoki-cherry forest at Property 465. 18 June 2021.

MTF4 - Crack willow-māhoe forest/scrub on river margins

Abundant crack willow (*Salix xfragilis*) and māhoe occur along the banks of the Ōhau River at Property 212. Kanono, kawakawa, hangehange, mamaku, karamū, koromiko (*Veronica stricta* var. *stricta*), and *Muehlenbeckia australis* occur occasionally. Exotic species such as montbretia (*Crocosmia ×crocosmiiflora*), German ivy (*Delairea odorata*), and greater bindweed also occur occasionally. Fern species include turawera (*Pteris tremula*), mouku (*Asplenium bulbiferum*), and *Diplazium australe* (Plate 19).

Plate 19: Crack willow-māhoe forest/scrub at Property 212. 22 March 2021.

MTF5- Mixed indigenous-exotic planted forest on hillslopes

Mixed indigenous-exotic planted forest occurs at Properties 19, 40, 42, 47, 52, 307, 311, 326, 473, 484, and 488.

At Property 19, this vegetation type occurs on a hillslope above a culvert and wetland. Plant species include mamaku, ornamental cherry, tītoki, rimu, and crack willow.

At Property 40, this vegetation type comprises occasional rimu and tarata. Non-local indigenous species include kauri, pōhutukawa, karo (*Pittosporum crassifolium*), and Chatham Island akeake. Exotic species include banksia (*Banksia* sp.), purple toetoe (*Cortaderia jubata*), and coast tea tree (*Leptospermum laevigatum*) (Plate 20).

Mixed indigenous-exotic planted forest along an escarpment at Property 47 includes māhoe, mamaku, tōtara, tarata, and a peach tree (*Prunus persica*). Pasture grasses dominate the understorey.

At Property 47 and 52, an area of mixed indigenous-exotic planted forest occurs adjacent to South Manakau Road. A stream flows through the centre of this area. Plant species include tōtara, oak (*Quercus* sp.), kauri, ginkgo (*Ginkgo biloba*), pūriri, karaka, tarata, liquidambar (*Liquidambar styraciflua*), camellia (*Camellia japonica*), magnolia (*Magnolia* sp.), poplar (*Poplar* sp.), and pōhutukawa. Naturally established māhoe, kanono, tōtara, and kohekohe occur in the subcanopy and tradescantia and montbretia is common in the ground tier. These plantings are estimated to be approximately 45 years old.

This vegetation type also occurs west of Arapaepae Road at Properties 311, 326, and 307. Plant species include Japanese cedar (*Cryptomeria japonica*), ornamental cherry, eucalyptus (*Eucalyptus* sp.), elm (*Ulmus* sp.), poplar, redwood, magnolia, māhoe, rimu, kahikatea, tī kōuka, tītoki, mamaku, whekī, kohekohe, and false acacia. Wild ginger (*Hedychium flavescens*) and agapanthus (*Agapanthus praecox*) occur in the ground tier.

At Properties 473 and 484 this vegetation type includes planted kahikatea, red beech (*Fuscospora fusca*), exotic conifers, ramarama (*Lophomyrtus bullata*), rewarewa, kōwhai (*Sophora tetraptera*), kānuka, tarata, tōtara, kauri, and toro (*Myrsine salicina*). Indigenous species are naturally regenerating within the understorey, including mamaku, whekī, karamū, and māhoe.

Plate 20: Mixed indigenous-exotic planted forest at Property 40. 23 March 2021.

MTF6 - Karaka-māhoe-kawakawa forest and scrub on terrace

At Property 479 there is an area of scrub dominated by karaka, māhoe, and kawakawa, with frequent ornamental cherry, locally common old man's beard (*Clematis vitalba*), and occasional porokaiwhiri. The reduced abundance of false acacia within this vegetation type differentiates it from the other vegetation types at Property 479.

MTF7 - Tītoki-karaka forest on terrace

Tītoki-karaka forest occurs in the southeast corner of the forested area at Property 465. Tītoki and karaka are common in the canopy. Cherry trees are locally common along the margin. The understorey is relatively sparse, but includes frequent māpou and occasional poataniwha (Plate 21).

Plate 21: Tītoki-karaka forest at Property 465. 18 June 2021.

MTF8 - Tītoki-false acacia-poataniwha-karaka forest on terrace

In this vegetation type at Property 465, the canopy comprises tītoki, false acacia, poataniwha, and karaka. The understorey is relatively sparse, with occasional kawakawa. Tradescantia is common in the ground tier (Plate 22).

Plate 22: Tītoki-false acacia-poataniwha-karaka forest at Property 465. 18 June 2021.

MTS1 - Māhoe-karo scrub with emergent radiata pine on hillslope

At Property 20, a *c*.3-5 metre tall scrub canopy comprises abundant māhoe and karo, with frequent emergent radiata pine to *c*.10-15 metres. Emergent radiata pine trees comprise *c*.20% of this vegetation type. The presence of other species is likely the result of natural establishment and planting. Other species include frequent karamū and sweet cherry, with occasional ponga, tarata, houhere (*Hoheria sexstylosa*), and hangehange (Plate 23).

Plate 23: Māhoe-karo scrub with emergent radiata pine at Property 20. 22 March 2021.

MTS2 - Barberry scrub with emergent totara on river escarpment

Barberry scrub occurs along an old river terrace escarpment at Property 212, with a canopy approximately 2-3 metres tall. Whilst barberry is common, mature tōtara trees occur as canopy emergents, and tawa, māhoe, kawakawa, mamaku, māpou and kāpuka (*Griselinia littoralis*) trees are occasional. The tōtara trees measured have DBHs of between 35-70 centimetres and are approximately eight metres tall. The tawa has a 29-centimetre DBH. River rocks are common in the ground layer, which reflects the geological history of the site (Plate 24).

Plate 24: Barberry scrub with emergent tōtara at Property 212. 22 March 2021.

MTS3 – Barberry-blackberry-*Muehlenbeckia australis*-greater bindweed-(māhoe) scrub on escarpment

This vegetation type occurs along an escarpment to the south of a stream at Property 207. Barberry, blackberry, *Muehlenbeckia australis*, and greater bindweed are common, and māhoe occurs frequently within the canopy (approximately two to three metres tall). Other species include locally abundant bracken, and occasional gorse, mamaku, tōtara, hangehange, kawakawa, huruhuru whenua, makawe (*Asplenium flaccidum*), inkweed, foxglove (*Digitalis purpurea*), and tradescantia. Seedling kohekohe, tītoki, pukatea, and kanono were observed in the ground tier (Plate 25).

Plate 25: Barberry-blackberry-*Muehlenbeckia australis*-greater bindweed-(māhoe) scrub at Property 207. 20 May 2021.

MTS4 - Māhoe-mamaku-blackberry-barberry scrub on escarpment

At Property 151, māhoe-mamaku scrub occurs along an escarpment with common blackberry and barberry, and a single mature pukatea tree. Pasture occurs above and below this vegetation type.

ETF1 - Crack willow forest/scrub on riparian margins and hillslope

Crack willow forest and scrub occurs at Properties 151, 158, 209, 212, 459, and 659.

At Properties 151, 158, and 659, this vegetation type occurs on either side of a tributary of the Manakau Stream and comprises abundant crack willow, occasional brush wattle (*Paraserianthes lophantha*), and locally common blackberry.

At Property 209, crack willow forest and scrub occurs along the southern bank of the Ōhau River and includes a canopy of abundant crack willow, with occasional Sydney golden wattle (*Acacia longifolia*) and tree lucerne. Some indigenous species are regenerating within the understorey including frequent māhoe, and occasional karamū, tutu (*Coriaria arborea* var. *arborea*), and kawakawa. *Muehlenbeckia australis* occurs occasionally. Pest plant species include frequent gorse, blackberry, German ivy, and occasional stinking iris (*Iris foetidissima*) and tree privet (*Ligustrum lucidum*).

At Property 212, crack willow forest and scrub occurs along the northern bank of the Ōhau River, and includes a 10 to 12 metre tall canopy of abundant crack willow trees with a four to six metre tall subcanopy of occasional māhoe, tutu, and karamū. Old man's beard and greater bindweed occur occasionally (Plate 26).

At Property 459, crack willow trees have been planted along the railway. Frequent regenerating māhoe and kawakawa occur in the understorey, as does occasional karamū, taupata (*Coprosma repens*), karo, barberry, and cotoneaster. Frequent old man's beard, Japanese honeysuckle, and blackberry are also present.

Plate 26: Crack willow along the Ōhau River as viewed from Property 212. 22 March 2021.

ETF2 - Eucalyptus forest on terrace

A canopy of eucalyptus trees occurs at Properties 167 and 171. Understorey vegetation is largely absent and the ground tier features creeping buttercup and/or Yorkshire fog with locally abundant blackberry. Locally abundant māhoe forms a subcanopy in two locations with occasional kawakawa, porokaiwhiri, poroporo, tarata, and kanono. A small stream runs through this vegetation type and includes occasional pūrei (Plate 27).

Plate 27: Eucalyptus forest at Property 167. 24 April 2021.

ETF3 - Radiata pine forest on hillslopes

Radiata pine forest occurs at Properties 158, 207, 221, 472, and 493.

Small areas of radiata pine forest occur on the banks of a tributary of the Manakau Stream at Property 158, and to the south of the quarry at Property 221. An area of radiata pine forest also occurs within the possible highway footprint in the northern extent of Property 207.

Radiata pine forest at Property 493 and 472 includes a canopy of abundant radiata pine trees with an understorey of frequent māhoe shrubs and occasional sweet cherry and inkweed. The pines are approximately 15 metres tall and have DBH of *c*.40 centimetres (Plate 28).

Plate 28: Radiata pine forest at Property 493. 22 March 2021.

ETF4 - Exotic treeland and forest on terraces and hillslopes

Exotic treeland and forest occurs at the following Properties: 9, 12, 14, 19, 21, 28, 29, 30, 31, 33, 43, 53, 57, 88, 91, 125, 132, 134/144, 139, 264, 273, 282, 286, 337, 349, 360, 363, 418, 421, 470, 472, 473, 485, 490, 493, 498, 499, 519, 535, 544, 550, 555, 586, 599. Tree species within this vegetation type include poplar, Tasmanian blackwood (*Acacia melanoxylon*), eucalyptus, false acacia, Douglas fir (*Pseudotsuga menziesii*), radiata pine, spruce (*Picea* sp.), liquidambar, ornamental cherry, banksia, redwood, oak, macrocarpa (*Cupressus macrocarpa*), crack willow, and a several of fruit tree species.

Permission to access Property 132 was not granted. As such, this vegetation type was assessed using desktop information and aerial imagery.

ETF5 - Sweet cherry forest on terrace

Along the southern margin of the forest area at Property 465 the canopy is dominated by sweet cherry. This vegetation type includes one redwood tree and has a very sparse understorey (Plate 29).

Plate 29: Sweet cherry forest at Property 465. 18 June 2021.

ETF6 - Redwood forest on terrace

Along the eastern margin of the forest at Property 465 the canopy is dominated by abundant redwood with occasional tītoki, tarata, karaka, sweet cherry, and false acacia. In the understorey there are occasional kawakawa, cape gooseberry and inkweed. The ground cover is dominated by pātītī (*Microlaena stipoides*) (Plate 30).

Plate 30: Redwood forest at Property 465. 12 April 2021.

ETF7 - False acacia-karaka forest on terrace

Mixed indigenous-exotic forest occurs at Property 479. The canopy is dominated by false acacia, with occasional emergent macrocarpa. Karaka (a non-local indigenous species) is also common in the canopy. Māpou, tītoki, māhoe, Chinese windmill palm (*Trachycarpus fortunei*), and ornamental cherry are frequent (Plate 31).

Plate 31: False acacia-karaka forest at Property 479. 22 March 2021.

ETF8 - Macrocarpa-radiata pine-false acacia forest on terrace

Along the northern margin of the forest area at Property 479, macrocarpa, radiata pine, and false acacia are common in the canopy, with occasional English oak (*Quercus robur*) and redwood. Frequent poataniwha, karaka, māhoe, kawakawa, Jerusalem cherry (*Solanum pseudocapsicum*), and barberry occur in the understorey. The ground tier is dominated by abundant tradescantia (Plate 32).

Plate 32: Macrocarpa-radiata pine-false acacia forest at Property 479.

ETG1 - Rank grassland on riparian margins

Rank grassland occurs at Properties 151, 158, 162, and 212. Some areas of pasture are also likely to be rank grassland at times, depending on mowing and grazing schedules. This vegetation type includes areas that were identified as likely to contain rank grassland most of the time (i.e., they are not subject to mowing or grazing).

Rank grassland dominated by cocksfoot occurs on either side of the tributary of the Manakau Stream at Property 151, 162, and 158. At Property 158, this vegetation type includes occasional emergent buddleia (*Buddleja davidii*), purple pampas, tutu, Australian fireweed, and gorse.

At Property 212, this vegetation type includes cocksfoot, tall fescue (*Lolium arundinaceum* subsp. *arundinaceum*), yarrow (*Achillea millefolium*), creeping buttercup, lotus (*Lotus pedunculatus*), blackberry, and mātātā (Plate 33).

Plate 33: Rank grassland at Property 212. 22 March 2021.

ETS1 - Crack willow-brush wattle-tree lucerne scrub on riparian margin

At Property 158, an area of crack willow-brush wattle-tree lucerne scrub occurs north of a tributary of the Manakau Stream. Crack willow, brush wattle, and tree lucerne are common in this vegetation type, which has regenerated since *c*. 2013 as a result of changes to the stream flow path. Broom (*Cytisus scoparius*) and gorse occur occasionally (Plate 34).

Plate 34: Crack willow-brush wattle-tree lucerne scrub at Property 158. 22 March 2021.

ETS2 - Gorse scrub on terrace

Gorse scrub occurs on Properties 209 and 212, on the terrace above the Ōhau River. Gorse is abundant, with occasional kānuka, inkweed, tall fescue, and māhoe (Plate 35).

Plate 35: Gorse scrub at Property 212. 22 March 2021.

ETS3 - Gorse-pampas shrubland on hillslope

Adjacent to the quarry at Property 209 and 221 there is an area of shrubland dominated by gorse. Pampas (*Cortaderia selloana*) is common, along with frequent blackberry and occasional inkweed, blackberry, radiata pine, and Australian fireweed (Plate 36).

Plate 36: Gorse-pampas shrubland at Property 209. 18 June 2021.

ETV1 - Blackberry vineland on terraces, riparian margins and hillslopes

Blackberry vineland occurs at Properties 19, 21, 25, 119, 207, 212, 459, 461, 472, and 493.

Blackberry is abundant on the hillslopes of Property 19, adjacent to a natural wetland. This vegetation type also occurs on Properties 21 and 25.

At Property 119, blackberry vineland occurs in a gully with occasional karamū and tī kōuka.

At Property 207, blackberry vineland occurs adjacent to a stream and includes frequent greater bindweed and velvet nightshade, with occasional *Carex geminata* and tradescantia.

At Property 212, patches of blackberry vineland occur within rank grassland, and include occasional tī kōuka, māhoe (DBH = 33 centimetres), barberry, inkweed, and montbretia (Plate 37).

At Property 459, blackberry is abundant in a gully with occasional greater bindweed, barnyard grass (*Echinochloa crus-galli*), *Muehlenbeckia australis*, fumitory (*Fumaria officinalis*), and māhoe shrubs.

At Property 461, blackberry is abundant beside a wetland and pond, with frequent inkweed and greater bindweed, and occasional crack willow, poplar, barberry, karamū, and mamaku.

On a north-facing bank above the gully at Properties 493 and 472, blackberry is common with occasional emergent karamū and mahoe.

Plate 37: Blackberry vineland at Property 212. 22 March 2021.

Wetlands

Terminology

The Clarkson (2013) methodology classifies all plant species that have been recorded in wetlands into five categories:

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

Species that are classed as OBL, FACW, or FAC are considered hydrophytic and indicative of wetland habitat. Species that are not on the current classification list are assumed to be upland (UPL) species

IWFn1 - Bracken-whekī fernland on gully floor

At Property 21, bracken (FACU)-whekī (FACU) fernland occurs in a wetland. Bracken and whekī are common, with occasional *Carex secta* (OBL), kiokio (FAC), *Diplazium australe* (FACU), water pepper (*Persicaria hydropiper*, FACW), Yorkshire fog (*Holcus lanatus*, FAC), and watercress (*Nasturtium officinale*, OBL) (Plate 39).

Plate 39: Bracken-whekī fernland at Property 21. 23 March 2021.

MWFn1 - Kiokio-Spike sedge-Yorkshire fog fernland on gully floor

At Property 19 and 21, 'islands' of kiokio (FAC) occur within a wider matrix of spike sedge (*Eleocharis acuta*, OBL) and Yorkshire fog. Soil moisture content was high and other species include occasional creeping buttercup (FAC), tall fescue (FAC), *Isolepis prolifera* (OBL), and *Carex secta* (Plate 40).

Plate 40: Kiokio-spike sedge-Yorkshire fog fernland at Property 21. 14 April 2021.

IWRe1 - Raupō reedland on gully floor

At Property 493 abundant raupō (*Typha orientalis*, OBL) occurs in the pond. Locally frequent *Carex virgata* (FACW) and kiokio are present, particularly along the pond margins. Occasional grey willow (FACW) and crack willow (FACW) are also present (Plate 41).

Plate 41: Raupō reedland at Property 493. 22 March 2021.

IWSe1 - *Isolepis prolifera* sedgeland on stream floodplain

Isolepis prolifera sedgeland occurs on the flats at Property 47 and 207.

At Property 47 this vegetation type occurs within a grazed paddock and connects the stream on the property to wetland vegetation types on the adjacent property. *Isolepis prolifera* is common, but is heavily grazed. Occasional soft rush and Yorkshire fog are also present within this vegetation type.

At Property 207 abundant *Isolepis prolifera* occurs in an old stream channel that contains standing water. Other species include locally abundant creeping bent (*Agrostis stolonifera*, FACW) and reed sweet grass (OBL), and occasional water pepper, broad-leaved dock (*Rumex obtusifolius*, FAC), rautahi (*Carex geminata*, FACW), and creeping buttercup. Frequent soft rush (*Juncus effusus* var. *effusus*, FACW) is present at slightly higher elevations.

IWSe1-SPG - *Isolepis prolifera* sedgeland in seepage wetland

Abundant *Isolepis prolifera* occurs within seepage wetlands on hillslopes at Property 519. Other species present in this vegetation type include frequent Mercer grass (*Paspalum distichum*, FACW), spike sedge, *Isolepis reticularis* (FACW), water pepper, soft rush, Yorkshire fog, and creeping buttercup. Occasional *Juncus planifolius* (FACW), jointed rush (*Juncus articulata*, FACW), *Daucus carota*, hawkbit (*Leontodon saxatilis*, FAC), tar weed (*Parentucellia viscosa*, FAC), and broomrape (*Orobanche minor*) are also found throughout (Plate 42).

Plate 42: *Isolepis prolifera* sedgeland at Property 519. 25 March 2021.

IWSe2 - *Isolepis prolifera*-kiokio-spike sedge sedgeland in depressions

Isolepis prolifera, kiokio, and spike sedge are common in a low depression at Properties 455/ 461. Frequent creeping buttercup, soft rush, Yorkshire fog, and water celery (*Apium nodiflorum*, FAC) are also present with occasional water pepper, lotus (FAC), and hyssop loosestrife (*Lythrum hyssopifolia*, FACW) (Plate 43). The underlying soil holds a relatively high moisture content.

Plate 43: *Isolepis prolifera*-kiokio-spike sedge sedgeland at Property 461. 26 March 2021.

IWSe3 - Rautahi sedgeland on gully floor

At Property 21, abundant rautahi occurs on the valley floor alongside the stream. This vegetation type also includes frequent lotus and water celery, with occasional creeping buttercup (Plate 44).

Plate 44: Rautahi sedgeland at Property 21. 23 March 2021.

IWSe4 - Isolepis prolifera-Juncus planifolius sedgeland on gully floor

A small area of *Isolepis prolifera-Juncus planifolius* sedgeland occurs adjacent to the stream at Property 19. *Isolepis prolifera* is abundant and *Juncus planifolius* is common. Occasional Yorkshire fog and water celery are also present (Plate 45).

Plate 45: *Isolepis prolifera-Juncus planifolius* sedgeland adjacent to the stream at Property 19. 27 May 2021.

IWSe5 - Kiokio-spike sedge-kāpūngāwhā sedgeland on gully floor

Kiokio-spike sedge-kāpūngāwhā (*Schoenoplectus tabernaemontani*, OBL) sedgeland occurs within a valley floor swamp adjacent to a stream at Property 19 and 20. Within this vegetation type kiokio and spike sedge are abundant, and kāpūngāwhā is common. Frequent spike sedge and Yorkshire fog, and occasional tall fescue, blackberry (FAC), soft rush, and creeping bent are also present (Plate 46).

Plate 46: Kiokio-spike sedge- kāpūngāwhā sedgeland. 27 May 2021.

MWSe1-SPG - *Isolepis prolifera*-soft rush sedgeland on seepage wetland

Within a hillslope seepage wetland at Property 38, *Isolepis prolifera* is abundant and soft rush is common. This vegetation type also contains frequent creeping buttercup, *Isolepis reticularis*, floating sweetgrass (*Glyceria fluitans*, OBL), and Yorkshire fog, with occasional water pepper, lotus, kiokio, spike sedge, *Juncus planifolius*, water forget-me-not (*Myosotis laxa*, OBL) and chickweed (*Stellaria media*, FACU) (Plate 47). Creeping bent is locally common along the wetland margins.

Plate 47: *Isolepis prolifera*-soft rush sedgeland within a seepage wetland at Property 38. 14 April 2021.

MWSe2 - *Isolepis prolifera*-floating sweet grass sedgeland on gully floor

Isolepis prolifera-floating sweet grass (OBL) sedgeland occurs at Properties 134/144 and 207 (Plate 48).

At Property 134/144 abundant *Isolepis prolifera* and floating sweet grass occur within a gully upstream of a pond. Occasional water forget-me-not, creeping buttercup, and lotus occur throughout. Mercer grass and water pepper are locally common, and soft rush is frequent on higher ground.

At Property 207, abundant *Isolepis prolifera* and floating sweet grass occur within a shallow depression beside a stream. Frequent water pepper, Mercer grass, creeping bent, soft rush, and creeping buttercup are also present.

Plate 48: *Isolepis prolifera*-floating sweet grass sedgeland. 20 May 2021.

MWSe3 - *Isolepis prolifera*-Mercer grass sedgeland on gully floor and seepage wetlands

Isolepis prolifera-Mercer grass sedgeland occurs on Properties 47, 52, and 472.

At Property 47, abundant *Isolepis prolifera* and Mercer grass occur in a moist to shallowly inundated oxbow, with patches of open standing water. Water pepper, creeping bent, and soft rush are frequent.

This vegetation type also occurs at Property 47 and 52 within a valley floor seepage wetland. *Isolepis prolifera* and Mercer grass are common, with frequent water pepper and water celery, and occasional karearea (*Lemna disperma*, OBL) and creeping buttercup (Plate 49).

A small area of abundant *Isolepis prolifera* and Mercer grass occurs within a gully at Property 472. Occasional water pepper, water forget-me-not, and soft rush are also present.

Plate 49: *Isolepis prolifera*-Mercer grass sedgeland within an oxbow on Property 47. 24 March 2021.

MWSe4 Pūrei-spike sedge-Yorkshire fog sedgeland on gully floor

Pūrei-spike sedge-Yorkshire fog sedgeland occurs within a natural wetland at Property 19. Pūrei and spike sedge are abundant, with Yorkshire fog common and tall fescue occasional (Plate 50).

Plate 50: Pūrei-spike sedge-Yorkshire fog sedgeland at Property 19. 27 May 2021.

MWV1 - Blackberry-spike sedge vineland on margins on gully floor

On the upper margins of a wetland at Property 461 is an area dominated by blackberry and spike sedge, with occasional Kiokio (Plate 51).

Plate 51: Blackberry-spike sedge vineland at Property 461. 26 March 2021.

MWG1 - Yorkshire fog-*Isolepis prolifera*-spike sedge grassland on gully floor

At Property 461, Yorkshire fog and *Isolepis prolifera* are abundant on the margins of a pond. Within this vegetation type spike sedge is common and Mercer grass, soft rush, and hyssop loosestrife are frequent. Jointed rush, water cress, creeping buttercup, and water pepper occur occasionally (Plate 52).

Plate 52: Yorkshire fog-*Isolepis prolifera*- spike sedge grassland at Property 461. 26 March 2021.

MWG1d – Mixed wetland species grassland

Mixed wetland species grassland has been identified at Properties 132, 134, 164, 166, 577, and 605. These wetland areas were identified using desktop information and aerial images, as access was not granted to visit these properties. A conservative approach has been adopted, and it is still recommended that field work be undertaken if access is negotiated.

MWG2 - Yorkshire fog-spike sedge grassland on gully floor

This vegetation type occurs on the valley floor at Properties 19 and 21, Yorkshire fog is abundant and spike sedge is common. This vegetation type also includes locally abundant creeping buttercup and water celery, and occasional *Symphyotrichum subulatum* (FAC), *Machaerina rubiginosa* (OBL), marsh bedstraw (*Galium palustre*, OBL), *Isolepis prolifera*, tall fescue, *Juncus pallidus* (FACW), broad-leaved fleabane (*Erigeron sumatrensis*, FACU), lotus, and pūrei. Soft rush occurs frequently in areas adjacent to the stream. Spike sedge increases in abundance to the east of the property. This vegetation type occurs on moist soil, high in organic content (Plate 53).

Plate 53: Yorkshire fog-spike sedge sedgeland at Property 19. 27 May 2021.

MWG3 - Yorkshire fog-*Isolepis prolifera* grassland on gully floor

A wet gully floor at Property 287 contains dense Yorkshire fog and *Isolepis prolifera* (Plate 54). This vegetation type includes frequent lotus, water pepper and *Juncus planifolius,* and occasional spike sedge, *Isolepis reticularis,* soft rush, creeping bent, tarweed, broad-leaved dock, red clover (*Trifolium pratense*, FACU), white clover (*Trifolium repens*, FACU), sweet vernal (*Anthoxanthum odoratum*, FACU), narrow-leaved plantain (*Plantago lanceolata*, FACU) and hyssop loosestrife. (Plate 54).

Plate 54: Yorkshire fog-*Isolepis prolifera* grassland at Property 287. 25 March 2021.

EWF1 - Crack willow forest on gully floor

A canopy of abundant crack willow trees occurs within a natural wetland on a valley floor at Property 19. Bare ground is common under the canopy, with frequent velvet nightshade, *Muehlenbeckia complexa* (FACU) and karamū (FACU) saplings, arum lily (*Zantedeschia aethiopica*, FAC), black nightshade (*Solanum nigrum*, FACU), Yorkshire fog, and occasional water celery, tall fescue and creeping buttercup. *Isolepis prolifera* is locally common. The soil within the wetland contains elevated levels of organic matter content and at the time of the survey contained high soil moisture levels (Plate 55).

Plate 55: The understorey beneath the crack willow forest canopy at Property 19. 27 May 2021.

EWG1 - Floating sweet grass grassland in depression

Property 573 largely comprises pasture; however, a depression with higher soil moisture levels occurs in the easternmost paddock. This area is indicative of an old stream channel, which was modified by the creation of a drain along the southeastern boundary of the property. Floating sweet grass is common within this vegetation type, with frequent creeping buttercup, water celery and water pepper, locally common jointed rush, and occasional sheep’s sorrel (*Rumex acetosella*; FACU), *Isolepis cernua* (OBL), white clover, narrow-leaved plantain, broad-leaved plantain (*Plantago major*; FACU), pukatea (*Pseudognaphalium luteoalbum* agg., FACU), creeping bent (FACW) and Yorkshire fog (FAC) (Plate 56). The ground was reasonably firm during the autumn 2021 site visit, although there is evidence of pugging, which indicates at least seasonal waterlogging.

Plate 56: *Isolepis cernua* within an old stream channel wetland at Property 573.

EWG2 - Mercer grass grassland on gully floor

Mercer grass grassland occurs at Properties 472, 493 and 134/144.

On Properties 493 and 472, this vegetation type comprises abundant Mercer grass in a gully, with water celery, locally common *Isolepis prolifera*, frequent *Juncus squarrosa* (FACW) and occasional creeping buttercup (Plate 57).

At Property 134/144, abundant Mercer grass occurs within a channel, upstream of a pond, and includes occasional creeping buttercup and lotus.

Plate 57: Mercer grass grassland at Property 493. 22 March 2021.

EWG3 - Blue sweetgrass-creeping buttercup grassland on low-lying terrace

At Property 499, there is an area within a flow path which comprises abundant blue sweetgrass (*Glyceria declinata*, OBL) and creeping buttercup with frequent water pepper and occasional starwort (*Callitriche stagnalis*, OBL), water forget-me-not, soft rush, toetoe upoko-tangata (*Cyperus ustulatus* f. *ustulatus*, FACW), and Yorkshire fog. There is evidence of water pooling within this vegetation type at Property 499, and the soils are rich in organic matter with a high moisture content (Plate 58).

Plate 58: Blue sweetgrass-creeping buttercup grassland at Property 499. 25 March 2021.

EWG4 - Mercer grass-water pepper grassland on gully floor

Abundant Mercer grass and water pepper occur within a gully at Property 40. Associated species include frequent creeping buttercup and occasional lotus, soft rush, *Isolepis prolifera*, jointed rush, marsh bedstraw, white clover, *Galium trilobum* (FACW) and water forget-me-not (Plate 59). Moist soils are present within this vegetation type.

Plate 59: Mercer grass-water pepper grassland at Property 40. 26 March 2021.

EWG5 - Yorkshire fog-creeping buttercup grassland in depression

A small area of abundant Yorkshire fog and creeping buttercup that contains occasional water pepper and lotus is located in a low depression at Property 30 (Plate 60). The soil within the grassland is organic loam.

Plate 60: Yorkshire fog-creeping buttercup grassland at Property 30.

EWG6 - Yorkshire fog-creeping buttercup-Mercer grass grassland on gully floor and depressions

This vegetation type occurs within very shallow gullies and depressions in grazed paddocks at Property 117. Yorkshire fog, creeping buttercup and Mercer grass are common (Plate 61). This vegetation type includes locally abundant water pepper and broad-leaved dock and has been conservatively mapped as a wetland. However, uncertainties remain as to whether this should be mapped as this habitat type. It is therefore recommended that plots are established at the property to confirm the presence of wetland habitat.

Plate 61: Yorkshire fog-creeping buttercup-Mercer grass grassland at Property 117. 24 March 2021.

EWG7 - Creeping bent grassland on gully floor

Properties 550 and 535 largely contain pasture. An intermittent flow path occurs in the southwest of the property, and includes standing and flowing water and soils with a high moisture content (Plate 62). Vegetation comprises abundant creeping bent grassland with frequent creeping buttercup, while rye grass (*Lolium perenne*; UPL) is abundant in the surrounding pasture. Occasional water pepper, Yorkshire fog, sheep's sorrel, and soft rush are also present. There is *c.*1,062m^2 of this wetland vegetation type within the proposed designation.

Establishing wetland plots at this property is needed to enable clearer delineation of the wetland, as it is difficult to differentiate between areas of stream, wet pasture, and natural wetland.

Plate 62: The flow path and gully floor wetland at Property 550. 12 April 2021.

EWG8 – Soft rush/Yorkshire fog-creeping buttercup grassland in gully

A grazed paddock at Property 131 contains grassland comprising soft rush over abundant Yorkshire fog and common creeping buttercup. Other species that are present include Mercer grass and occasional dock, lotus and white clover (Plate 63). The soil within much of the paddock was waterlogged at the time of the survey.

Plate 63: Soft rush/Yorkshire fog-creeping buttercup grassland at Property 131.
18 June 2021

EWG9 - Mercer grass-open water grassland on gully floor

Mercer grass is common (*c.*60% canopy cover) over open water at Property 209. In areas of slightly higher elevation along the margins of this vegetation type, locally common Yorkshire fog and frequent soft rush are common (Plate 64). This vegetation type also includes occasional toetoe upoko-tangata, creeping buttercup and sorrel. Blackberry is occasionally present on the elevated margins.

Plate 64: Mercer grass-open water grassland occurs at Property 209. 18 June 2021.

EWG1d - Exotic wetland species grassland

Exotic wetland species grassland has been identified at Property 592. These exotic wetland areas were identified using desktop information and aerial images, as permission was never granted to access and survey the site. A conservative approach has been adopted, and it is recommended that a field survey be undertaken if access is granted in the future.

MWH1 - Water celery-kikuyu-*Isolepis prolifera* herbfield in stream oxbow

An area of water celery-kikuyu (*Cenchrus clandestinus*, FACU)-*Isolepis prolifera* herbfield occurs within an oxbow wetland at Property 207, and includes common water celery, kikuyu and *Isolepis prolifera*, locally common watercress, creeping buttercup and chickweed, and occasional broad-leaved dock, rautahi, tall fescue, hedge woundwort (*Stachys sylvatica*), marsh bedstraw and lotus (Plate 65).

Plate 65: Water celery-kikuyu-*Isolepis prolifera* herbfield at Property 207. 20 May 2021.

EWH1 - Creeping buttercup herbfield on gully floor

Creeping buttercup herbfield occurs at Properties 21, 25, and 28.

At Property 21, abundant creeping buttercup occurs within an old, drained pond. Associated species that are present include Yorkshire fog, and occasional water celery, soft rush, broad-leaved dock and water pepper.

Property 25 contains abundant creeping buttercup within a gully. The soils within this site were moist and high in organic matter content. This vegetation type also includes frequent Yorkshire fog and greater bindweed, and occasional chickweed, mouse ear chickweed, tall fescue and broad-leaved dock (Plate 66).

Plate 66: Creeping buttercup herbfield at Property 25. 14 April 2021.

EWH2 - Creeping buttercup-water pepper herbfield on gully floor

Abundant creeping buttercup and frequent water pepper, soft rush, and Yorkshire fog occurs within a gully floor at Property 472 (Plate 67). This vegetation type occurs within a possible stream channel and is located on slightly higher ground than the adjacent wetland. However, the soil contains a high organic matter content and was moist at the time of the summer site visit, suggesting that the area warrants classification as a wetland.

Plate 67: Creeping buttercup-water pepper herbfield at Property 472. 12 April 2021.

EWH3 - Water celery herbfield on gully floor

Water celery herbfield occurs at Properties 19, 21, 459, 461, 470, 472, 473, and 493.

Abundant water celery occurs within a drain and stream at Property 19, and includes frequent *Isolepis prolifera*, spike sedge, creeping buttercup, Yorkshire fog and lotus.

Abundant water celery occurs within a natural wetland at Property 21, and includes a small area of sedgeland containing locally common rautahi, and occasional water pepper, soft rush, Yorkshire fog, creeping buttercup and broad-leaved dock (Plate 68).

The gully on Properties 459 and 461 support abundant water celery with frequent creeping buttercup.

At Property 470, abundant water celery occurs upstream of a man-made pond/dam and includes frequent creeping buttercup and reed sweetgrass (*Glyceria maxima*, OBL), and occasional *Carex secta*.

At Property 472, abundant water celery occurs within a channel with both standing and slow flowing water. Karearea occurs occasionally within areas of open water.

Abundant water celery occurs upstream of a man-made pond/dam within a gully at Property 473, and includes occasional starwort, soft rush, *Carex secta*, water pepper, kiokio and creeping buttercup.

Abundant water celery occurs at Property 493 within a moist gully wetland, with locally abundant water pepper, and occasional creeping bent and Yorkshire fog.

Plate 68: Water celery herbfield at Property 21. 23 March 2021.

EWH4 - Water celery-creeping buttercup herbfield on gully floor

At Property 461, abundant water celery and creeping buttercup occurs at the upper section of a wetland. Associated species include frequent *Isolepis prolifera* and Yorkshire fog, and occasional lotus, crack willow, creeping bent and tall fescue (Plate 69).

Plate 69: Water celery-creeping buttercup herbfield (photograph centre) at Property 461. 26 March 2021.

EWH5 - Water pepper herbfield on gully floor and pond edges

Water pepper herbfields occur on Properties 21, 481, and 531.

Abundant water pepper occurs within an old, dried-out dam at Property 21. Frequent creeping buttercup, occasional *Isolepis prolifera*, and soft rush occur within this vegetation type.

A small wetland comprising abundant water pepper also occurs within a grazed paddock at Property 481, with creeping buttercup common, water cress frequent, and occasional broad-leaved dock and creeping bent.

At Property 531, abundant water pepper occurs within a stream channel, with frequent water celery and creeping buttercup, and occasional soft rush, creeping bent, water forget-me-not and broad-leaved dock (Plate 70). A channelized flow path occurs to the south of this area.

Plate 70: Water pepper herbfield at Property 531. 25 March 2021.

EWH6 - Water pepper-creeping buttercup-Yorkshire fog herbfield on gully floor

At Property 40, this small area of vegetation occurs at the bottom of a gully and primarily contains water pepper, creeping buttercup and Yorkshire fog (Plate 71). Other species that are present include white clover, broomrape, and water forget-me-not. Soils within this area were waterlogged at the time of the site visit.

Plate 71: Water pepper-creeping buttercup-Yorkshire fog herbfield at Property 40. 14 April 2021.

EWH7 - Water pepper-Mercer grass herbfield in depression on stream terrace

At Property 44 and 47, abundant water pepper and Mercer grass occur within a natural depression in a grazed paddock. *Isolepis prolifera*, creeping buttercup and lotus are also common (Plate 72).

Plate 72: Water pepper-Mercer grass herbfield in a natural depression on Property 47. 24 March 2021.

EWH8 – Broad-leaved fleabane/Yorkshire fog herbfield on gully floor

At Property 19, a slightly elevated area between two water channels contains broad-leaved fleabane that has grown above abundant Yorkshire fog (Plate 73). Other plant species present include frequent soft rush, creeping buttercup, *Isolepis prolifera*, water celery and occasional creeping bent, rautahi, and Australian fireweed (FACU). This vegetation type occurs on soils that are moisture laden.

Plate 73: Broad-leaved fleabane/Yorkshire fog herbfield at Property 19. 27 May 2021.

EWH9 - Exotic dominant wetland in depression

At Property 207, an area of wetland that primarily contains exotic plant species was observed through binoculars and via the use of aerial imagery. This vegetation occurs in a depression within pasture and is likely to be flooded periodically. The wetland contains water pepper, soft rush, broad-leaved dock, and creeping buttercup. Wetland plots are recommended to accurately delineate areas of natural wetland on this property (Plate 74).

Plate 74: A wetland within a depression at Property 207 dominated by exotic plant species. 20 May 2021.

EWH10 – Soft rush/creeping buttercup-Yorkshire fog-Mercer grass herbfield on gully floor

Property 131 contains a gully that is adjacent to a pond (Plate 75). The margins of the pond and the gully contain grazed herbfield comprising emergent soft rush over abundant creeping buttercup and Yorkshire fog, and locally abundant *Isolepis prolifera*, floating sweetgrass, Mercer grass, and watercress within the wetter areas close to open water. *Juncus planifolius*, water pepper, water forget-me-not, lotus, white clover, and narrow-leaved plantain are locally common. Inkweed (FACU), and arum lily are also present but are rare. \

Plate 75: Soft rush/creeping buttercup-Yorkshire fog-Mercer grass herbfield at Property 131. 18 June 2021.

MWRs1 - Soft rush/Yorkshire fog-spike sedge rushland on gully floor

At Property 19, emergent soft rush occurs over common Yorkshire fog and spike sedge in an area adjacent to the stream on the property (Plate 76). Soil moisture levels were high at the time of the survey.

Plate 76: Soft rush/Yorkshire fog-spike sedge rushland at Property 47. 24 March 2021.

EWRs1 - Soft rush rushland at the foot of terrace risers

Soft rush rushland occurs on Properties 47, 52, and a property with no number.

At Property 47 and 52, this vegetation type frequently includes *Isolepsis prolifera*, creeping buttercup, Mercer grass, lotus, Yorkshire fog, and *Juncus edgariae* (FACW).

The property adjacent to 47 and 52 contains frequent *Juncus edgariae* and *Isolepsis prolifera*.

EWRs2 - Soft rush-creeping buttercup-Yorkshire fog rushland on gully floor

At Property 21, soft rush and creeping buttercup is common on the margins of a natural wetland. Yorkshire fog is common, and soils are moist and rich in organic matter content, indicating at least intermittent moisture levels (Plate 77).

Plate 77: Soft rush-creeping buttercup-Yorkshire fog rushland. 23 March 2021.

EWRs3 - Soft rush-Yorkshire fog rushland on gully floor

At the base of a hillslope at Property 19 and 20 there is an area of soft rush and Yorkshire fog rushland. Associated species within this vegetation type include frequent water celery, locally abundant creeping buttercup, and occasional *Carex secta*, tall fescue, water pepper, spike sedge, and creeping bent (Plate 78). Locally frequent kiokio occurs on higher mounds within this vegetation type.

Plate 78: Soft rush-Yorkshire fog rushland at Property 20. 23 March 2021.

Other

OW - Open water in constructed ponds

Standing water occurs within ponds on Properties 21, 39, 131, 134/144, 207, 461, 470, 473, 493, 519, 535.

Open water occurs within constructed ponds on Properties 21, 207, 493, and 535.

At Property 39, a pond occurs in the bottom of a gully within an area of restoration plantings.

At Property 131, pools of open water within a damned gully contain karearea.

At Property 461, open water occurs in gully ponds adjacent to the railway. These areas contain wetland vegetation on the margins of the ponds and blackberry vineland along the railway embankment (Plate 79). This gradient in vegetation indicates variable (seasonal) water levels within the ponds.

At Property 470, a constructed pond contains an area of open water in which water lilies (*Nymphaea alba*) are present. Planted pūrei, harakeke, kiokio, *Chionochloa flavicans* and rengarenga (*Arthropodium cirratum*) occur frequently along the margins of this habitat type.

At Property 473, open water occurs within a series of man-made ponds. These ponds contain water lilies and Pacific azolla (*Azolla rubra*) and provide habitat for goldfish (*Carassius auratus*). Planted *Carex secta*, harakeke and tī kōuka occur frequently along the margins of this habitat type.

At Property 519, the area of open water within a dam includes locally abundant *Isolepis prolifera* and occasional soft rush and kiokio on the margins of the constructed dam, and one grazed pūrei.

At Property 134/144, crack willows surround an area of open water.

Plate 79: Open water at Property 461. 26 March 2021.

TG1 – Gravelfield in river and stream beds

Gravel boulderfields occur along the stream and river beds that flow across the proposed roading footprint within Properties 151, 158 and 209. Flowing water has been mapped within this vegetation type, and varies depending on the intensity and duration of rainfall events (Plate 80).

Plant species within this vegetation type include occasional tall fescue, lupin (*Lupinus arboreus*), tutu, crack willow saplings, and *Senecio vulgaris*.

Plate 80: The gravelfield adjacent to Ōhau River, viewed from Property 212. 22 March 2021.

EHG - House, gardens and farm buildings on terraces and hillslopes

Homes, gardens and farm buildings occur frequently along the possible highway corridor on Properties 14, 15, 19, 20, 21, 25, 28, 29, 33, 40, 41, 42, 47, 53, 57, 58, 61, 64, 70, 88, 91, 99, 104, 137, 143, 158, 182, 185, 190, 197, 203, 207, 249, 253, 268, 272, 273, 275, 297, 298, 304, 307, 328, 337, 345, 346, 349, 355, 360, 363, 374, 387, 392, 403, 404, 428, 435, 441, 443, 444, 446, 448, 453, 461, 463, 465, 472, 480, 481, 485, 490, 494, 495, 504, 506, 513, 514, 519, 531, 535, 555, 561, 566, 570, 577, 582, 586, 590, 592, 594, 596, 598, 599, 602, 604, 605, 619 (Plate 81).

Plate 81: Maintained garden areas at Property 58. 24 March 2021.

ETP - Cropping and pasture on terraces and hillslopes

Areas of pasture and cropping land are widespread along the possible highway corridor. This vegetation type includes pasture, market gardens, fields planted with cover crops, shelter belts and scattered specimen trees, and drains, the latter of which contain several wetland species; however, these drains do not qualify as natural wetlands (Plate 82).

Plate 82: Pasture (right) and maize cropping (left) on properties 44 and 47. 24 March 2021.

RRR - River/Road/Rail on terraces and hillslopes

The North Island main trunk line and a number of local roads intersect the possible highway corridor, as do waterways, including tributaries of significant rivers. Properties which contain these features that are impacted by the possible highway corridor include 4, 7, 14, 44, 47, 52, 53, 55, 203, 207, 209, 403, 404, 405, 411, 413, 418, 419, 420, 421, 425, 429, 430, 433, 578, 587, 590, 594, and 605. Some of these features do not occur on numbered properties.

QRY – Quarry on hillslope

An active quarry occurs at Property 209. Some gorse grows on the upper slopes, but vegetation is otherwise uncommon (Plate 83).

Plate 83: The quarry at Property 209. 18 July 2021.

APPENDIX J.4

TECHNICAL ASSESSMENT FOR EFFECTS ON BATS FOR THE Ō2NL PROJECT AREA

IN THE MATTER OF	the Resource Management Act 1991
AND	
IN THE MATTER OF	applications for resource consents and notices of requirement in relation to the Ōtaki to North of Levin Project
BY	**WAKA KOTAHI NZ TRANSPORT AGENCY** Applicant

ŌTAKI TO NORTH OF LEVIN: TECHNICAL ASSESSMENT

BATS

TABLE OF CONTENTS

EXECUTIVE SUMMARY

1. The Ō2NL Project comprises the construction, operation, use, and maintenance of a 24-kilometre length of four-lane highway from Ōtaki to north of Levin. The purpose of the assessment was to determine whether endemic long-tailed bats (*Chalinolobus tuberculatus*) or central lesser short-tailed bats (*Mystacina tuberculata rhyacobi*) are using habitats within the Ō2NL Project area.

2. The landscape within the proposed alignment potentially provides moderate-quality foraging habitat for long-tailed bats and some potential roosting habitat in mature indigenous and exotic trees. No potential short-tailed bat roosting habitat is present within the proposed alignment.

3. Although suitable potential habitat for long-tailed bats is present, based on the information held in the Department of Conservation (DOC) Bat Distribution Database it is considered unlikely that long-tailed bats are present within the Ō2NL Project Area. The closest long-tailed bat record is approximately 21 kilometres east of the alignment. Based on the information held in the Department of Conservation Bat Distribution Database, and the absence of potential roosting habitat, it is considered highly unlikely that short-tailed bats are present within the Ō2NL Project Area. The closest short-tailed bat record to the site is approximately 30 kilometres southeast of the alignment.

4. A total of 28 automatic bat monitors (ABMs) were deployed throughout the Ō2NL Project Area and nearby habitats for 10-22 valid survey nights between 16 March and 30 April 2021. Most ABMs within the Ō2NL Project Area recorded 15 or more valid survey nights each in accordance with Department of Conservation protocols for surveys in areas where bats have not been previously recorded. Seven ABMs did not achieve 15 valid survey nights of data due to a combination of battery failures, property access constraints, and the end of the bat monitoring season. Of these, four recorded 14 nights of data, two 12 nights, and one 10 nights.

5. No bats were detected during the surveys. This indicates that although potential bat foraging and roosting habitat exists within the Ō2NL Project Area, these habitats are not currently used by indigenous bats.

INTRODUCTION

6. My full name is Jamie William Booth MacKay. I have prepared this technical assessment with support from Keely Paler (Senior Ecologist, formerly Wildland Consultants, Wellington, now Greater Wellington Regional Council) and Brent Henry (Ecologist, Wildland Consultants, Auckland). Keely Paler assisted with deployment of bat survey devices and Brent Henry assisted with analysis. This technical assessment addresses bat surveys undertaken for the Ō2NL project.

QUALIFICATIONS AND EXPERIENCE

7. I have the following qualifications and experience relevant to this assessment:

   (a) I am a Principal Ecologist at Wildland Consultants Ltd, an ecological consultancy company specialising in ecological assessments, ecological restoration, ecological survey and monitoring, and ecological research. I joined the company in 2014 and in this role, I provide terrestrial and freshwater ecological services and advice to a range of clients.

   (b) I hold the degrees of Bachelor of Science (Honours) in Ecology from the University of Edinburgh (2004), Master of Science (Applied Ecology and Conservation) from the University of East Anglia (2005), and Doctor of Philosophy (Ecology) from the University of Auckland (2011). Prior to joining Wildlands, I worked for two years as a post-doctoral researcher at the University of Auckland.

   (c) My research background is in the behavioural ecology of pest mammal species in New Zealand with a focus on using knowledge of animal behaviour to improve control and monitoring methodologies. I am lead- or co-author on over 20 peer-reviewed scientific publications in the field of pest mammal biology and management

   (d) I am a Department of Conservation-certified bat ecologist and have designed and implemented numerous bat surveys ABMs and hand-held bat detectors. I have used radio-tracking to locate daytime bat roosts, and radio-tracking and thermal imaging to describe bat behaviour while foraging at night. I have assessed the potential ecological impacts of a range of activities on long-tailed bats, and have prepared management plans to allow these potential impacts to be avoided, minimised, or mitigated.

(e) I have undertaken radio-tracking of long-tailed bats in Hamilton in a landscape very similar to that present in the Ō2NL Project Area. This has given me an excellent understanding of the habitat preferences of long-tailed bats in fragmented habitat mosaics.

(f) I have provided expert peer review services in the field of bat ecology to Waikato District Council and Waikato Regional Council since 2019. In this role I have reviewed bat monitoring reports provided to meet consent conditions for the Cambridge, Hamilton, and Huntly sections of the Waikato Expressway.

8. I attended a Cultural and Environmental Design Framework for the Project in December 2020. Following this workshop, I drove to Kuku East Road to inspect vegetation in an area where there had been anecdotal records of bat presence.

9. I spent three days deploying ABMs within the proposed route of the Project between 16 and 18 March 2021. I supervised Brent Henry (Wildland Consultants Ltd) in the analysis of data from ABMs and reviewed all files identified as containing potential bat calls.

CODE OF CONDUCT

10. I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2014. This assessment has been prepared in compliance with that Code, as if it were evidence being given in Environment Court proceedings. In particular, unless I state otherwise, this assessment is within my area of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

PURPOSE AND SCOPE OF ASSESSMENT

11. The purpose of the assessment was to determine whether endemic long-tailed bats or central lesser short-tailed bats are using habitats within the Ō2NL Project Area. For the purposes of this assessment, the Ō2NL Project Area is defined as "the designation corridor and any adjacent areas of high value that might be subject to indirect effects i.e., noise/traffic

mortality/fragmentation – these are included at the ecologist's discretion e.g., forest at Property 43".

12. The scope of the assessment was to:

    (a) Review existing information regarding bat distribution within and around the Ō2NL Project Area.

    (b) Undertake a desktop assessment to identify potential foraging and roosting habitat for long-tailed bats and short-tailed bats within the Ō2NL Project Area.

    (c) Deploy ABMs in potential bat foraging and roosting habitat.

    (d) Analyse data collected by ABMs to determine if bats are present within the Ō2NL Project Area.

ASSUMPTIONS AND EXCLUSIONS IN THIS ASSESSMENT

13. Bat distribution data was sourced from the July 2020 version of the Department of Conservation Bat Distribution Database. The information in this database comes from a number of different sources including: DOC-led monitoring projects, local and regional councils, ecological consultants, community groups and casual observations. The data from some of the sources is likely to be more reliable than others and it is difficult to determine the accuracy of individual records from the information available in the database. However, there is no reason to doubt the accuracy of any of the records relied upon during this assessment.

PROJECT DESCRIPTION

14. The Design and Construction Report provides a description of the Project.

15. The components of the Project particularly relevant to bats are:

    (a) The earthworks, vegetation clearance (including exotic trees), and landform modifications required to construct the highway.

    (b) The construction and operational activities that could have adverse effects on bats and bat habitats, including road lighting and the potential for vehicle collisions.

EXISTING ENVIRONMENT

16. The landscape within the proposed alignment comprises a mosaic of agricultural land, fragments of indigenous and exotic forest, shelterbelts, riparian corridors, and urban areas. A detailed description of vegetation and habitat types within the Ō2NL Project Area is provided in Technical Assessment J – Terrestrial Ecology.

NEW ZEALAND BAT SPECIES

Long-tailed bats

17. Long-tailed bats are classified as Threatened – Nationally Critical by O'Donnell *et al*. (2018). They preferentially forage in forest edge and riparian habitats of both indigenous and exotic forest types (O'Donnell 2006, Griffiths 2007, Rockell 2017), and have adapted to roosting in exotic tree species such as pine (*Pinus* sp.) and macrocarpa (*Cupressus macrocarpa*). They also forage over farmland and urban areas (Griffiths 2007, O'Donnell and Borkin 2021).

18. Long-tailed bats have very large home ranges. In continuous forest in the Eglington Valley, Fiordland the maximum home range size recorded was 5,629 hectares, with median range sizes falling between 330-1,589 hectares (O'Donnell 2001). Ranges in landscapes similar to that in the Project Area in South Canterbury and Hamilton were smaller. In South Canterbury, home range areas were between 322 and 642 hectares (Griffiths 2007) and in Hamilton the average range was 307 hectares with a maximum range of 841 hectares (O'Donnell and Borkin 2021).

19. Long-tailed bats have been recorded flying at 60 kilometres per hour and in South Canterbury bats were recorded foraging within four kilometres of their daytime roost sites (Griffiths 2007). In Eglington Valley, bats had home range lengths of up to 19 kilometres (O'Donnell 2001).

20. The landscape within the proposed alignment provides moderate-quality potential foraging habitat for long-tailed bats and some potential roosting habitat in mature indigenous and exotic trees. Long-tailed bat populations are known to be present in similar landscapes elsewhere, most notably a population around southern Hamilton. If present, long-tailed bats within the Ō2NL Project Area are likely to exhibit similar ranging behaviour to the populations studied in South Canterbury and Hamilton. However, for the

purposes of this assessment the ranging behaviour observed in the Eglington Valley will be used to identify long-tailed bat populations that may utilise habitats within the Ō2NL Project Area (i.e., populations within a 19 kilometre radius of the road).

Short-tailed bats

21. There are three subspecies of lesser short-tailed bat recognised in New Zealand and the subspecies present in the central and southern North Island and Taranaki (central lesser short-tailed bat, *Mystacina tuberculata rhyacobi*) is classified as At Risk – Declining by O'Donnell *et al*. (2018). Short-tailed bats are only found in large areas of indigenous forest, although they will forage and commute outside of these areas (Parsons and Toth 2021).

22. Short-tailed bats in the Eglington Valley had home ranges of between 127-1,223 hectares, with a median range of 478 hectares. Ranges in the Pureora Forest Park were smaller, between 5 and 560 hectares, with a median of 30 hectares (Parsons and Toth 2021).

23. The maximum range length recorded for short-tailed bats in the Eglington Valley was 23.6 kilometres (O'Donnell *et al*. 1999).

24. Currently, short-tailed bat roosts are exclusively found in native trees in large areas of native forest (Parsons and Toth 2021). No potential short-tailed bat roosting habitat is present within the proposed alignment.

STATUTORY CONSIDERATIONS, INCLUDING NATIONAL STANDARDS, REGIONAL AND DISTRICT PLANS, AND OTHER RELEVANT POLICIES

Resource Management Act 1991

25. Significant habitats of indigenous fauna are protected as a matter of national importance under section 6(c) of the RMA.

Horizons Regional Council's One Plan

26. Objective 6-1 of the Horizons One Plan for Indigenous Biological Diversity is to:

    (a) Protect areas of significant indigenous vegetation and significant habitats of indigenous fauna and maintain indigenous biological diversity, including enhancement where appropriate.

27. Policy 13-4 states that consent decision making activities are regulated, having regard for significant habitat of indigenous fauna.

28. Under Policy 13-5, consent must not be granted unless:

    (a) Any **more than minor adverse effects** on the habitat's representativeness, rarity, or distinctiveness are avoided.

    (b) Where these effects are not avoided, they are remedied or mitigated.

    (c) Where these effects are not avoided, remedied or mitigated, they are offset to result in a net biological diversity gain.

Greater Wellington Regional Council's Proposed Natural Resources Plan:

29. Indigenous ecosystems and habitats with significant biodiversity values should be maintained and restored to a healthy functioning state (Objective 16) under the Greater Wellington Regional Council's Proposed Natural Resources Plan. In Policy 47 there is a list of effects to be considered when preparing an application for a resource consent that may affect significant indigenous biodiversity values.

Wildlife Act 1953

30. Within the Wildlife Act (1953), both long-tailed bats and short-tailed bats are afforded absolute legal protection. It is an offence to kill or have in possession absolutely protected wildlife without a Wildlife Act Authorisation (also known as a Wildlife Permit) issued by the Department of Conservation.

METHODOLOGY

Overview

31. An assessment of habitat values for long-tailed and short-tailed bats within the Ō2NL Project Area was undertaken by:

    (a) Reviewing bat distribution in the vicinity of the Ō2NL Project Area.

    (b) Identifying potential bat habitat within the Ō2NL Project Area as a desktop exercise using aerial photographs in Google Earth.

    (c) Undertaking a bat survey using ABMs developed by the Department of Conservation.

Stakeholder engagement

32. Stakeholder engagement is summarised in Technical Assessment J.

New Zealand guidelines for bat surveys

33. The Department of Conservation protocol for bat monitoring away from roosts using automatic bat detectors (Sedgeley 2012) has not been updated since it was published in 2012. It is noted in this protocol that there are no strict guidelines for sampling effort for surveying bats in New Zealand using automatic bat detectors. Instead, the protocol provides an overview of methods and case studies to allow an effective survey to be designed. The sampling effort applied in this survey was designed to meet recommendations from the Department of Conservation Bat Recovery Group for surveys in areas where bats have not previously been recorded. The recommendations are:

(a) Surveys should take place over 15 fine nights.

(b) Recording should start one hour before sunset and stop one hour after sunrise.

(c) The temperature should not drop below 7 degrees Celsius during the first three hours after sunset.

(d) Surveys should be undertaken during a period of minimal overnight precipitation and light winds.

Application of the EcIAG

34. The Ecological Impact Assessment Guidelines (EcIAG) prepared by the Environment Institute of Australia and New Zealand were not used during the preparation of this assessment. Long-tailed bats are habitat generalists and using EcIAG criteria such as diversity and pattern, and representativeness of species assemblages, does not effectively capture potential high value long-tailed bat habitat. I relied on published accounts of bat habitat preferences and my own observations of bat habitat use in a similar landscape south of Hamilton to identify potential high value long-tailed bat habitat.

Desktop review

35. I used the July 2020 version of the Department of Conservation Bat Distribution Database to search for records of long-tailed bats and short-tailed bats within 19 kilometres of the Ō2NL Project Area. This search radius was chosen as it is the maximum home range length recorded for long-tailed bats in forested habitats in the Eglington Valley, Fiordland (O'Donnell 2001).

Habitat assessment

36. I used aerial images in Google Earth to identify potential long-tailed bat and short-tailed bat roosting and high or moderate-quality foraging habitat within the Ō2NL Project Area. The habitats identified included:

    (a) Indigenous and exotic forest.

    (b) Indigenous and exotic treeland.

    (c) Riparian margins.

    (d) Large shelter belts.

ABM deployment

37. Model AR4 ABMs, manufactured by the Department of Conservation, were used. The ABMs were all running ARM v1.4 software and all were checked using the Department of Conservation Bat Recorder Tester Application before deployment.

38. ABMs were deployed by experienced ecologists in locations determined to give the best chance of detecting any bats using the habitat. ABMs were set to start recording one hour before sunset and stop recording one hour after sunrise. ABM batteries were changed one week after deployment and ABMs were retrieved approximately one week after the battery change.

39. Temperature and rainfall data were obtained for the duration of the deployment period from the Levin electronic weather station (data obtained from https://cliflo.niwa.co.nz/).

RESULTS

Desktop review

Long-tailed bats

40. The Department of Conservation Bat Distribution Database (July 2020 version) contains no recent records of long-tailed bats within 19 kilometres (the maximum range length recorded in forested habitats in the Eglinton Valley, Fiordland by O'Donnell (2001)) of the Ō2NL Project Area. There is a 1999 record from a survey on the eastern side of the Tararua Forest Park approximately 21 kilometres east of the alignment. Long-tailed bats are known to be present on the eastern side of the Tararua Forest Park at Waiohine, approximately 30 kilometres southeast of Ōtaki.

41. Surveys undertaken on the western side of the Tararua Forest Park in 1997 and 1998 all failed to detect either long-tailed bats or short-tailed bats. The closest survey to the Ō2NL Project Area was undertaken on North Manakau Road, approximately 1.7 kilometres southeast of Property 195. Surveys undertaken in 1997 and 1998 near the Ohau River on the edge of the Tararua Forest Park also failed to detect bats.

42. Surveys undertaken by the Department of Conservation in 2013 in the centre of the Tararua Forest Park failed to detect bats. The location of this survey is approximately 10 kilometres east of the Ō2NL Project Area.

Short tailed bats

43. A short-tailed bat was recorded in the front yard of a dwelling on Bowen Street in Levin in 1958. This property is approximately one kilometre west of the Ō2NL Project Area; however, no further short-tailed bats have been detected during surveys within a 19 kilometre radius of the Ō2NL Project Area.

44. Short-tailed bats are known to be present on the eastern side of the Tararua Forest Park at Waiohine, approximately 30 kilometres southeast of Ōtaki. However, this population may have gone extinct as it has not been detected since 2017 (Jim O'Malley, Sustainable Wairarapa, pers. comm.).

Conclusion

45. Based on the information held in the Department of Conservation Bat Distribution Database it is considered unlikely that long-tailed bats are present within the Ō2NL Project Area. However, anecdotal reports of bat presence at 102 Kuku East Road and the Muhunoa East Road bridge were received during the course of the project and this, together with the fact that no surveys have been undertaken close to the Ō2NL Project Area since 1999, means that additional surveys for long-tailed bats were required.

46. Based on the information held in the Department of Conservation Bat Distribution Database, and the absence of potential roosting habitat, it is considered highly unlikely that short-tailed bats are present within the Ō2NL Project Area. However, the ABMs used can detect and record short-tailed bats calls and they were searched for during ABM analysis.

Potential bat habitat and habitat values within the Ō2NL Project Area

47. Habitats identified as providing potential long-tailed bat roosting or moderate quality foraging habitat were:

    (a) Indigenous forest.

    (b) Indigenous treeland.

    (c) Mixed indigenous-exotic forest.

    (d) Mixed indigenous-exotic scrub.

    (e) Exotic Forest.

48. Potential long-tailed bat roosting or moderate-quality foraging habitat was identified on 17 properties during the desktop assessment. Two further survey sites were identified following anecdotal reports of bat presence resulting in 19 properties where surveys for long-tailed bats were required.

49. No potential short-tailed bat roosting habitat was identified during the desktop assessment.

50. The long-tailed bat habitat values identified within the Ō2NL Project Area are provided in Table 1. Habitat values were assessed through observations made during ABM deployment and a review of the vegetation and habitat descriptions prepared by Dr Tim Martin. These habitat values were assessed with the assumption that long-tailed bats are present in the area.

Table 1: Habitat types and associated long-tailed bat habitat values where ABM surveys were undertaken within the Ō2NL Project Area.

Habitat Type	Vegetation Type	Code	Property ID	Description of Long-Tailed Bat Habitat Values	Assigned Value Assuming Long-Tailed Bats Present
Indigenous forest	Tawa forest, Tawa-kohekohe forest	ITF1, ITF2	42 43 163 102 Kuku East Road	• Potential roosting habitat in cracks and crevices in live and dead trees • Potential roost habitat in large epiphyte clumps where present • Potential foraging habitat	High
Indigenous treeland	Tawa-tītoki treeland	ITT7	207	• Potential roost habitat in cavities in dead trees • Potential foraging habitat	High
Mixed indigenous-exotic forest	False acacia-tītoki-cherry forest, False acacia-indigenous species forest,	MTF3, MTF4,	465 479	• Potential roosting habitat in cracks and crevices in live and dead trees • Potential foraging habitat	High
	Crack willow-māhoe forest/scrub	MTF5	212	• Potential foraging habitat (riparian)	Moderate
Mixed indigenous-exotic scrub	Māhoe-karo scrub with emergent pine	MTS1	20	• Potential foraging habitat	Low
Exotic Forest	Crack willow forest/scrub (riparian),	ETF1	151 158 Muhunoa East Road bridge	• Potential foraging habitat (riparian)	Moderate
	Exotic treeland and forest	ETF4	30 43 470 501	• Potential foraging habitat	Low

ABMs

51. ABMs were deployed at 16 of the 19 locations where potential bat habitat was identified during the desktop review (Appendix 1). The following properties did not have ABMs deployed:

    (a) Property 461 - access was denied; however, an ABM was placed close by on an adjoining property (Property 470). The area of trees at this property that are visible on aerial photographs has since been mapped as māhoe-karamū scrub. Therefore, a survey is not required.

    (b) Property 473 - trees visible in aerial photographs had been felled so no remaining habitat.

    (c) Property 493 - trees were small so not considered to provide potential habitat.

52. Twenty-eight ABMs were deployed across the 16 survey locations. ABM deployment information is provided in Table 2. Due to access constraints, ABMs were installed in three deployments between 16 March and 16 April 2021. ABMs were retrieved between 6 and 30 April 2021.

53. The sunset and sunrise times used for ABM settings at the beginning of each deployment are provided below:

    (a) Deployment 1 (16 March 2021) - sunset 19:53; sunrise 05:31.

    (b) Deployment 2 (30 March 2021) - sunset 19:14; sunrise 06:00.

    (c) Deployment 3 (14 April 2021)[1] - sunset 17:50; sunrise 05:16.

54. The temperature at sunset was above 7 degrees Celsius at sunset on all survey nights except 28 April 2021, where the temperature was 6 degrees Celsius. Five ABMs at sites outside of the Ō2NL Project Area were active on 28 April 2021, and this night has been removed from the analysis. Minimal overnight rain was recorded during the survey period and no nights were removed from the analysis due to rainfall.

---

[1] Note: the April deployment occurred after Daylight Saving Time ended.

Table 2: Summary of properties and search effort for bats during March and April 2021.

Site	ABM Number	Habitat Targeted	Date Deployed	Number Nights	Bats Detected?
20	57	Pine shelter belt/small plantation on edge of gully	17/03/2021	21	No
30	38	Shelterbelt approximately 600 metres from large plantation	18/03/2021	18	No
42	40	On edge of indigenous forest remnant	17/03/2021	21	No
43	13	On edge of indigenous forest remnant (Staples Bush)	17/03/2021	10	No
43	15	On edge of indigenous forest remnant (Staples Bush)	17/03/2021	21	No
43	48	Shelterbelt approximately 100 metres west of Staples Bush	17/03/2021	17	No
151	18	Riparian margin	17/03/2021	22	No
158	83	Riparian margin	17/03/2021	22	No
163	32	On edge of indigenous forest remnant	17/03/2021	22	No
207	21	Indigenous treeland in pasture	17/03/2021	15	No
212	27	Riparian margin	30/03/2021	14	No
212	43	Riparian margin	30/03/2021	14	No
287	81	On edge of indigenous forest remnant	16/03/2021	12	No
465	23	On edge of indigenous forest remnant	16/03/2021	14	No
470	20	Shelterbelt	16/03/2021	22	No
470	45	Edge of redwood plantation	16/03/2021	22	No
470	52	Pond edge	16/03/2021	12	No
479	16	On edge of indigenous forest remnant	16/03/2021	21	No
479	28	On edge of indigenous forest remnant	16/03/2021	22	No
479	82	On edge of indigenous forest remnant	16/03/2021	22	No
501	22	Pine shelter belt/small plantation with stream	16/03/2021	21	No
501	29	Pine shelter belt/small plantation with stream	16/03/2021	22	No
102 Kuku East Road	33	Indigenous forest (out of project area)	16/04/2021	17	No
102 Kuku East Road	46	Indigenous forest (out of project area)	16/04/2021	16	No
102 Kuku East Road	47	Indigenous forest (out of project area)	16/04/2021	17	No
Muhunoa East Road bridge deployment 1	27	Riparian margin (out of project area)	30/03/2021	17	No
Muhunoa East Road bridge deployment 2	33	Riparian margin (out of project area)	30/03/2021	14	No
Muhunoa East Road bridge deployment 2	42	Riparian margin (out of project area)	14/04/2021	14	No
Muhunoa East Road bridge deployment 1	43	Riparian margin (out of project area)	14/04/2021	14	No

55. Seven ABMs did not record 15 nights of data:

(a) Property 43 - one ABM recorded 10 nights of data due to battery failure. Two other ABMs deployed at this property recorded 17 and 21 nights of data.

(b) Property 287 - the only ABM at this property recorded 12 nights of data due to battery failure.

(c) Property 470 - one ABM at this property recorded 12 nights of data. The other two ABMs at this property each recorded 22 nights of data.

(d) Property 212 - both ABMs at this property were retrieved after 14 nights on 30 April at the end of the bat monitoring season.

(e) Property 465 - the only ABM at this property recorded 14 nights of data due to battery failure.

(f) Muhunoa East Road bridge (second deployment) - two ABMs were retrieved after 14 nights on 30 April at the end of the bat monitoring season.

56. No long-tailed bats or short-tailed bats were detected on any ABM. I am confident that sufficient data was collected to support the conclusion that there are no bats within the Ō2NL Project Area.

ASSESSMENT OF ECOLOGICAL VALUES FOR BATS

57. As no long-tailed bats were detected the ecological value of habitats within the Ō2NL Project Area for long-tailed bats are considered to be negligible.

58. As no short-tailed bats were detected and no potential short-tailed bat roosting habitat was identified, the ecological value of habitats within the Ō2NL Project Area for short-tailed bats are considered to be negligible.

ASSESSMENT OF EFFECTS

59. No bats were detected and therefore the project will not have any adverse effects on either long-tailed bats or short-tailed bats.

MEASURES TO REMEDY OR MITIGATE ACTUAL OR POTENTIAL ADVERSE EFFECTS ON BATS

60. The Project will have no actual or potential adverse effects on bats and therefore no remediation or mitigation measures are required.

Dr Jamie MacKay

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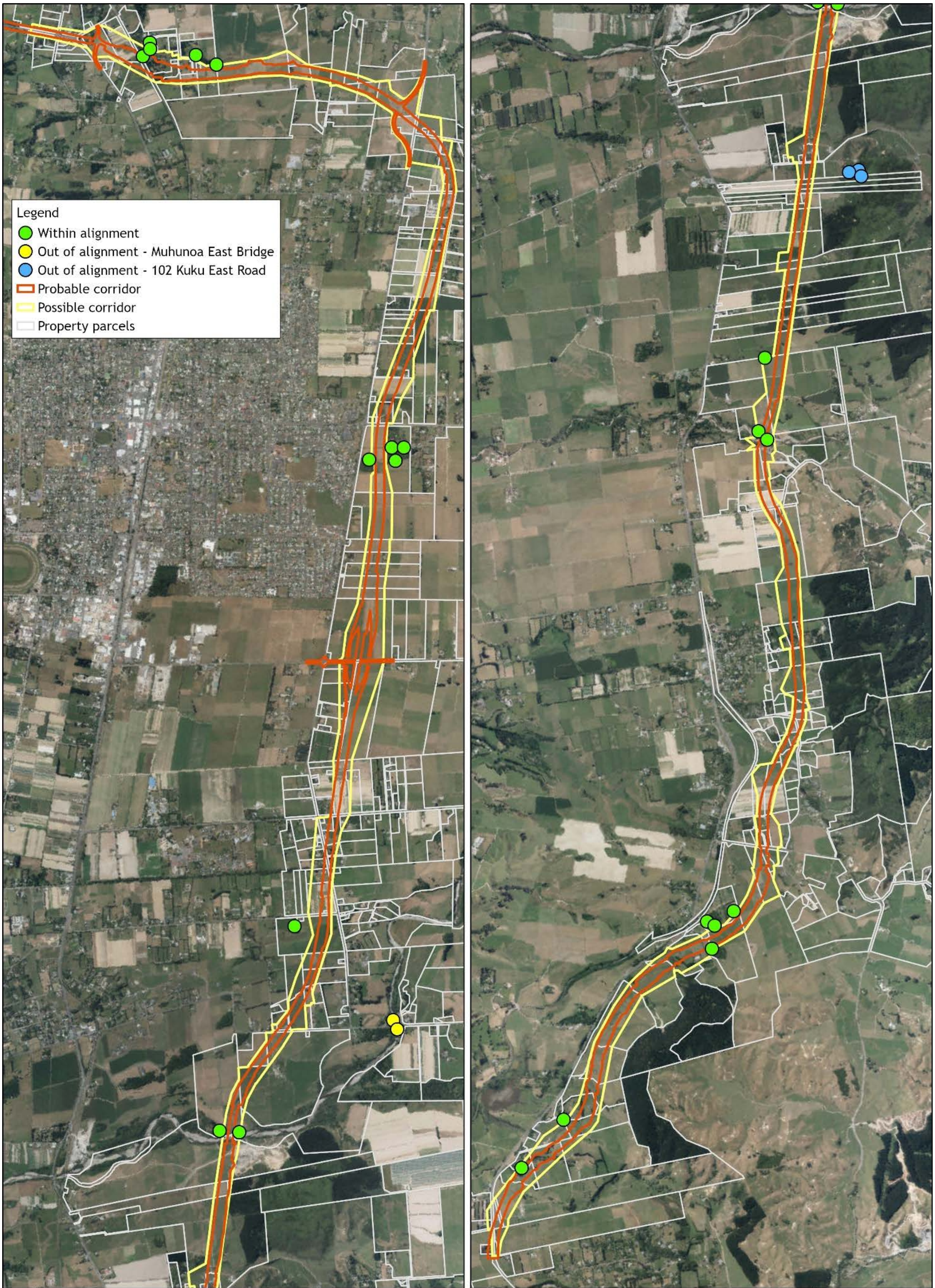
MAP OF ACOUSTIC SURVEY LOCATIONS FOR THE Ō2NL PROJECT AREA



Automatic Bat Monitor locations

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Date: 3/08/2021
Cartographer: TP
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APPENDIX J.5

TECHNICAL ASSESSMENT FOR EFFECTS ON BIRDS FOR THE Ō2NL PROJECT AREA

IN THE MATTER OF	the Resource Management Act 1991
AND	
IN THE MATTER OF	applications for resource consents and notices of requirement in relation to the Ōtaki to North of Levin Project
BY	**WAKA KOTAHI NZ TRANSPORT AGENCY** Applicant

ŌTAKI TO NORTH OF LEVIN: TECHNICAL ASSESSMENT

AVIFAUNA ECOLOGY

TABLE OF CONTENTS

EXECUTIVE SUMMARY

1. The report provides an assessment of potential effects of the Ōtaki to North of Levin Project (the Ō2NL Project) on birds to inform the notice of requirement and resource consent applications for the Project.

2. A desktop bird assessment was carried out and showed that several species and their habitats may be present within the Project footprint, including species classified as 'Threatened' or 'At Risk' under the Department of Conservation's New Zealand Threat Classification System.

3. Following the desktop assessment, a bird survey was carried out in selected properties and habitat types within the Project alignment. Two Threatened and six At Risk species were recorded: koekoeā/long-tailed cuckoo (Threatened - Nationally Vulnerable), karakahia/grey duck (Threatened - Nationally Vulnerable), koitareke/marsh crake (At Risk - Declining), pihoihoi/New Zealand pipit (At Risk - Declining), pūweto/spotless crake (*Porzana tabuensis*, At Risk - Declining), weweia/New Zealand dabchick (*Poliocephalus rufopectus,* At Risk - Recovering), black-fronted dotterel (At Risk - Naturally Uncommon), and kawau/black shag (*Phalacrocorax carbo novaehollandiae*, At Risk - Relict).

4. Notable species that were not recorded during the survey but may be present include matuku/Australasian bittern (*Botaurus poiciloptilus*, Threatened - Nationally Critical), kākā (*Nestor meridionalis*, At Risk -Recovering), tūturiwhatu/banded dotterel (*Charadrius bicinctus*, At Risk - Declining), karearea/bush falcon (*Falco novaeseelandiae ferox*, At Risk - Recovering), pōpokatea/whitehead (*Mohoua albicilla*, Not Threatened), and torea/South Island pied oystercatcher (*Haematopus finschi*, At Risk -Declining). Further species are likely to be recorded during upcoming bird surveys scheduled for Spring 2021.

5. Ecological values have been assigned to all of the notable taxa identified in the desktop assessment and survey using the Ecological Impact Assessment Guidelines (EcIAG) prepared by the Environment Institute of Australia and New Zealand (EIANZ). The habitats within the Project footprint have also been assigned a score using the EcIAG methodology based on the value they provide to bird species. All bird species potentially present within the Project alignment have also been conservatively assessed as being present.

6. A conservative effects assessment has been undertaken based on the bird species confirmed and likely to be present. The overall level of effect of the Project on potentially present ‘Threatened’ or ‘At Risk’ bird species, and on bird habitat values, is assessed as being Low to Moderate (varying by species/habitat).

7. Based on the presence and/or likely presence of ‘At Risk’ and ‘Threatened’ bird species, minimisation, effects avoidance, offset, and compensation measures are proposed. Activities include avoiding vegetation clearance during the breeding season or undertaking nest surveys before construction starts, avoiding the construction of open water or stormwater ponds on both sides of the road at any location to minimise the frequency of wetland birds flying over the road, and plantings of indigenous trees and shrubs to minimise noise disturbance on birds (Ow and Ghosh 2017). Forest and wetland habitat restoration, at locations away from the Project footprint, will address loss of habitat within the Project corridor; these habitat restoration measures will be guided by an ecological offset and compensation plan to ensure there is a net gain for avifauna values within the Project area. These offsets may include restoration

8. The avoidance, mitigation, and offset measures described in this assessment will appropriately address the potential adverse effects of the Project on indigenous birds.

INTRODUCTION

9. My full name is Della Gaye Bennet. I have prepared this technical assessment, which addresses the potential effects of the Ōtaki to North of Levin (Ō2NL) Project on local avifauna.

Qualifications and experience

10. I have the following qualifications and experience relevant to this assessment:

    (a) I am a Senior Avifauna Ecologist with Wildland Consultants Ltd (Wildlands), based in Christchurch. I have worked for Wildlands since early 2020. Prior to working with Wildlands, I have undertaken avifauna work throughout the South Island, including surveys (five-minute bird counts, transects, and incidental observations) and monitoring of pasture, wetland, forest, and seabird species using mist netting and bird banding. I have also carried out monitoring of ‘Threatened’ or ‘At Risk’ species including Hutton’s shearwater

(*Puffinus huttoni*), banded dotterel (*Charadrius bicinctus bicinctus*), black-fronted tern (*Chlidonias albostriatus*), bush falcon (*Falco novaeseelandiae ferox*), and black-billed gulls (*Larus bulleri*).

(b) In 2018, I graduated with a Doctor of Philosophy in Biological Science from the University of Canterbury. I also hold the degrees of Bachelor of Science (Endorsement in Ecology) and a Postgraduate Diploma of Science with Distinction, both from the University of Canterbury, where my studies were undertaken at the School of Biological Sciences.

(c) For my PhD research I focused on understanding the at-sea behaviour of the endangered, endemic Hutton's shearwater (*Puffinus huttoni*) using a variety of methods, including stable isotope analysis, time–depth recorders (TDRs), and GPS trackers. The study aimed to quantify the diving behaviour, diet, and foraging locations of breeding adult birds, and to use this information to identify potential areas of conflict with fisheries and the effectiveness of a recently-created marine reserve in protecting the foraging habitat of this species. This research required working closely with the Department of Conservation, Hutton's Shearwater Charitable Trust, Ngāti Kuri hapū, and the residents of Kaikōura. I am lead-author on five peer-reviewed scientific publications.

(d) I also have considerable experience with other seabirds. Examples include: potential impacts of a mussel (*Perna* sp.) farm expansion on a king shag (*Leucocarbo carunculatus*) colony, potential effects on seabirds from a proposed mussel spat farm, bird strike risk assessment for a temporary stormwater retention basin located close to an international airport, and the detection of plastic metabolites in the preen wax of seabirds.

(e) I provided ecological advice to Gore District Council on the application for a designation to construct the Longford Bridge across the Mataura River.

(f) I undertook surveys of avifauna throughout the Project site on 22-26 March 2021.

Code of conduct

11. I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2014. This assessment has been prepared in compliance with that Code, as if it were evidence being given in Environment Court proceedings. In particular, unless I state otherwise, this assessment is within my area of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

Purpose and scope of assessment

12. The purpose of this assessment is to determine bird species, including 'Threatened' and 'At Risk' species, that are using or likely to use habitats within the Project footprint and the potential effects of the Project on those species, as well as to recommend measures to address those effects.

13. The scope of the assessment was to:

    (a) Compile and review existing information regarding bird distribution within and around the Ō2NL Project footprint.

    (b) Determine the potential notable bird species and sites where these are likely to be recorded within the Project footprint. All potential habitats were identified including forests, pasture, river and riparian margins.

    (c) Undertake five-minute bird counts, transects surveys, and incidental bird surveys within the Ō2NL Project footprint.

    (d) Describe the potential effects of the Ō2NL Project on avifauna, and corresponding avoidance, remediation, mitigation, offsetting, or compensatory actions.

Assumptions and exclusions in this assessment

14. This assessment addresses the effects on avifauna anticipated from the Project as detailed in the Project plans and summarised in the Design Construction Report (DCR).

15. Avifauna habitat values are incorporated into the vegetation and habitat values described in Technical Assessment J – Terrestrial Ecology. As such, the assessment of the level of effect associated with vegetation loss will also account for the loss of these habitat values. The loss of indigenous avifauna habitat is therefore appropriately covered in the report. While habitat values

within the Project footprint are described below, effects associated with habitat loss are not discussed in this report.

16. Where 'Threatened' and 'At Risk' indigenous birds have been previously found but were not recorded during targeted surveys, they have been assumed to use the habitat.

PROJECT DESCRIPTION

17. Technical Assessment J includes a project description.

18. The components of the Project particularly relevant to birds are:

    (a) The earthworks, vegetation clearance (including exotic trees), and landform modifications required to construct the Project.

    (g) The construction and operational activities that could have adverse effects on birds and bird habitats retained within and near the Project footprint, including road lighting, traffic noise, and the potential for vehicle collisions.

EXISTING ENVIRONMENT

19. The proposed alignment falls almost entirely in the southern Manawatū Plains Ecological District, in the Manawatū Ecological Region. A small section of the proposed route, near Manakau, lies within the western edge of the Tararua Ecological District.

20. The southern parts of the Manawatū Plains Ecological District lie between the coastal sands of the Foxton Ecological District to the west and the ranges of the Manawatū Gorge South and Tararua Ecological Districts to the east. Detailed descriptions of the Manawatū Plains and Tararua Ecological Districts are provided in Technical Assessment J.

21. The landscape within the Project footprint comprises a mosaic of agricultural land, fragments of indigenous and exotic forest, shelterbelts and riparian corridors. These environments provide potential habitat for a range of notable bird species, including 'Threatened' and 'At Risk' species.

METHODOLOGY

Introduction

22. I have adopted a best practice approach to my assessment of ecological effects on the basis that:

(a) My assessment broadly follows the EIANZ EcIAG (Roper-Lindsay *et al*. 2018). The EcIAG provides a systematic approach to assessing ecological effects.

(b) Where threatened birds have been previously found but were not recorded during targeted surveys, they have been assumed present.

(c) Where site surveys could not be carried out (due to land owner permission delays or refusals), avifauna values assessments were informed by the detailed vegetation and habitat assessments provided in Technical Assessment J, or interpretation of aerial imagery.

Desktop review

23. A desktop review was undertaken to identify existing background information regarding avian species distribution and abundance within the Project footprint. Sources of information include:

(a) Scientific papers, particularly those in Notornis (the scientific publication of Birds New Zealand).

(b) Other sources of information on bird populations and species composition within the Project footprint, including the Atlas of Bird Distribution 1999-2004 (Robertson et al. 2007).

(c) eBird website (www.ebird.com/newzealand, accessed February 2021) and the New Zealand Bird Atlas (New Zealand Bird Atlas (ebird.org/atlasnz), accessed June 2021) are real-time, global online checklist programmes where people submit bird observations, and now contain several hundred million bird records. The eBird database is maintained by Cornell University, which has bird records for sites within New Zealand. All bird records from within a five-kilometre radius of each site were considered in the assessments of avifauna values.

(d) iNaturalist (www.inaturalist.nz, accessed February 2021) is a website that contains indigenous and exotic bird species records, including indigenous 'Threatened' and 'At Risk' species. The iNaturalist database is maintained by the Californian Academy of Sciences and National Geographic. All bird records five-kilometre from the edges of the Project site were considered in the assessments of avifauna values.

(e) Unpublished data (for example, Department of Conservation and Birds New Zealand reports).

Site surveys

24. The Project footprint was assessed using Google Earth imagery to identify all properties that may contain key avifauna habitats (whether indigenous or exotic). By doing so, a total of 17 properties were identified for survey (Table 1, Figure 1a-d). This equates to approximately 20% of the *c*.80 properties identified for ecosystem mapping in Technical Assessment J.

25. Bird surveys were undertaken between 22 and 26 March 2021, 29 November and 3 December 2021 (inclusive) and 24 February 2022. Surveying techniques varied depending on the target ecosystem at each site and included five-minute bird counts, transect counts, playback calls, and incidental observations. Further playback calls were carried out at property #493 (29 April 2021, Figure 1a) when at least one spotless crake was heard responding to the playback calls during a freshwater survey and a koitareke/marsh crake responded to a playback call 3 December 2021 during a bird survey. A weweia/New Zealand dabchick was observed at property #461 on the 3 August 2021 during a freshwater survey and on 2 December 2021 during a bird survey (Figure 1d). A karakahia/grey duck was observed on 29 November 2021 and a koekoeā/long-tailed cuckoo was heard on 29 November and 2 December 2021 during bird surveys.

26. All surveys were undertaken during fine weather with little to no wind.

<u>Five-minute bird counts</u>

27. Forty-one five-minute bird counts (5MBC) were conducted in indigenous and exotic forests and wetlands following the methods described in Bibby *et al.* (2000) (Figure 1). During each five-minute interval, all birds seen or heard within 100 metres of the stationary observer were recorded. No birds were knowingly recorded twice within a survey period and no birds were assumed to be present.

28. In smaller remnants a single count was undertaken in the centre of the fragment. In larger fragments, count stations were located 100-200 metres from the forest edge with 100-200 metres between survey stations.

Table 1: Summary of properties and survey methods used during March 2021, November-December 2021 and February 2022.

Property ID	Survey Dates	Ecosystem Type	Survey Method
19	01/12/22		Incidental
20	23/03/21, 26/03/21, 01/12/21, 03/12/21	Wetland	5MBC, Playback survey, Incidental
21	23/03/21, 23/02/22	Wetland	Incidental
30	23/03/21	Exotic treeland and forest	Incidental
31	25/02/22		Incidental
38	23/03/21, 25/03/21, 01/12/21, 03/12/21, 22/02/21,	Indigenous forest remnants	5MBC
		Pasture/cropping land	Transect count
40	23/03/21, 25/03/21, 01/12/21, 03/12/21, 21/02/22	Indigenous forest	5MBC, Incidental
42	23/03/21, 25/03/21, 26/03/21, 20/01/22, 24/02/22	Mixed indigenous-exotic planted forest	5MBC, Incidental
43	23/03/21	Indigenous forest remnant	5MBC, Incidental
		Exotic scrub	5MBC
47	24/03/21, 18/02/22	Mixed indigenous-exotic planted forest	Incidental
52	18/2/22		Incidental
55	22/02/22		Incidental
61	24/03/21	Indigenous treeland	Incidental
88	24/03/21	Indigenous treeland and forest	Incidental
151	25/02/22		Incidental
158	22/03/21, 25/03/21, 02/12/21, 17/2/22, 24/02/22	River, and exotic scrub	Transect count, Incidental
163	24/03/21, 01/12/21	Indigenous forest	5MBC
		Pasture/cropping land	Transect count, Incidental
		Exotic forest	5MBC, Incidental
209	24/02/22		Incidental
212	22/03/21, 25/03/21, 30/11/21, 02/12/21, 24/02/22	River	Transect count, Incidental
		Indigenous forest and scrub	5MBC
		Exotic scrub	5MBC
287	25/03/21, 03/12/221	Wetland	Playback survey, Transect count
		Indigenous forest	5MBC
461	25/03/21, 26/03/21, 29/11/21, 02/12/21, 15/02/22	Wetland	Playback survey, Transect count
		Pasture/cropping land	Transect count
		Open water	Transect count
465	24/03/21, 02/12/21	Indigenous treeland	5MBC, Incidental
473	26/03/21, 29/11/21, 02/12/21	Indigenous scrub	Transect count, Incidental
479	22/03/21	Indigenous forest and scrub	5MBC, Incidental
490	25/03/21	Exotic treeland and forest	Incidental
493	22/03/21, 24/03/21, 26/03/21, 29/11/21, 03/12/21, 18/02/22,	Wetland	5MBC, Playback survey, Incidental
		Exotic forest	5MBC

Property ID	Survey Dates	Ecosystem Type	Survey Method
499	25/03/21	Exotic treeland and forest	Incidental
501	24/03/21, 26/03/21, 29/11/21, 02/12/21	Wetland	Transect count, Playback survey
		Exotic forest	5MBC
519	25/03/21, 15/02/22	Exotic treeland, exotic forest and open water	Incidental
114/119	24/03/21, 01/12/22	Pasture stream	Transect count, Incidental

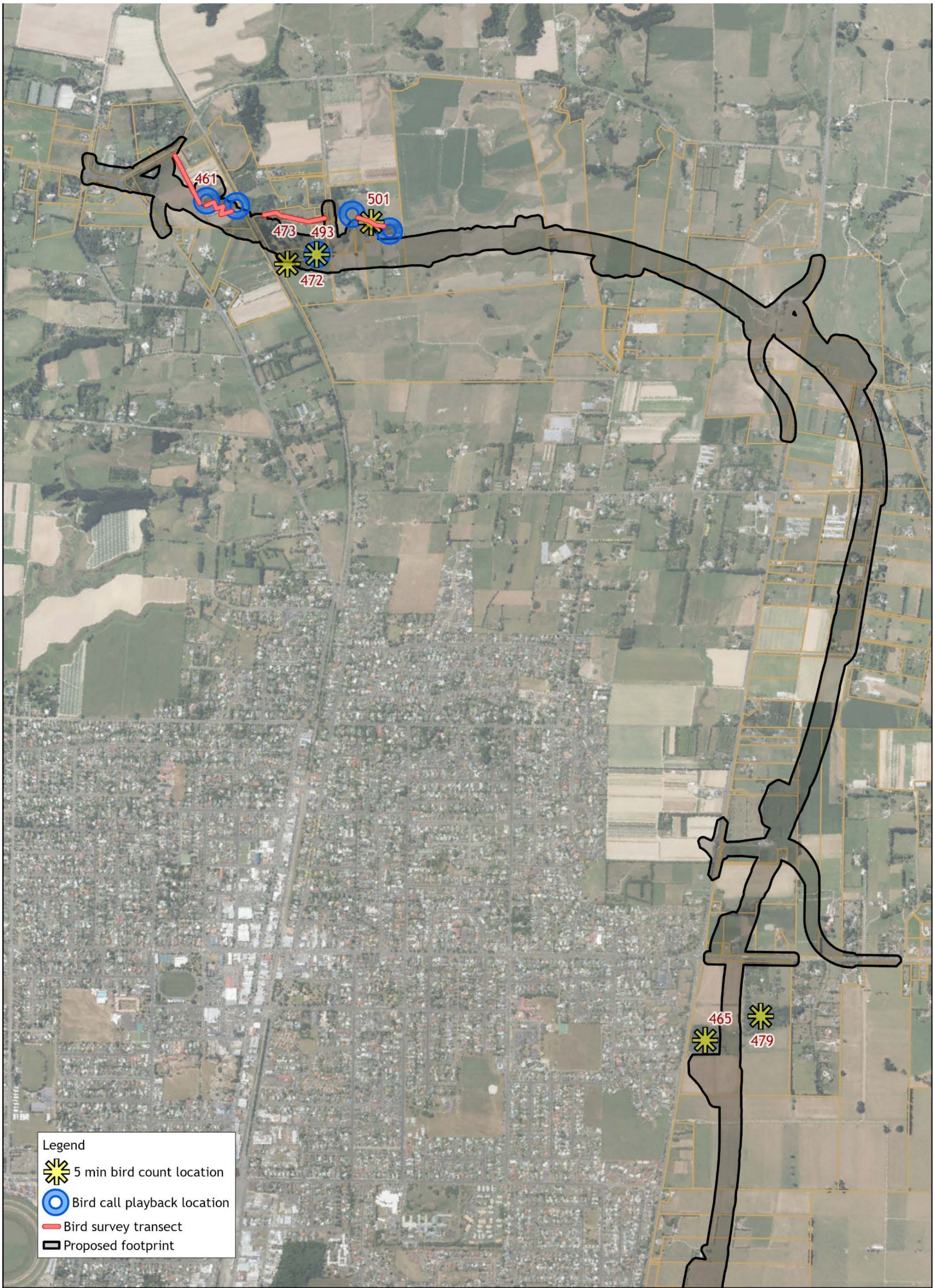

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Figure 1a. Bird survey locations

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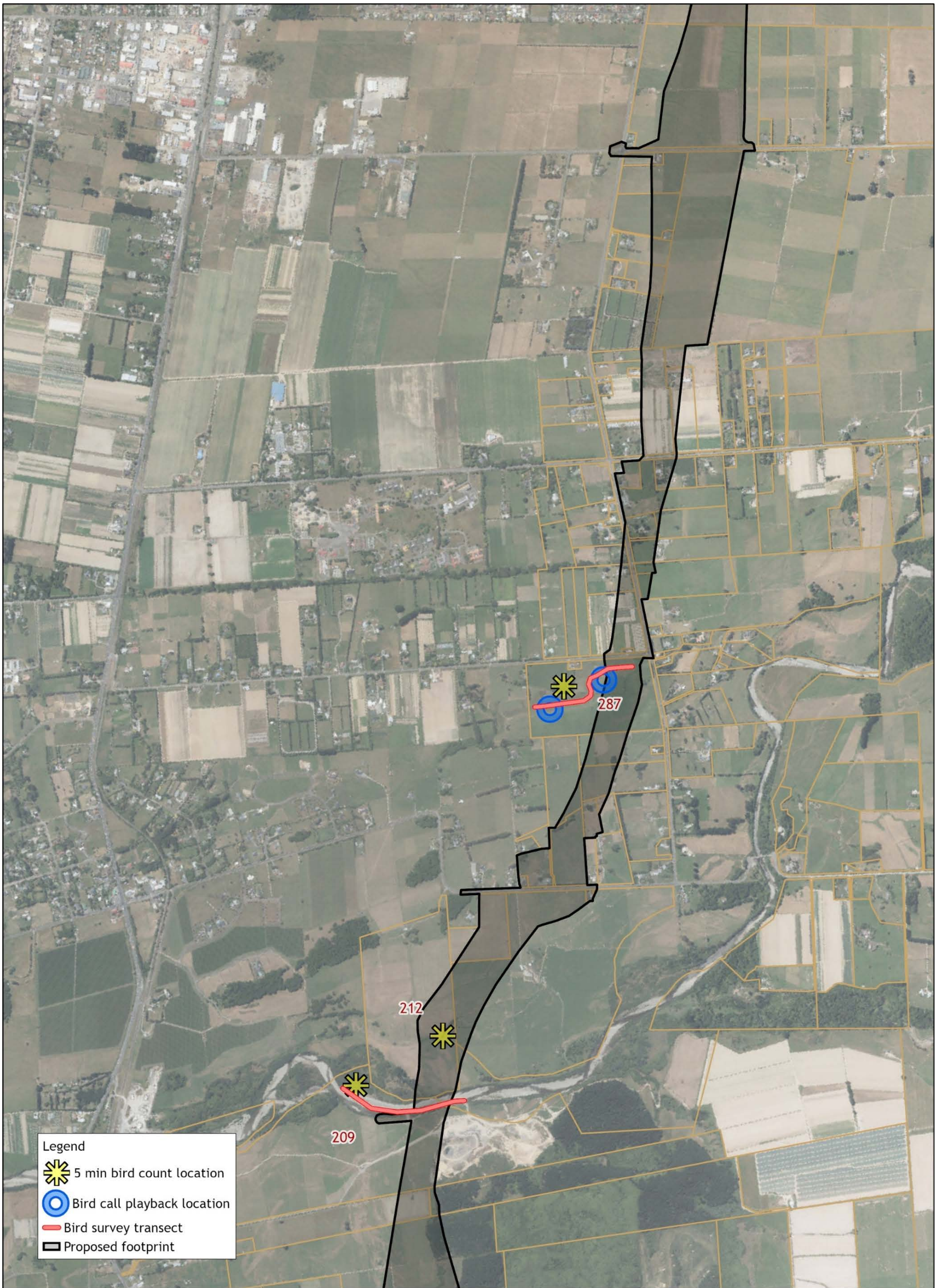

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Figure 1b. Bird survey locations

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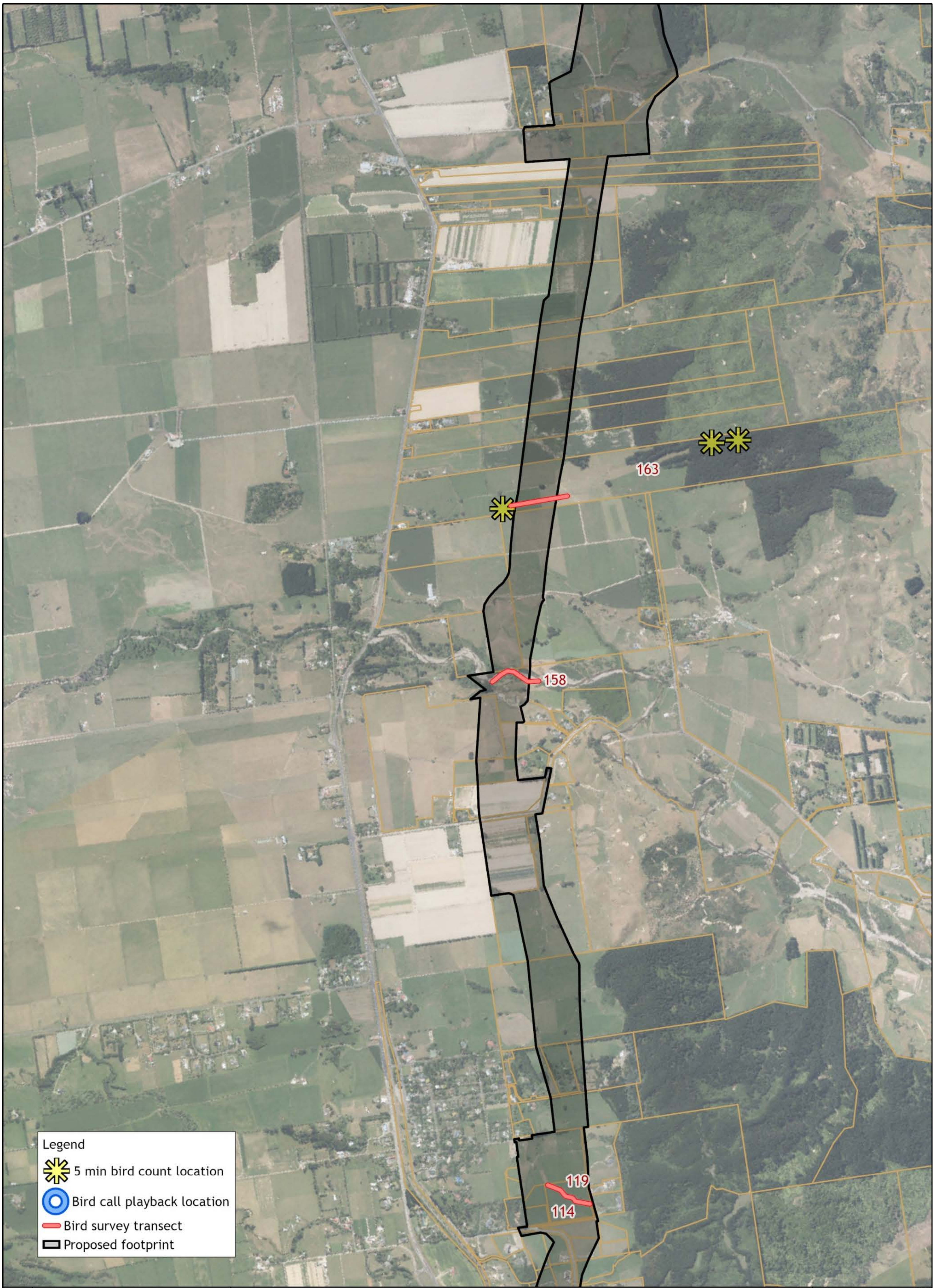

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Figure 1c. Bird survey locations

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Scale: 1:15,000
Date: 14/09/2021
Cartographer: TP
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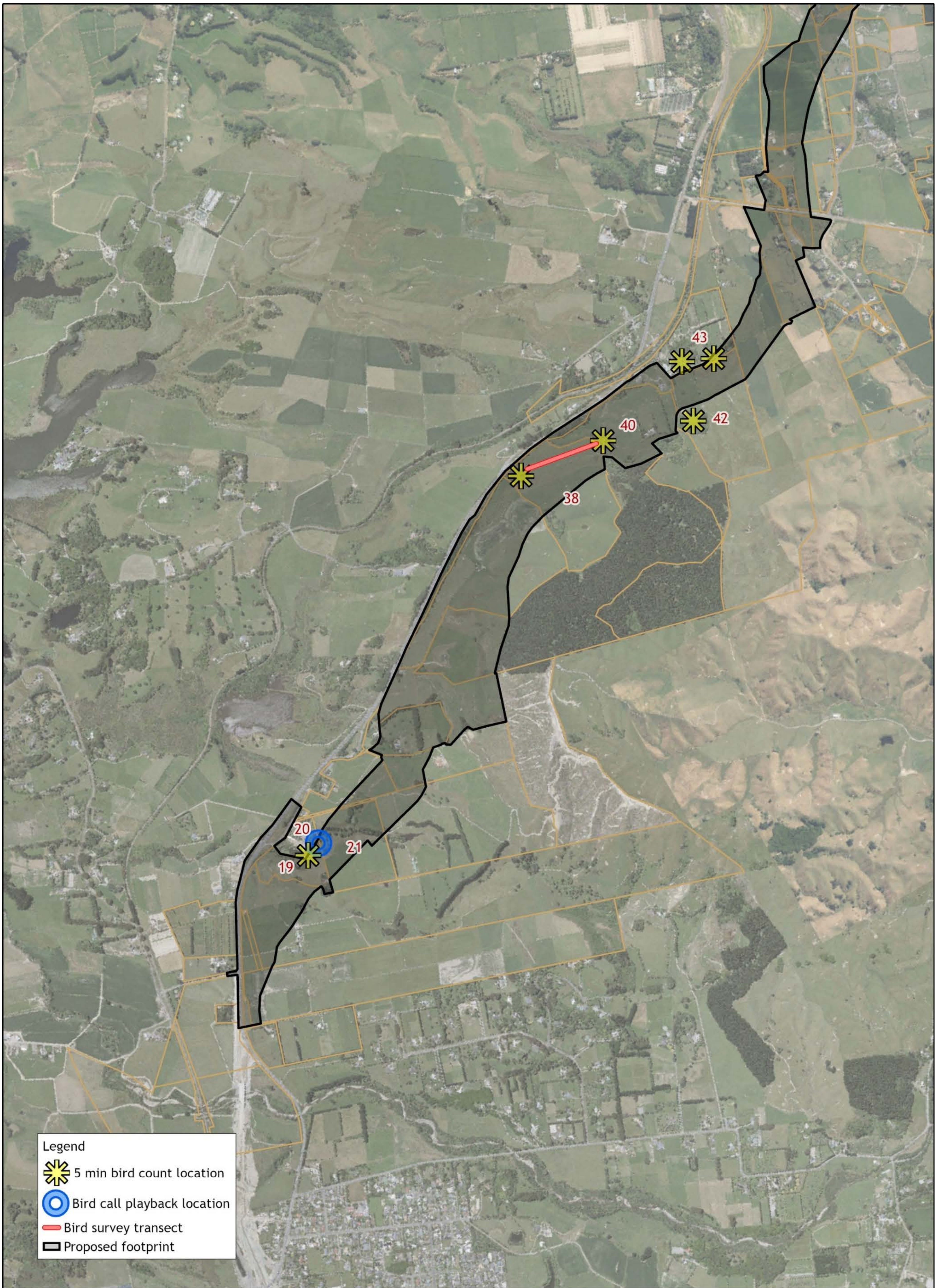

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Figure 1d. Bird survey locations

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Scale: 1:15,000
Date: 14/09/2021
Cartographer: TP
Format: A3

Playback surveys

29. Playback surveys were conducted in wetlands to identify the presence of pūweto/spotless crake (March 2021) and pūweto/spotless and koitareke/marsh crake (November-December 2021; Figure 1). Playback calls were conducted over 10-minute periods. Each survey consisted of two minutes of passive listening, followed by five minutes of alternate 30 seconds of playback and 30 seconds of listening, followed by three minutes of passive listening.

Transect counts

30. Transect counts were conducted to identify bird species within (and in the vicinity of) wetlands, river margins, pastural streams, and agricultural land (Figure 1). All birds within 100 metres of the observer's path were recorded while slowly walking along a transect (Bibby *et al.* 2000). Transect lengths varied between 110 and 500 metres (averaging 250 metres).

Incidental bird counts

31. Sixty-one incidental bird counts of species seen and heard were undertaken when arriving, leaving, or moving between survey sites on each property. This includes records of birds on properties where vegetation surveys were undertaken but no specific bird counts were conducted.

Application of the EcIAG

32. I have assessed the avifauna values, and the 'Level of Effects' of the Project on these values, using the guidelines provided by the EcIAG (2018). As discussed above, effects associated with habitat loss are appropriately addressed in Technical Assessment J, and are not discussed in detail here. This report focuses on all other potential effects on birds.

33. The EcIAG was prepared to provide direction on the general approach to be adopted when assessing ecological impacts. In brief, the EcIAG approach involves the following steps:

    (a) Assigning the 'Ecological Value' of the species likely to be impacted within the Project footprint and immediate surrounds. The 'Ecological Value' of a species is scored on a scale of "Negligible" to "Very High" and is assessed in terms of threat status (Table 2).

Table 2: Factors considered when assigning value to terrestrial species.

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

(b) The 'Magnitude of Effect' from a proposed activity on the environment is assigned after all efforts to avoid, remedy, or minimise potential adverse effects have been implemented. The 'Magnitude of Effect' is a measure of the extent or scale of the effect of an activity and the predicted degree of change that it will cause. The 'Magnitude of Effect' is scored on a scale of ''Negligible'' to 'Very High' and is assessed in terms of:

(i) Level of confidence in understanding the expected effect

(ii) Spatial scale of the effect

(iii) Duration and timescale of the effect

(iv) The relative permanence of the effect

(v) Timing of the effect in respect of key ecological factors.

(c) An overall level of residual effects that cannot be avoided or minimised for each habitat or species value is determined using a matrix approach that combines the 'Ecological Values' with the 'Magnitude of Effects' resulting from the activity. The matrix describes an overall 'Level of Effect' on a scale from ''Negligible'' to 'Very High'.

34. The level of residual effect that cannot be avoided or minimised is then used to guide the type and quantum of offsetting or compensation measures that are proposed to adequately address residual adverse effects associated with the Project. I note that for the Proposed Greater Wellington Regional Plan (Policy 41) that more than minor adverse effects should be remedied where adverse effects on ecosystems or habitats cannot be avoided, and where residual adverse effects remain, the use of biodiversity offsets may be proposed or agreed by the Applicant. Similarly, in the Horizons One Plan

(Policy 13-5), consents within significant habitats should not be granted unless any effects that are more than minor are avoided, remedied, mitigated, or offset to result in a net indigenous biodiversity gain.

35. The EcIAG (p. 84) equate 'not more than minor' effects to a 'Very Low' level of effect, and suggest that 'Low or Very Low' levels of effect are not normally of concern. The EcIAG also notes that effects that are of 'High or Moderate' effect require further management, including offsetting (where relevant).

RESULTS

Desktop review

36. The desktop literature review and database search indicated the presence of 73 bird species in the vicinity of the Project footprint (~5 kilometres). All species recorded within a five-kilometre radius of the Project footprint are listed in Appendix 1. Forty-seven indigenous bird species were recorded, 15 of which are classified as 'At Risk', and seven as 'Threatened' (Table 3). The river beds and banks feature boulderfields with finer gravel areas where banded dotterel may nest. Indigenous species that were present (current survey) or are likely to be present (literature search) within each habitat type are listed in Table 4.

Five-minute bird counts

37. Twelve indigenous bird species were recorded within indigenous forest habitats using the 5MBC survey method (Table 3) and one species is classified as 'Threatened' (koekoeā/long-tailed cuckoo). Seven were recorded within exotic habitats; However, none of these species are classified as 'Threatened' or 'At Risk' (Robertson *et al.* 2021). Fifteen exotic species were recorded within indigenous forest habitats and ten were recorded within exotic habitats using the 5MBC survey method. Eleven indigenous bird species and fourteen exotic species were recorded within the wetland areas.

38. The five-minute bird count (property #212, Figure 1b) undertaken in the patch of low exotic scrub (Appendix 2 - Plate 1) identified single individuals of five bird species (blackbird, *Turdus merula*; house sparrow, *Passer domesticus*; greenfinch, *Carduelis chloris*; chaffinch, *Fringilla coelebs*; and kāhu/swamp harrier, *Circus approximans*). The kāhu/swamp harrier was actively circling the area and may have influenced the bird count.

Wetlands - Playback surveys and transect observation

39. Nineteen indigenous (Table 3) and 14 exotic bird species were recorded within wetland habitats during transect surveys.

40. No responses were heard during playback surveys for pūweto/spotless crake during the initial survey period (22-26 March 2021)**.** However, at least one pūweto/spotless crake was heard responding to two playback surveys (one on each side of a raupō (*Typha orientalis*) reedland) at property #493 on 29 April 2021 (Figure 1a), and a koitareke/marsh crake responded to a playback call on 03 December 2021.

41. During the afternoon survey (2.30 pm, 25 March 2021) at property #461 (Figure 1a), a kawau/black shag (At Risk - Relict) was observed foraging and drying its wings (Appendix 2 - Plate 1) and a weweia/New Zealand dabchick (At Risk - Recovering) was observed foraging 9.25 am, 2 December 2021). A karakahia/grey duck (Threatened - Nationally Vulnerable; 29 November 2021) and a koekoeā/long-tailed cuckoo (Threatened - Nationally Vulnerable; 29 November and 2 December 2021) were observed during bird surveys at property #501. These species were not observed during subsequent visits.

Braided river bird survey

42. Thirteen indigenous and 16 exotic bird species were recorded within braided river habitats (Table 3). Two indigenous species classed as ‘At Risk’ (pihoihoi/New Zealand pipit and tūturiwhatu/black-fronted dotterel) were recorded but no species classified as 'Threatened' were observed (Robertson *et al*. 2021).

Pastural Stream

43. Seven indigenous (Table 3) and 11 exotic bird species were recorded within pastural stream habitat. One indigenous species classed as ‘At Risk’ (pihoihoi/New Zealand pipit) was recorded but no species classified as 'Threatened' was observed (Robertson *et al*. 2021). The pastural stream is approximately two-three metres wide and contains occasional soft rush (*Juncus effusus* var. *effusus*), mercer grass (*Paspalum distichum*), and water pepper (*Persicaria hydropiper*).

Pastural/cropping land

44. Ten indigenous (Table 3) and 15 exotic bird species were recorded within pastural land habitats. One indigenous species classed as ‘At Risk’ (pihoihoi/New Zealand pipit) were recorded but no species classified as 'Threatened' were observed (Robertson *et al.* 2017). Pasture and cropping areas are widespread throughout the Project footprint.

Incidental bird counts

45. Twenty indigenous and 15 exotic bird species were recorded during incidental bird counts (Table 3). Two indigenous species classed as ‘At Risk’ (pihoihoi/New Zealand pipit and kawau/black shag) and one species classified as 'Threatened' (koekoeā/long-tailed cuckoo) were recorded (Robertson *et al.* 2021).

Summary of survey results

46. A total of 28 indigenous bird species were recorded during the survey period (across all ecosystem types and survey methods). A summary of the ecosystem types and properties where each species was recorded is provided in Table 3. A summary of the indigenous bird species recorded or likely to be present within each ecosystem type is provided in Table 4. Species ‘likely’ to be present are defined as birds recorded within a five-kilometre radius of the Project footprint on eBird and iNaturalist.

Table 3: Indigenous bird species observed during surveys within the Project footprint. *Survey methods include 5-minute bird counts (5BMC), transect counts (Trans), incidental (Inc) and playback (PlayB).*

Common Name	Scientific Name	Threat Status	Habitat Types Where Species Detected	Properties Species was Detected	Survey Method
Black-fronted dotterel	Elseyornis melanops	At Risk - Naturally Uncommon	River	212	Trans
Kāhu; Swamp harrier	*Circus approximans*	Not Threatened	Exotic forest/scrub	163, 212, 287, 499	5BMC, Inc
			Pasture	21, 114/119, 151, 163, 212, 287, 461, 499, 519	Inc, Trans
			River	158, 212	Inc, Trans
			Indigenous wetland	20, 287, 461, 493, 501	5BMC, Trans
Karakahia; grey duck	*Anas superciliosa*	Threatened - Nationally Vulnerable	Indigenous wetland	501	Trans
Kākāriki; Yellow-crowned parakeet	*Cyanoramphus auriceps*	At Risk - Declining	River	212	Inc
Karoro; Southern black-backed gull	*Larus dominicanus dominicanus*	Not Threatened	Indigenous forest/scrub	163	5BMC
			Indigenous wetland	20, 461,493, 519	5BMC, Inc
			Pasture	519	Inc
			River	158	Trans
Kawau; Black shag	*Phalacrocorax carbo novaehollandiae*	At Risk - Relict	Wetland/pond	151, 461, 501	Trans
Kererū; New Zealand pigeon	*Hemiphaga novaeseelandiae*	Not Threatened	Exotic forest/scrub	163, 493	5BMC, Inc
			Indigenous forest/scrub	40, 42, 212, 287, 465, 479	5BMC, Inc
Koekoeā; long-tailed cuckoo	*Eudynamys taitensis*	Threatened - Nationally Vulnerable	Indigenous wetland	501	Trans
			Pasture	19	Inc
			Indigenous forest/scrub	38	5BMC, Inc
Koitareke; marsh crake	*Porzana pusilla affinis*	At Risk - Declining	Indigenous wetland	493	PlayB
Korimako; Bellbird	*Anthornis melanura melanura*	Not Threatened	Exotic forest/scrub	163, 212	5BMC, Inc
			Indigenous forest/scrub	40, 42, 287, 465, 479	5BMC, Inc
			Indigenous wetland	20, 473, 493	5BMC, Inc
			Pasture	19, 38	Trans
Kōtare; New Zealand kingfisher	*Todiramphus sanctus vagans*	Not Threatened	Indigenous forest/scrub	21, 212	5BMC, Inc
			Indigenous wetland	20, 461, 493	5BMC, Inc

Common Name	Scientific Name	Threat Status	Habitat Types Where Species Detected	Properties Species was Detected	Survey Method
			Pasture	19, 21, 38	Trans, Inc
			River	212	Inc
Kuruwhengi; Australasian shoveler	*Anas rhynchotis*	Not Threatened	Wetland	461	Inc
Matuku moana; white-faced heron	*Egretta novaehollandiae*	Not Threatened	Pasture	55, 519	Inc
Pihoihoi; New Zealand pipit	*Anthus novaeseelandiae novaeseelandiae*	At-Risk - Declining	Pasture	38, 163, 212	Trans, Inc
			Stream pasture	114/119	Trans
			River	158, 212	Trans, Inc
Pīpīwharauroa; Shining cuckoo	*Chrysococcyx lucidus lucidus*	Not Threatened	Indigenous forest/scrub	38, 43, 465	5BMC, Inc
			River	212	Inc
			Wetland	20, 461, 493, 501	Inc
Pīwakawaka; North Island fantail	*Rhipidura fuliginosa placabilis*	Not Threatened	Exotic forest/scrub	163, 212	Inc
			Indigenous forest/scrub	38, 40, 42, 43, 55, 163, 212, 287, 465, 479	5BMC, Inc
			River	158, 212	Trans
			Indigenous wetland	20, 461, 473, 493, 501	5BMC, Trans, Inc
Poaka; pied stilt	*Himantopus himantopus leucocephalus*	Not Threatened	Pasture	21, 212	Inc
Pūkeko	*Porphyrio melanotus melanotus*	Not Threatened	Indigenous wetland	20, 287, 461,473, 493, 499, 501, 519	5BMC, Inc, Trans
			Indigenous scrub	212	Inc
			River	55, 158	Inc, Trans
			Pasture	19, 21, 52, 151	Inc
			Pasture stream	114/119	Trans
Pūtangitangi; Paradise shelduck	*Tadorna variegata*	Not Threatened	Indigenous forest/scrub	38, 40, 42, 465	5BMC, Inc
			Indigenous wetland	493	5BMC, Inc
			Pasture	19, 31, 151, 163, 209, 519	Inc, Trans
			Pasture stream	114/119	Inc
			River	158, 212	Trans
Pūweto; Spotless crake	*Porzana tabuensis tabuensis*	At Risk - Declining	Indigenous wetland	493	PlayB

Common Name	Scientific Name	Threat Status	Habitat Types Where Species Detected	Properties Species was Detected	Survey Method
Riroriro; Grey warbler	*Gerygone igata*	Not Threatened	Exotic forest/scrub	163, 212, 493	5BMC, Inc
			Indigenous forest	38, 40, 42, 43, 163, 287, 465, 479	5BMC, Inc
			Indigenous wetland	20, 473, 493, 501	5BMC, Inc
			River	212	Inc
			Pasture	21, 31, 47, 158, 163, 209, 212, 461, 490	Inc, Trans
Spur-winged plover	*Vanellus miles novaehollandiae*	Not Threatened	Pasture	38, 47, 114/119, 163, 209, 212, 519	Trans, Inc
			Indigenous wetland	461	Trans
			River	212	Inc
Tauhou; Silvereye	*Zosterops lateralis lateralis*	Not Threatened	Exotic forest/scrub	43, 212	5BMC
			Indigenous forest/scrub	38, 40, 42, 43, 287, 465, 479	5BMC, Inc
			Pasture	19, 31, 151, 461	Inc
			Indigenous wetland	20, 473, 493	5BMC, Inc
			River	158, 212	Inc, Trans
Tete; grey teal	*Anas gracilis*	Not Threatened	Indigenous wetland	461	Trans
Tūī	*Prosthemadera novaeseelandiae novaeseelandiae*	Not Threatened	Indigenous forest/scrub	38, 40, 42, 43, 163, 287, 465	5BMC, Inc
			Pasture	37, 42, 47, 158, 461, 493	Trans
			River	212	Inc
			Indigenous wetland	20, 47, 493	5BMC, Inc
Warou; Welcome swallow	*Hirundo neoxena neoxena*	Not Threatened	Indigenous forest/scrub	38, 40, 42, 43	Inc,
			Pasture	19, 21, 38, 52, 88, 151, 158, 209, 212, 461, 493, 519	Trans, Inc
			Pasture stream	114/119	Inc
			River	158, 212	Inc, Trans
			Indigenous wetland	287, 461, 473	Trans, Inc
Weweia; New Zealand dabchick	*Poliocephalus rufopectus*	At Risk - Recovering	Indigenous wetland	461	Trans

Table 4: Indigenous species present or likely to be present (desktop review) by habitat type.

Habitat Type	Species Detected	Other Species Likely to be Present
Pasture/cropland	Kāhu/swamp harrier, kererū/New Zealand pigeon, korimako/bellbird, kōtare/New Zealand kingfisher, pihoihoi/New Zealand pipit, poaka/pied stilt pūkeko, pūtangitangi/paradise shelduck, riroriro/grey warbler, spur-winged plover, tūī, warou/welcome swallow, matuku moana/white-faced heron	Karearea/bush falcon, torea/South Island pied oystercatcher, tūturiwhatu/banded dotterel, wāna/black swan, tarāpuka/black-billed gull, ruru/morepork, spur-winged plover
Exotic forest/scrub	Kāhu/swamp harrier, kererū/New Zealand pigeon, korimako/bellbird, pīwakawaka/North Island fantail, riroriro/grey warbler, tauhou/silvereye	pīpīwharauroa/shining cuckoo, kākāriki/yellow-crowned parakeet, karearea/bush falcon, pōpokatea/whitehead, ruru/morepork, miromiro/pied tomtit
Indigenous forest/scrub	Karoro/southern black-backed gull, kererū/New Zealand pigeon, korimako/bellbird, kōtare/New Zealand kingfisher, pīpīwharauroa/shining cuckoo, pīwakawaka/North Island fantail, pūtangitangi/paradise shelduck, riroriro/grey warbler, tauhou/silvereye, tūī, warou/welcome swallow, koekoeā/long-tailed cuckoo	Kākā, karearea/bush falcon, pōpokatea/whitehead, ruru/morepork, miromiro/pied tomtit
Mixed exotic/indigenous forest	Kererū/New Zealand pigeon, korimako/bellbird, pīwakawaka/North Island fantail, riroriro/grey warbler, tauhou/silvereye, warou/welcome swallow	Pīpīwharauroa/shining cuckoo, kākā, kākāriki/yellow-crowned parakeet, karearea/bush falcon, pōpokatea/whitehead, ruru/morepork, miromiro/pied tomtit
Exotic wetland (short grazed)	Kōtare/New Zealand kingfisher, pūkeko, pūtangitangi/paradise shelduck, spur-winged plover	Torea/South Island pied oystercatcher, matuku moana/white-faced heron
Indigenous wetland (with established reed beds/swamp shrubland etc.)	Kāhu/swamp harrier, karoro/southern black-backed gull, kōtare/New Zealand kingfisher, pūkeko, pūweto/spotless crake, tauhou/silvereye, tūī, warou/welcome swallow, koitareke/marsh crake	Matuku/Australasian bittern, pūweto/spotless crake, tūturiwhatu/banded dotterel, kuruwhengi/Australasian shoveler, matuku moana/white-faced heron
Open water	Kawau/black shag**,** karakahia/grey duck, weweia; New Zealand dabchick, kuruwhengi/Australasian shoveler	Torea/South Island pied oystercatcher, , Australian coot, tūturiwhatu/banded dotterel, wāna/black swan, tete/grey teal, kawaupaka/little pied cormorant, pāpango/New Zealand scaup, karuhiruhi/pied shag
Ōhau River, Waikawa Stream	Kāhu/swamp harrier, kākāriki/yellow-crowned parakeet, karoro/southern black-backed gull, kōtare/New Zealand kingfisher, pīwakawaka/North Island fantail, pūkeko, pūtangitangi/paradise shelduck, spur-winged plover, tauhou/silvereye, warou/welcome swallow, pihoihoi/New Zealand pipit, black-fronted dotterel	Tūturiwhatu/banded dotterel, kawau/black shag, torea/South Island pied oystercatcher, tarāpuka/black-billed gull, taranui/Caspian tern, kawaupaka/little pied cormorant, poaka/pied stilt, matuku moana/white-faced heron

47. The most commonly recorded bird species were blackbird, house sparrow, and pīwakawaka/North Island fantail (21 properties); goldfinch (20); riroriro/grey warbler (19); Australasian magpie and warou/welcome swallow (18), greenfinch, pūkeko, tauhou/silvereye and tūī (16); chaffinch (15); pūtangitangi/paradise shelduck, yellowhammer, and swamp harrier (14) (Figure 4).

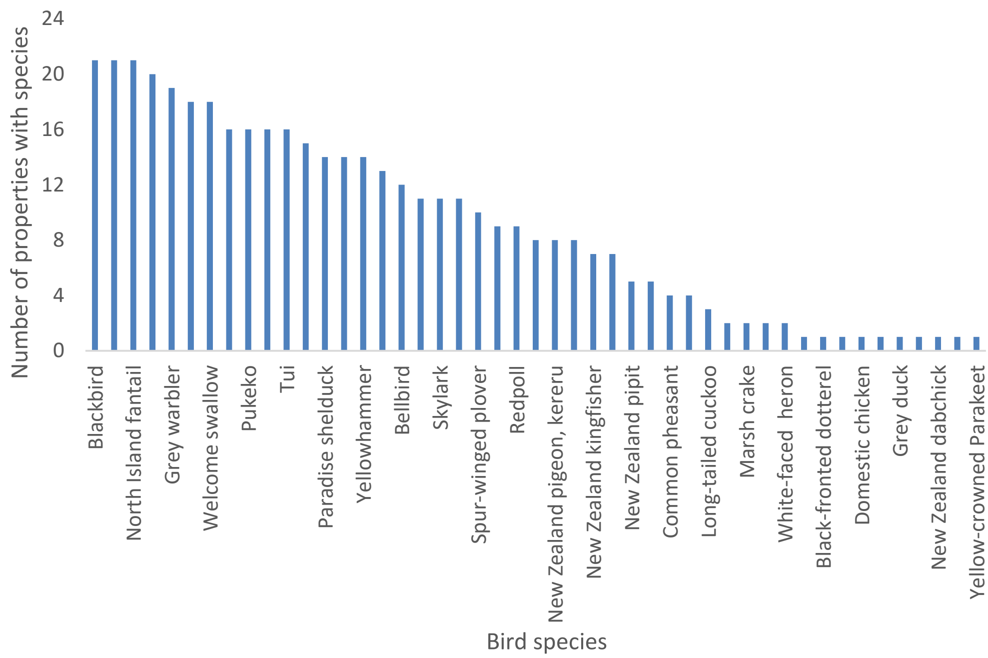

Figure 4: Total number of properties where each bird species was observed.

48. The greatest number of species recorded at a site was 31 species at property #212 (recorded during four transect surveys and five five-minute bird counts, Figure 1b), 30 species at property #461 (recorded during eight transect surveys, Figure 1a), and 29 species at #493 (recorded during five five-minute bird counts) (Figure 1a, Figure 5).

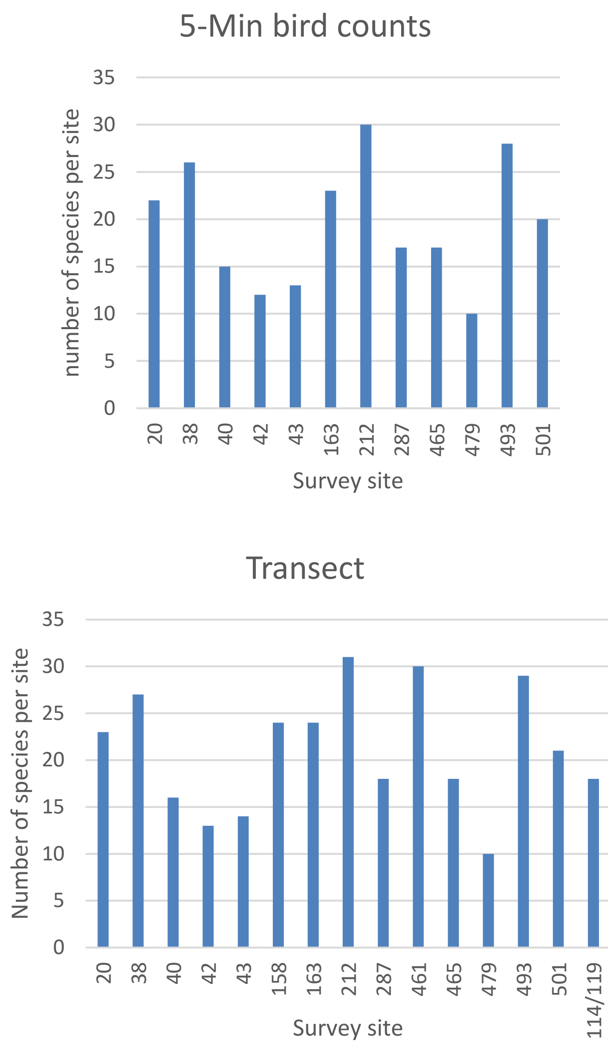

Figure 5: Total number of species observed at a property during five-minute bird counts and transect surveys.

49. The highest diversity of indigenous species was recorded at properties #212 (Ōhau River, Figure 1b) and #461 (pasture and wetland Figure 1a) with 16 indigenous species, and #493 (wetland, Figure 1b) with 15 species. Twelve species were recorded at each of the following properties:

(a) #20 (wetland, Figure 1d).

(b) #38 (indigenous forest, Figure 1d).

50. The highest counts of a single species within a survey were:

(a) Sixty mallards at property #212 (Figure 1b, Transect, Figure 6).

(b) Sixty starlings at property #20 (Figure 1c, incidental count, Figure 8).

(c) House sparrow - transect survey of 50 individuals at property #461 (Figure 1a, transect, Figure 6a).

(d) Thirty-four rock pigeons at property #114/119 (Figure 1c, transect, Figure 6).

(e) Twenty-five goldfinches at properties #114/119 (Figure 1c, incidental count).

(f) Eighteen tauhou/silvereyes at property #212 (Figure 1b, Figure 7).

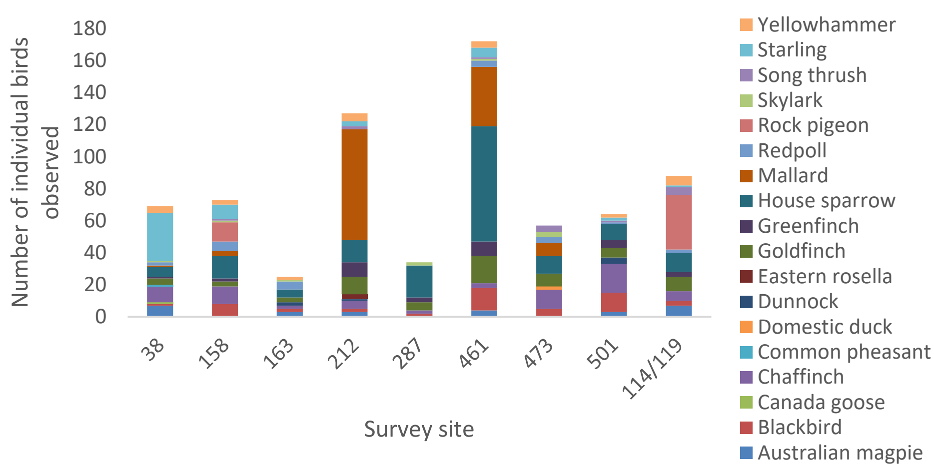

Figure 6: Total abundance of exotic birds observed during transect bird surveys.

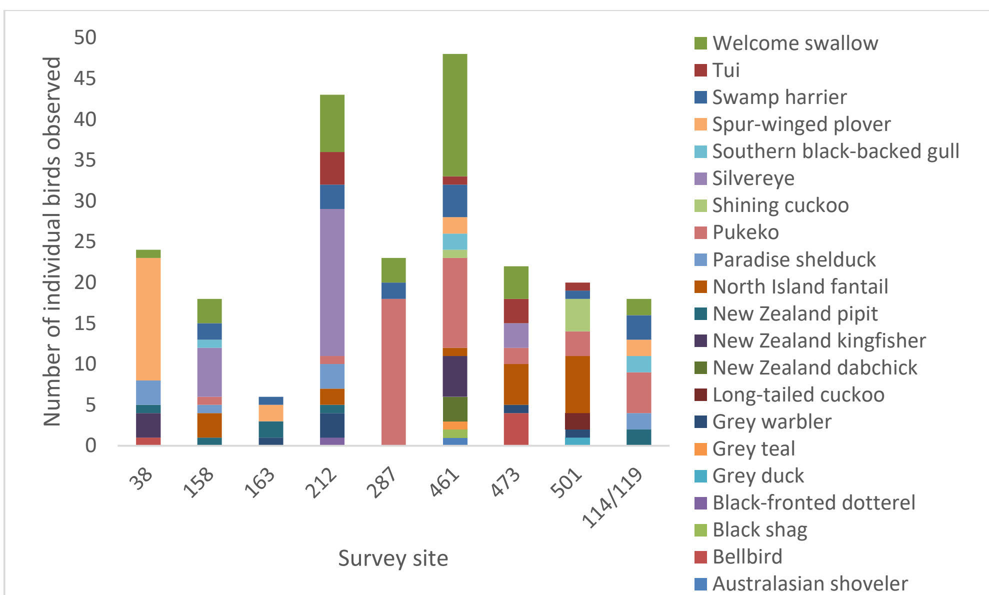

Figure 7: Total abundance of indigenous birds observed during transect bird surveys.

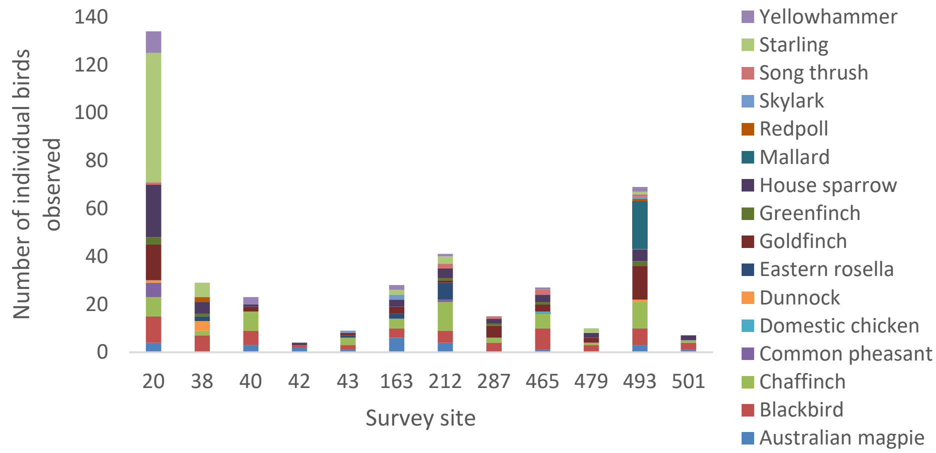

Figure 8: Total abundance of exotic birds observed during five-minute bird counts.

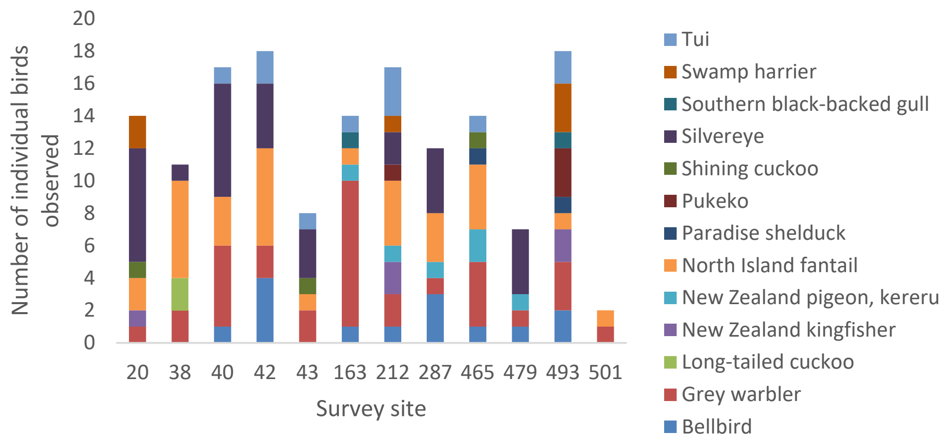

Figure 9: Total abundance of indigenous birds observed during five-minute bird counts.

Notable bird species

51. The field survey detected the presence of six notable indigenous bird species in the Project footprint which are At Risk (Table 5): kawau/black shag, weweia/New Zealand dabchick, tūturiwhatu/black-fronted dotterel (At Risk-Naturally Uncommon), pihoihoi/New Zealand pipit, koitareke/marsh crake and pūweto/spotless crake are considered to have High Ecological Value and may be using the area for nesting, foraging and or roosting. Two Threatened species (Very High Ecological Value) were also observed during surveys: koekoeā/long-tailed cuckoo and karakahia/grey duck. Kākāriki/yellow-crowned parakeet (*Cyanoramphus auriceps*; At Risk-Declining) is also a notable species as these birds prefer podocarp and beech forests; however, a single bird was detected overflying property #212 beside the Ōhau River (Figure 1b).

52. Species that were not detected during the surveys but have been recorded in the local area on eBird and iNaturalist may use habitats within the Project footprint. These species include matuku/Australasian bittern, tūturiwhatu/banded dotterel, karearea/bush falcon, pōpokatea/whitehead, and torea/South Island pied oystercatcher. The Project footprint is close to but does not directly affect Lake Horowhenua and the Tararua Range, which provide high value habitats for water/wetland birds and forest birds respectively.

Table 5: Notable bird species present or with suitable habitat within the Project footprint.

Notable Species	Field Survey Results	Habitat, Behaviour, Breeding and Ecological Value (using EcIAG criteria)
Black-fronted dotterel (At Risk-Naturally Uncommon)	A single black-fronted dotterel was detected at property #212	• Breeds on braided rivers, gravel pits and bare ground. After breeding, flocks form on lake margins and sometimes short grass. • Some birds remain on territory all year in solitary pairs, but in winter loose flocks can form with groups of up to 100 birds. • August to March. • Moderate
Kākā (At Risk - Recovering)	No kākā were detected during the surveys.	• Indigenous forest and predator-free offshore islands and mainland sanctuaries, but some may visit city and rural gardens and orchards. • Very conspicuous when in a flock and when flying, but cryptic when feeding alone. • October to June. • Moderate
Kākāriki/yellow-crowned parakeet (At Risk-Declining)	A single kākāriki was incidentally detected at property #212.	• Prefer podocarp and beech forests. • Solitary or in pairs, form small flocks in autumn and winter. • October to March. Breed throughout New Zealand but are uncommon. • Moderate
Karakahia/grey duck (Threatened - Nationally Vulnerable)	A single karakahia was observed at property #501.	• Mainly in remote wetlands, including forest lakes and rivers. • Seen in small flocks outside of the breeding season, but do not remain in family group once the young have fledged. • August to January. • Moderate

Notable Species	Field Survey Results	Habitat, Behaviour, Breeding and Ecological Value (using EcIAG criteria)
Kārearea/bush falcon (At Risk - Recovering)	No kārearea were detected during the surveys.	• Forest and bush patches. Juveniles disperse to cities, orchards and off-shore islands. • Falcons are territorial during the breeding season and may dive-bomb people near nests. • Breed between August and March. • Moderate
Kawau/black shag (At Risk - Relict)	A single kawau was observed at property #461.	• Rivers, streams, lakes, estuaries, harbours and sheltered coastal waters. • Kawau generally feed alone, but can form flocks of more than 100 birds when food is abundant. They often roost on logs, rocks and in trees. • April to January. • Moderate
Koekoeā/long-tailed cuckoo (Threatened - Nationally Vulnerable)	Koekoeā were detected at properties #38 and #501.	• Native and exotic forests • Kawau generally feed alone, but can form flocks of more than 100 birds when food is abundant. They often roost on logs, rocks and in trees. • November to January. • Moderate
Koitareke/marsh crake (At Risk - Declining)	A single koitareke was heard during playback call at property #493.	• Dense beds with reeds and rushes in freshwater wetlands. • Koitareke are secretive, cryptic, and rarely seen. They are quite mobile and probably fly at night. • September to January. • High

Notable Species	Field Survey Results	Habitat, Behaviour, Breeding and Ecological Value (using EcIAG criteria)
Matuku/Australasian bittern (Threatened – Nationally Critical)	No matuku were detected during the surveys.	• Mainly freshwater wetlands, especially with dense cover of raupō or reeds. Some move to coastal wetlands in autumn and winter. • Usually solitary and stealthy. When disturbed, they may stand tall with neck fully stretched up with head and bill to the sky, or slowly drop into the vegetation by retracting their head and crouching down. • August to March. • Very High
Pihoihoi/New Zealand pipit (At Risk – Declining)	Pihoihoi were detected during the surveys at properties #38, #114/119, #158, #163, and #212.	• Open habitats; mainly near coast, on shingle riverbeds, gravel roads and scree-slopes. • Pairs are strongly territorial during breeding, but some birds (perhaps mainly juveniles) form loose flocks of up to 20 birds in autumn and winter. • August to March. • High
Pōpokatea/whitehead (Not Threatened)	No pōpokatea were detected during the surveys.	• Indigenous and exotic forest and scrub in the North Island. • In small flocks all year and gregarious. Will feed with parakeets. Territorial during the breeding season with a main pair and young from previous years. Have a large home range in autumn and winter. • September to January. • High

Notable Species	Field Survey Results	Habitat, Behaviour, Breeding and Ecological Value (using EcIAG criteria)
Pūweto/spotless crake (At Risk - Declining)	Pūweto were heard during playback call at property #493.	• Freshwater wetlands with raupō or sedge, especially in the North Island. • Pūweto are shy, cryptic, and live within dense vegetation. Most unsolicited calls are heard at dawn and dusk when birds are most active. • August to February. • High
Torea/South Island pied oystercatcher (At Risk - Declining)	No torea were detected during the surveys.	• Breeds inland on riverbeds and farmland, mainly in the South Island. Most of the ~80,000 birds migrate to the North Island and northern South Island to spend January to July at estuaries. • Behaviour is very ritualised, including mobbing aerial predators and lead ground predators away from the nest or chicks with conspicuous walking. • August to January. • High
Tūturiwhatu/banded dotterel (At Risk-Declining)	No tūturiwhatu were detected during the surveys.	• Breeds on sandy beaches, shellbanks and braided rivers. After breeding, flocks form on estuaries, lake margins and sometimes short grass. • Gregarious at winter roosts, but often form loose flocks and can be territorial while feeding. They can be site territorial, returning each year. They are solitary when breeding on well defended territory. • July to January. • Very High

Notable Species	Field Survey Results	Habitat, Behaviour, Breeding and Ecological Value (using EcIAG criteria)
Weweia/New Zealand dabchick (At Risk - Recovering)	A weweia was detected at property #461 during a freshwater survey.	• Sheltered parts of lakes, farm ponds and, in winter, sewage ponds. • In pairs during the breeding season and form loose flocks in autumn and winter. They will dive, swim and skitter across the water surface if disturbed. They fly between waterbodies only at night. • June to March. • Moderate

ASSESSMENT OF ECOLOGICAL VALUES

53. Avifauna habitat values are incorporated into the vegetation and habitat values described in Technical Assessment J. As such, the assessment of the level of effect associated with vegetation loss will also account for the loss of these habitat values. The loss of indigenous avifauna habitat is therefore appropriately covered in Technical Assessment J and is not discussed further below. A summary of avifauna habitat values is provided in Table 6.

54. Table 6 provides an Ecological Values assessment for each habitat type within the Project footprint. Some habitats beyond but adjacent to the Project footprint have also been included in the assessment on the following basis:

    (a) The habitat is of Moderate to High ecological value or has previously been recognised as a natural area, or

    (b) The habitat is of a type that may be subject to adverse effects other than direct clearance or loss, due to its proximity to the footprint (e.g., increased isolation of resident fauna).

55. The ecological values of all habitat types within the Project footprint were assessed, including habitats such as pasture and cropping land, forests and river beds.

56. Site specific information for some species is limited (i.e., bird use was surveyed for representative habitats along the route rather than for every area of each habitat). Therefore, species that may be present in any one area of habitat, based on habitat preference and known distribution, are assumed to be present for the purposes of the ecological values assessments.

Habitat values

Indigenous forests

57. The indigenous vegetation supports a range of common indigenous bird species and contains good potential habitat for At Risk species, including karearea/bush falcon (Risk - Recovering), and kākā (At Risk - Recovering).

Exotic forests

58. The exotic forest sites comprise radiata pine (*Pinus radiata*) forests, crack willow (*Salix* × *fragilis*), and exotic herbaceous species with an occasional understory of indigenous plants. These areas will support various indigenous and exotic bird species including korimako/bellbird, and possibly the

occasional miromiro/tomtit (*Petroica macrocephala toitoi*) or pōpokatea/whitehead

Wetlands

59. The wetlands are potential habitat for pūweto/spotless crake, koitareke/marsh crake and matuku/Australasian bittern and as such the vegetation is of high ecological value. These areas may also support various indigenous and exotic bird species including weweia/New Zealand, tete/grey teal (*Anas gracilis*), and pūtangitangi/paradise shelduck (*Tadorna variegata*).

Rivers

60. The braided river provides foraging and breeding habitat for Threatened and At Risk species, including kawau/black shag, taranui/Caspian tern (*Hydroprogne caspia*, Threatened - Nationally Vulnerable), pihoihoi/New Zealand pipit, tūturiwhatu/banded dotterel, tōrea/South Island pied oystercatcher and ngutu parore/wrybill (*Anarhynchus frontalis*).

Pastural Stream

61. The pastural stream area provides habitat for species including pihoihoi/New Zealand pipit (At Risk-Declining), pūkeko (*Porphyrio melanotus melanotus*), house sparrow (*Passer domesticus domesticus*), blackbird (*Turdus merula merula*), goldfinch (*Carduelis carduelis*), Australian magpie (*Gymnorhina tibicen*) and starling (*Sturnus vulgaris*). None of these species are classified as 'Threatened' (Robertson *et al.* 2021).

Pasture and cropping land

62. The vegetation of the pasture and cropping land may provide habitat for pihoihoi/New Zealand pipit and other common indigenous species such as tauhou/silvereye (*Zosterops lateralis lateralis*), spur-winged plover (*Vanellus miles novaehollandiae*), ruru/morepork (*Ninox novaeseelandiae novaeseelandiae*), kōtare/New Zealand kingfisher (*Todiramphus sanctus vagans*) and warou/welcome swallow (*Hirundo neoxena neoxena*).

Open water

63. Open water provides habitat for kawau/black shag and weweia/New Zealand dabchick, and may also support, karuhiruhi/pied shag (At Risk - Recovering), and Australian coot (*Fulica atra australis*, At Risk - Naturally Uncommon). ‘Not Threatened’ species may include tete/grey teal, pūtangitangi/paradise shelduck, kawaupaka/little pied cormorant (*Phalacrocorax melanoleucos brevirostris*), pūkeko, kōtare/New Zealand kingfisher, wāna/black swan, and pāpango/New Zealand scaup (*Aythya novaeseelandiae*). Open water areas include wetland areas, dammed gullies, and man-made ponds.

Table 6: Habitat types and ecological values for avifauna for the Ō2NL Project footprint.

Habitat Type	Vegetation Type	Code	Property ID	Avifauna Habitat Values	Assigned Value
Indigenous forest	Tawa forest	ITF1	87, 163, 287	• Korimako/bellbird, tūī, pihoihoi/New Zealand pipit, pīwakawaka/North Island fantail and riroriro/grey warbler were observed during the on-site surveys on 24/03/21 25/03/21, 01/12/21 and 03/12/21. • Plant species within these habitats can provide fruit, seeds and nectar for korimako/bellbird, kererū, tauhou/silvereye, tūī, kākā, and pōpokatea/whitehead. • The invertebrates within the habitat could provide important food for miromiro/tomtit.	Very High
	• Tawa-kohekohe forest • Tarata-rewarewa forest • Kohekohe-tītoki-karamū forest • Tītoki forest • Māhoe forest and scrub • Puka-kōhūhū forest	ITF2 - ITF7	38, 39, 40, 42, 43, 151, 167, 171 465, 493	• Korimako/bellbird, pīpīwharauroa/long-tailed cuckoo and pīwakawaka/North Island fantail were observed during the on-site surveys at #38 on 23/03/21, 25/03/21, 26/03/21, 29/11/21 and 01/12/21. This property is outside of the proposed road designation. • Korimako/bellbird, tūī, riroriro/grey warbler, pīwakawaka/North Island fantail and tauhou/silvereye were observed at property #40 during the on-site surveys on 23/03/21, 25/03/21, 01/12/21, 03/12/21 and 21/02/22. • Korimako/bellbird, tūī, pīwakawaka/North Island fantail, riroriro/grey warbler and tauhou/silvereye were observed at property #42 during the on-site surveys on 23/03/21, 25/03/21 and 24/02/22; but is outside of the proposed road designation. • Tūī, pīwakawaka/North Island fantail, riroriro/grey warbler, pīpīwharauroa/shining cuckoo, and tauhou/silvereye were observed at property #43 during the on-site survey on 23/03/21. • Tūī, pīwakawaka/North Island fantail, riroriro/grey warbler, pīpīwharauroa/shining cuckoo, korimako/bellbird, kererū and tauhou/silvereye were observed at property #465 during the on-site survey on 01/12/21 and 02/12/21. • These properties include plants such as rewarewa (*Knightia excelsa*), kōhūhū (*Pittosporum tenuifolium*), kawakawa (*Piper excelsum* subsp. *excelsum*), karaka (*Corynocarpus laevigatus*), nīkau (*Rhopalostylis sapida*), tarata (*Pittosporum eugenioides*), tītoki (*Alectryon excelsus* subsp. *excelsus*), makomako (*Aristotelia serrata*), māhoe (*Melicytus ramiflorus* subsp. *ramiflorus*), and karamū (*Coprosma robusta*). • These plant species can provide fruit, seeds and nectar for korimako/bellbird, kererū, tauhou/silvereye, tūī, kākā, and pōpokatea/whitehead. • The invertebrates within the habitat and leaf litter may provide important food for miromiro/tomtit in closely linked habitats such as #38, #39, #40 and #42.	High
Indigenous treeland	(all)	ITT1 – ITT7	42, 55, 61, 91, 207, 307, 459, 465,	• The indigenous treeland may provide 'stepping stone' habitat between properties, aiding bird movement between sites, including tūī, korimako/bellbird, tauhou/silvereye and riroriro/grey warbler. • Indigenous plant species may provide fruit, seeds and nectar for small indigenous birds.	Low - Moderate
Indigenous scrub	(all)	ITS1	207, 455, 459, 461, 472, 473, 493	• These areas may provide fruit, seeds and nectar for indigenous birds.	Low - Moderate
Indigenous fernland	Kiokio fernland	ITFn01	19	• Probable habitat for insectivorous bird species.	Low
Mixed indigenous-exotic forest and or scrub (other)	• Tītoki-karaka forest • Tītoki-false acacia-poataniwha-karaka forest • False acacia-tītoki-cherry forest	MTF3, MTF7, MTF8	465	• Riroriro/grey warbler, korimako/bellbird, pīpīwharauroa/shining cuckoo, kererū and tauhou/silvereye were observed at property #465 during the on-site surveys on the 24/03/21 and 02/12/21. This is an isolated forest fragment which is situated outside of the proposed road designation. • Fruits and seeds will be consumed by tauhou/silvereye, kākā and kererū. There is a single tītoki tree which is within the Project footprint and may be used by birds for food, roosting and a stepping stone between property #465 and #479.	High

Habitat Type	Vegetation Type	Code	Property ID	Avifauna Habitat Values	Assigned Value
	• Māhoe-barberry-*Muehlenbeckia australis* forest and scrub • Māhoe-sweet cherry scrub and forest • Crack willow-māhoe forest/scrub (Ōhau River) • Mixed indigenous-exotic planted forest	MTF1, MTF2, MTF4, MTF5	19, 40, 42, 47, 52, 212, 307, 311, 326, 472, 473, 484, 488	• Pīwakawaka/North Island fantail, kererū, tauhou/silvereye, tūī, korimako/bellbird and kōtare/New Zealand kingfisher were observed during the on-site survey on 22/03/21, 01/12/21, 03/12/21, and 24/02/22. • Plant species within these forest fragments could provide some fruits and seeds for korimako/bellbird, kererū, tūī, kākā, and tauhou/silvereye.	Low - Moderate
	Karaka-māhoe-kawakawa forest and scrub	MTF6	479	• Kererū, korimako/bellbird, riroriro/grey warbler and tauhou/silvereye were observed during the on-site survey on 22/03/21. • These plants may provide fruit, seeds and nectar for korimako/bellbird, kererū, tūī, and kākā. This site is outside of the proposed road designation; however, birds will fly over the proposed roading to reach property #465.	High
Exotic forest, treeland and scrub.	• Radiata pine forests • Redwood forest • False acacia-karaka forest • Macrocarpa-radiata pine-false acacia forest	ETF3, ETF6, EFT7, EFT8	158, 163, 167, 171, 207, 221, 465, 472, 479, 493, 501	• Riroriro/grey warbler, pīwakawaka/North Island fantail, korimako/bellbird, kererū and an over flying kāhu/swamp harrier were observed at property #163 during the on-site survey on 24/03/21. • A single riroriro/grey warbler and kereru were observed at property #493 during the site visit on 22/03/21 and 02/12/21, respectively. • Pīwakawaka/North Island fantail, pūkeko and kāhu/swamp harrier were observed at #501 during the site visit on 24/03/21. Riroriro/grey warbler and pīwakawaka/North Island fantail were observed on the 26/03/21. These areas contain some indigenous plant species within the canopy or understory and will support various exotic and indigenous bird species including pōpokatea/whitehead (*Mohoua albicilla,* At Risk - Declining), korimako/bellbird (*Anthornis melanura melanura*), and occasionally miromiro/tomtit (*Petroica macrocephala toitoi*).	Moderate
	Exotic treeland and forest	ETF4	9, 12, 14, 19, 21, 28, 29, 30, 31, 33, 43, 53, 57, 88, 91, 125, 132, 134/144, 139, 264, 273, 282, 286, 337, 349, 360, 363, 418, 421, 470, 472, 473, 485, 490, 493, 498, 499, 519, 535, 544, 550, 555, 586, 599	• Trees may be used as temporary perches or 'stepping stones' when moving between forest areas. • Tūī and korimako/bellbird will be attracted to areas with plants like banksia (*Banksia* sp.) when in flower and kererū will forage on exotic tree leaves (e.g. broom (*Cytisus scoparius*), willow (*Salix* sp.) and poplar (*Populus* sp.)).	Low
	• Crack willow forest/scrub • Eucalyptus forest • Sweet cherry forest	ETF1, ETF2, EFT5	151, 158, 167, 171, 209, 212, 459, 465, 659	• A kāhu/swamp harrier was observed overflying property #212 during the site visit on 22/03/21, and riroriro/grey warbler, pīwakawaka/North Island fantail, korimako/bellbird, kereru and tauhou/silvereye were observed on the 03/11/21. • The occasional indigenous plants (e.g. karamū (*Coprosma robusta*), kawakawa and māhoe) may provide limited fruit and seed for tauhou/silvereye, korimako/bellbird, tūī and kererū.	Low
Exotic scrub and shrubland dominated by gorse	• Crack willow-brush wattle-tree lucerne scrub • Scrub dominated by gorse (*Ulex europaeus*)	ETS1-ETS3	158, 209, 212	• Exotic scrub/gorseland is unlikely to support a diverse range of indigenous bird species. • Kererū may forage on tree lucerne (*Chamaecytisus palmensis*) flowers and leaf buds. • Mature crack willow may provide suitable nesting sites for pūtangitangi/paradise shelduck.	Negligible - Low

Habitat Type	Vegetation Type	Code	Property ID	Avifauna Habitat Values	Assigned Value
Wetland habitats • Indigenous wetland • Mixed indigenous wetland • Exotic wetland	• Mixed wetland and sedgeland • Floating grassland	EWRs3, IWSe1, IWSe1-SPG, IWSe2, IWSe4, MWSe2, MWG1- MWG3, EWF1, EWG1-EWG9, MWH1-MWH10	19, 20, 21, 25, 28, 30, 40 47, 52, 131, 134/144, 207, 287, 455, 459, 461, 470, 472, 473, 481, 493, 499, 501, 531	• There is very little habitat for wetland birds within property #287. Nevertheless, pūkeko and spur-winged plover will visit the area. • Pūkeko, tauhou/silvereye, riroriro/grey warbler, pīwakawaka/North Island fantail, korimako/bellbird and an over-flying karoro/southern blackback-gull and a kāhu/swamp harrier were observed at #20 during the on-site surveys on 23/03/21 and 26/03/21. A kōtare/New Zealand kingfisher was also observed during the on-site survey on 01/12/21. • Pūkeko, warou/welcome swallow and a kāhu/swamp harrier were observed at #287 during the on-site survey on 25/03/21, and pūkeko were observed on 03/12/21. • Pūkeko, warou/welcome swallow, tauhou/silvereye, riroriro/grey warbler, pīwakawaka/North Island fantail, korimako/bellbird and tūī were observed at #473 during the on-site surveys on 29/11/21 and 02/12/21. • Pūkeko, pīwakawaka/North Island fantail and a kāhu/swamp harrier were observed at #501 during surveys on 24/03/21 and 26/03/21. A karakahia/grey duck was observed foraging on the western edge of the wetland and a koekoeā/long-tailed cuckoo was heard during the on-site survey on 29/11/21.	Low - Moderate
	• Raupō reedland • Kiokio-Spike sedge-Yorkshire fog fernland • Kiokio-spike sedge-*kāpūngāwhā* sedgeland	IWRe1, MWFn1, IWFn1, IWSe3, IWSe5, MWSe4	19, 20, 21, 493	• At least one spotless crake responded to playback calls in the raupō reedland at #493 on 29/04/21, and at least one marsh crake responded to playback calls on 03/12/21. • Pūkeko, kererū, riroriro/grey warbler and pīwakawaka/North Island fantail were observed during surveys at #20 on 22/03/21 and 26/03/21. This wetland has potential habitat for spotless crake and Australasian bittern. Kōtare/New Zealand kingfisher and a kāhu/swamp harrier were also observed on 01/12/21 and 03/12/21. • Property #493 may also support various exotic and indigenous bird species including weweia/New Zealand dabchick (At Risk - Recovering), tete/grey teal (*Anas gracilis*), and paradise shelduck (*Tadorna variegata*).	Very High
River	Gravel boulderfields and river beds	TG1	151, 158, 209, 212	• The braided river provides habitat for foraging and breeding of Threatened and At Risk species, including black shag, Caspian tern (*Hydroprogne caspia*), New Zealand pipit, tūturiwhatu/banded dotterel, South Island pied oystercatcher and ngutu parore/wrybill (*Anarhynchus frontalis*). • Pūkeko, warou/welcome swallow, kāhu/swamp harrier, tauhou/silvereye, karoro/southern black-backed gull and pīwakawaka/North Island fantail were observed during surveys at #158 on 22/03/21 and 25/03/21. A pihoihoi/New Zealand pipit was also detected on 02/12/21. • Pūtangitangi/paradise shelduck, warou/welcome swallow, kāhu/swamp harrier, kōtare/New Zealand kingfisher and pīwakawaka/North Island fantail were observed during surveys at #212 on 22/03/21 and 25/03/21. A single kākāriki/yellow-crowned parakeet was seen flying over the area during an incidental count on 25/03/21. A pihoihoi/New Zealand pipit and a pīpīwharauroa/shining cuckoo were also detected on 02/12/21.	Very High

Habitat Type	Vegetation Type	Code	Property ID	Avifauna Habitat Values	Assigned Value
Pasture/Pasture Stream		ETP, ETG1	38, 136, 151, 158, 162, 212, 461, 114/119	• Pīwakawaka/North Island fantail, pūtangitangi/paradise shelduck, spur-winged plover, kōtare/New Zealand kingfisher, korimako/bellbird and warou/welcome swallow were observed at property #38 on 23/03/21 and 25/03/21. A pihoihoi/New Zealand pipit was also detected on 02/12/21. • Riroriro/grey warbler and kāhu/swamp harrier were observed during the site survey at #136 on 24/03/21. • Kāhu/swamp harrier, warou/welcome swallow and a tūī were observed during the site survey at #461 on 25/03/21, 26/03/21 and 29/11/21. • Pūkeko, kāhu/swamp harrier and spur-winged plover were observed at property 114/119 on 24/03/21. Pūtangitangi/paradise shelduck, spur-winged plover and a pihoihoi/New Zealand pipit was also detected on 01/12/21. • Pastural land may provide habitat for New Zealand pipit and other common indigenous species such as tauhou/silvereye (*Zosterops lateralis lateralis*), spur-winged plover (*Vanellus miles novaehollandiae*), ruru/morepork (*Ninox novaeseelandiae novaeseelandiae*), kōtare/New Zealand kingfisher (*Todiramphus sanctus vagans*) and warou/welcome swallow (*Hirundo neoxena neoxena*). • Pastural streams provide habitat for species including pūkeko, house sparrow (*Passer domesticus domesticus*), blackbird (*Turdus merula merula*), goldfinch (*Carduelis carduelis*), Australian magpie (*Gymnorhina tibicen*) and starling (*Sturnus vulgaris*). None of these species are classified as 'Threatened' or 'At Risk'.	Low
Open water		OW	21, 39, 131, 134/144, 207, 461, 470, 519, 535	• Pūkeko, kāhu/swamp harrier, kawau/black shag, warou/welcome swallow, kōtare/New Zealand kingfisher, and spur-winged plover were observed at property #461 on 25/03/21, 26/03/21 and 29/11/21. A weweia/New Zealand dabchick (At Risk - Recovering) was also observed on 03/08/21. • These areas provide habitat for shag and duck species, pūkeko, kōtare/New Zealand kingfisher, Australian coot, wāna/black swan, and may also support weweia/New Zealand dabchick (At Risk - Recovering), Non-threatened (i.e. Not Threatened) species may include tete/grey teal, pūtangitangi/paradise shelduck, kuruwhengi/Australasian shoveler, little pied cormorant, pūkeko, and pāpango/New Zealand scaup.	Moderate to High

Fauna values

64. The following notable indigenous bird species (Threatened or At Risk) have been identified within the Project footprint (in bold) and surrounding area (all others), and may be adversely affected by the Project.

- **Black-fronted dotterel** (*Elseyornis melanops*)
- Kākā, North Island kākā (*Nestor meridionalis septentrionalis*)
- **Karakahia, grey duck** (*Anas superciliosa*)
- Kārearea, bush falcon (*Falco novaeseelandiae ferox*)
- **Kāruhiruhi, pied shag** (*Phalacrocorax varius varius*)
- **Kawau, black shag** (*Phalacrocorax carbo novaehollandiae*)
- **Koitareke, marsh crake** (*Porzana pusilla affinis*)
- **Koekoeā, long-tailed cuckoo** (*Eudynamys taitensis*)
- Matuku, Australasian bittern (*Botaurus poiciloptilus*)
- Ngutu parore, wrybill (*Anarhynchus frontalis*)
- **Pīhoihoi, New Zealand pipit** (*Anthus novaeseelandiae novaeseelandiae*)
- Pōpokatea, whitehead (*Mohoua albicilla*)
- **Pūweto, spotless crake (*Porzana tabuensis*)**
- Tara, white-fronted tern (*Sterna striata striata*)
- Taranui, Caspian tern (*Hydroprogne caspia*)
- Tarāpuka, red-billed gull (*Larus novaehollandiae scopulinus*)
- Tōrea, South Island pied oystercatcher (*Haematopus finschi*)
- Tūturiwhatu, banded dotterel (*Charadrius bicinctus bicinctus*)
- Tūturiwhatu, New Zealand dotterel (*Charadrius obscurus aquilonius*)
- **Weweia, New Zealand dabchick (*Poliocephalus rufopectus*)**

65. The ecological value of these species as well as all other indigenous bird species observed or possibly present is indicated in Table 7. It should be noted that the Ecological Value of "Low" assigned to Not Threatened species (as per the EcIAG) does not imply that adverse effects for these species are of little concern. Collectively, guilds of forest or wetland birds that are Not Threatened are critical for maintaining the health of indigenous ecosystems.

Table 7: Ecological value assessment for affected indigenous bird species (as per Roper-Lindsay *et al*. 2021)**.**

Species	Determining Factors	Assigned Value	Observed During Survey?
Black-fronted dotterel	At Risk - Naturally Uncommon (Robertson *et al.* 2021). Patchy distribution within New Zealand.	Moderate	Yes
Australian coot	At Risk - Naturally Uncommon (Robertson *et al.* 2021). Widespread and common on certain lakes. This species may visit open waterbodies.	Moderate	No
Hoary-headed grebe	Non-resident Native – Coloniser (Robertson *et al.* 2021). Mostly found in Australia. However, individuals have been found at Lake Horowhenua, but it is highly unlikely that individuals will be detected in the Project footprint.	Moderate	No
Kākā/North Island kākā	At Risk - Recovering (Robertson *et al.* 2021). Favours native forest and predator- and possum-free offshore islands and mainland sanctuaries, but some visit city and rural gardens and orchards. It is possible that individuals may be detected occasionally in the Project footprint.	Moderate	No
Kāhu/swamp harrier	Not Threatened (Robertson *et al.* 2021). Nationally and locally common indigenous species.	Low	Yes
Karakahia/grey duck	Threatened - Nationally Vulnerable (Robertson *et al.* 2021). Pure birds very rare, mainly in remote wetlands, including forest lakes and rivers.	Moderate	Yes
Karearea/bush falcon	Threatened - Nationally Vulnerable (Robertson *et al.* 2021). This species will be present, but only occasionally within exotic forests, bush and scrub patches and open pasture.	Moderate	No
Karoro/southern black-backed gull	Not Threatened (Robertson *et al.* 2021). Nationally and locally common indigenous species.	Low	Yes
Kāruhiruhi/pied shag	At Risk - Recovering. (Robertson *et al.* 2021). Patchy distribution within New Zealand and rarely found inland. However, juvenile birds may visit inland open water.	Moderate	No
Kawau paka/little pied cormorant	Non-resident Native – Vagrant (Robertson *et al.* 2021). Kawaupaka are distributed throughout New Zealand. Individuals are likely to use areas of open water and braided rivers.	Moderate	No
Kawau/black shag	At Risk-Relict (Robertson *et al.* 2021). Kawau breed widely throughout New Zealand and are likely to use the various waterbodies to forage, roost and potentially nest.	Moderate	Yes
Kereru/New Zealand pigeon	Not Threatened (Robertson *et al.* 2021). Nationally and locally common indigenous species.	Low	Yes

Species	Determining Factors	Assigned Value	Observed During Survey?
Koekoeā/long-tailed cuckoo	Threatened - Nationally Vulnerable (Robertson *et al.* 2021). Widespread and sometimes moderately common.	Moderate	Yes
Koitareke/marsh crake	At Risk-Declining Robertson *et al.* 2021). Widespread and sometimes moderately common.	High	Yes
Korimako/bellbird	Not Threatened (Robertson *et al.* 2021). Nationally and locally common indigenous species.	Low	Yes
Kotare/New Zealand kingfisher	Not Threatened (Robertson *et al.* 2021). Nationally and locally common indigenous species.	Low	Yes
Kōtuku-ngutupapa/royal spoonbill	At Risk - Naturally Uncommon (Robertson *et al.* 2021). Mainly overwinter on large lakes and estuaries. It is highly unlikely that individuals will be detected in the Project footprint.	Moderate	No
Kuruwhengi/Australasian shoveler	Not Threatened (Robertson *et al.* 2021). This is a highly mobile species that prefers fertile shallow wetlands, especially lakes fringed with raupō. This species may visit wetland areas and open waterbodies.	Low	No
Kuruwhengi/Northern shoveler	Non-resident Native – Vagrant (Robertson *et al.* 2021). Found in the Northern Hemisphere and only a few accepted records have been noted in New Zealand. It is highly unlikely that this species will be found the Project footprint.	Moderate	No
Matuku moana/white-faced heron	Not Threatened (Robertson *et al.* 2021). A common heron species. Individuals will utlise open-country, swamp margins and riverbeds.	Low	No
Matuku/Australasian bittern	Threatened - Nationally Critical (Robertson *et al.* 2021). This species is highly likely to move between wetland sites within the Project footprint that contain tall dense beds of raupō and reeds. Australasian bittern fly at night.	Very High	No
Miromiro/pied tomtit	Not Threatened. (Robertson *et al.* 2021). They are sparsely distributed; however, it is possible that miromiro may be present in large areas of connected forest within the Project footprint.	Low	No
Ngutu parore/wrybill	Threatened - Nationally Increasing (Robertson *et al.* 2021). Ngutu parore breed in the South Island and most birds fly north to tidal harbours after breeding. It is unlikely that individuals will use the braided river habitat within the Project footprint.	Very High	No
New Zealand scaup/pāpango	Not Threatened (Robertson *et al.* 2021). This species has a widespread but patchy distribution. They prefer large, deep lakes. It is possible that this species may be detected on waterbodies within the Project footprint.	Low	No

Species	Determining Factors	Assigned Value	Observed During Survey?
Pihoihoi/New Zealand pipit	At Risk - Declining (Robertson *et al.* 2021). This species is widely but patchily distributed in open habitat (e.g., riverbeds, rough pasture, tussockland and open areas in exotic forest). This species will be present, but only occasionally within braided rivers and open pasture.	High	Yes
Pīpīwharauroa/shining cuckoo	Not Threatened (Robertson *et al.* 2021). They breed throughout New Zealand and will be found in forest areas where grey warbler nest.	Low	Yes
Pīwakawaka/North Island fantail	Not Threatened (Robertson *et al.* 2021). Nationally and locally common indigenous species.	Low	Yes
Poaka/pied stilt	Not Threatened. (Robertson *et al.* 2021). Found throughout New Zealand. Poaka may forage within the braided river habitat or flooded pasture (when present).	Low	No
Pōpokatea/whitehead	Not Threatened (Robertson *et al.* 2021). Widespread in the North Island and locally common. May be found in large areas of forest habitat.	High	No
Pūkeko	Not Threatened (Robertson *et al.* 2021). Nationally and locally common indigenous species.	Low	Yes
Pūtangitangi/paradise shelduck	Not Threatened (Robertson *et al.* 2021). Nationally and locally common indigenous species.	Low	Yes
Pūteketeke/Southern crested grebe	Threatened - Nationally Vulnerable (Robertson *et al.* 2021). Found in the South Island. This is potentially a miss identification and not likely to be seen within the Project footprint.	Very High	No
Pūweto/spotless crake	At Risk - Declining (Robertson *et al.* 2021). Found in raupō- and sedge-dominated swamps in the North Island and are secretive and rarely seen. It is probable that individuals will occasionally use wetland habitat.	High	Yes
Riroriro/grey warbler	Not Threatened (Robertson *et al.* 2021). Nationally and locally common indigenous species.	Low	Yes
Spur-winged plover	Not Threatened (Robertson *et al.* 2021). Nationally and locally common indigenous species.	Low	Yes
Tara piroe/black-fronted tern	Threatened - Nationally Endangered (Robertson *et al.* 2021). Very low numbers may be found in the lower North Island and individual birds may be detected flying inland.	Very High	No

Species	Determining Factors	Assigned Value	Observed During Survey?
Tara/white-fronted tern	At Risk - Declining (Robertson *et al.* 2021). Mainly found on the east coast and off-shore islands. They are rarely recorded inland and are highly unlikely to use any habitat within the Project footprint.	High	No
Taranui/Caspian tern	Threatened - Nationally Vulnerable (Robertson *et al.* 2021). Found on both main islands of New Zealand and small numbers may be seen inland on rivers. Individuals may be detected on the braided rivers.	Very High	No
Tarāpuka/black-billed gull	At Risk-Declining (Robertson *et al.* 2021). Found in low numbers in the North Island and may visit the braided rivers, and flooded pasture.	Very High	No
Tarāpunga/red-billed gull	At Risk - Declining (Robertson *et al.* 2021). Found around New Zealand in winter. Individuals may forage on wet pasture.	High	No
Tauhou/silvereye	Not Threatened (Robertson *et al.* 2021). Nationally and locally common indigenous species.	Low	Yes
Tete/grey teal	Not Threatened (Robertson *et al.* 2021). Common in shallow coastal lakes and lagoons. Individuals may visit open waterbodies.	Low	No
Titipounamu/North Island rifleman	At Risk - Declining (Robertson *et al.* 2021). It is unlikely that tītpounamu will be present as there are large open spaces and very limited connectivity for bird movement.	High	No
Tōrea/South Island pied oystercatcher	At Risk - Declining (Robertson *et al.* 2021). A common wader that will visit habitat within the Project footprint.	High	No
Tūī	Not Threatened (Robertson *et al.* 2021). Nationally and locally common indigenous species.	Low	Yes
Tūturiwhatu/banded dotterel	At Risk-Declining (Robertson *et al.* 2021). Found throughout New Zealand and may visit farmland, lake margins and braided rivers.	Very High	No
Tūturiwhatu/Northern New Zealand dotterel	Threatened - Nationally Vulnerable (Robertson *et al.* 2021). Low numbers within the North Island and found along coastal areas and river mouths. It is unlikely that tūturiwhatu will use habitat within the Project footprint.	Very High	No
Wāna/black swan	Not Threatened (Robertson *et al.* 2021). Abundant throughout New Zealand and likely to visit various waterbodies, and crop and pasture land.	Low	No
Warou/welcome swallow	Not Threatened (Robertson *et al.* 2021). Nationally and locally common indigenous species.	Low	Yes

Species	Determining Factors	Assigned Value	Observed During Survey?
Weweia/New Zealand dabchick	At Risk - Recovering (Robertson *et al.* 2021). Found in sheltered parts of lakes, farm ponds and, in winter, sewage ponds. It is likely that weweia will use habitat within the Project footprint.	Moderate	Yes

ASSESSMENT OF EFFECTS

66. Potential adverse ecological effects on avifauna associated with construction of the Project include:

(a) Mortalities of nesting birds (including eggs and chicks);

- Vegetation removal during the breeding season could result in adverse effects on birds. Breeding birds could lose nests, eggs or chicks that are present in trees that are felled, or during Project works on riverbeds and within riparian areas. While many birds will produce extra clutches to compensate for failed breeding attempts, such effects should be avoided where possible. If an activity is likely to disturb or kill protected wildlife or their eggs, then a Wildlife Act Authority (permit) is needed from the Department of Conservation. Vegetation removal or earthworks within riverbeds or wetlands should as far as practicable be undertaken outside of the breeding season (forest birds: August-February; wetland birds: August-March; river birds: August-April). However, ruru (April), kererū (May), kākā (June), and weweia (June-July) have longer breeding seasons and the surrounding habitat will need to be surveyed before removal.

(b) Disturbance;

- Birds can be susceptible to noise and human activity, and heavy machinery will disturb and displace foraging birds. This increase in activity could also cause abandonment of nests and chicks during the breeding season (August to March for most species) and destroy sites where birds are breeding. The construction phase of the Project could potentially disturb foraging and roosting birds through the movement of trucks and machinery.

- Minimising the release of sediments into freshwater habitats is essential as this will potentially affect the food resources for aquatic foraging birds (Glenjarmon 2017; Matthaei *et al.* 2006). Suspended sediment increases turbidity and reduces visibility for foraging birds, which will impact aquatic species in the area and downstream from the construction site.

- Noise levels should be kept as low as possible (Parris & Schneider 2009). Wetlands that are located within close proximity of a road can be subject to edge effects, weed invasion, pollution, and the wildlife that inhabit them can be affected by noise and light pollution and increased risk of road mortality. Some wetland birds are very sensitive to loud or persistent noises, and could abandon wetlands after a noisy road is constructed nearby (Reijnen *et al.* 1995; Forman *et al.* 2003).

(c) Permanent habitat loss;

- Removal of vegetation or habitat modification at the site will result in the localised loss of feeding and breeding habitat for indigenous bird species. The removal of waterbodies may impact Threatened or At Risk species, including matuku/Australasian bittern, kawau/black shag, weweia/New Zealand dabchick, kāruhiruhi/pied shag, and tōrea/South Island pied oystercatcher.

(d) Modification of remaining habitat such as:

- Reduction of habitat connectivity through fragmentation and introduction of new barriers that may cause habitat isolation for species with limited mobility.
- Creation of edge effects such as altering the composition and habitat value of adjacent vegetation, which modifies the microclimates within created edge habitats and potentially impacts food resources for birds.
- During construction, potential sedimentation effects on foraging areas along the two rivers could reduce prey abundance and/or foraging efficiency.

67. Potential adverse ecological effects on avifauna associated with operation of the Project include:

(e) Traffic-related mortalities during road operation.

- During daylight hours, most bird species will overfly the roadway without issue due to the unobstructed visibility. However, issues or strikes could potentially occur during low light or poor weather conditions, especially during foggy conditions or at night (Shamoun-Baranes et al. 2006, Manville 2005). Species which forage through hunting are at a greater risk as their vision focuses on finding prey rather than avoiding mobile hazards (kāhu and kārearea). In addition, many bird species fly at night, e.g., spur-winged plover, matuku, karoro, tūturiwhatu and pūkeko (Bell and Harborne 2018, Heather and Robertson 2015, Rohweder and Lewis 2004). Stormwater ponds with riparian plantings that are installed on the margins of roads may attract species such as pūweto, matuku and pūkeko, especially when holding water. This increases the hazard of traffic-related mortality for such species (O'Donnell and Robertson 2016).

I note that traffic levels are expected to reduce on the existing State highway 1 and State highway 57 as a result of the Project. The reduced threat to avifauna on those roads will to some extent counter-balance the risks associated with the new highway.

(f) Road lighting on avian species

- Artificial lighting can attract and disorientate birds. Nocturnal species' orientation and movements through the landscape may be compromised, leading to injury and mortality from collisions and increased exposure to predation. Lighting may also alter the behaviour of bird species. For example, artificial lighting may affect the reproductive cycles of birds, the natural rhythms of which are mediated by light levels and day length. Further, the feeding behaviour of night-active species and the movement of photophobic species may be affected by increased light levels (reviewed in detail by Longcore and Rich 2004).

68. These potential effects are assessed in Table 8. Following the EcIAG approach, Table 8 addresses the indigenous bird species confirmed or conservatively assumed to be present, the value of each species, and impacts and recommended minimisation measures. It then provides my assessment of the magnitude of effects of the Project on each species, and accordingly the overall level of effect.

MEASURES TO REMEDY OR MITIGATE ACTUAL OR POTENTIAL ADVERSE ECOLOGICAL EFFECTS

69. An Ecological Management Plan will be prepared prior to the lodgement of the resource consent, and appended to this document. The Ecological Management Plan will include a subplan for avifauna. The subplan will address the impact and minimisation measures on avifauna and outline the key mitigation measures to reduce the level of adverse ecological effects (outlined below).

70. For birds, the key measures to be included in the Ecological Management Plan, and considered in the Magnitude of Effects in Table 8 are as follows:

    (a) Where needed, the establishment of alternative habitats close to the footprint prior to construction, to provide continuity of habitats for ‘Threatened’ or ‘At Risk’ fauna. These include:

        (i) Indigenous plantings should be established to complement existing remnants, and to link sites adjacent to the road alignment on the sides away from the road.

        (ii) Weed removal and the creation of sandy/fine shingle areas away from the construction site for river birds.

        (iii) Replacement of wetland areas or extension of existing areas with indigenous plantings should be established at a distance from the road alignment, preferably on one side of the road to reduce birds over flying.

    (b) Maximising habitat connectivity for fauna species by ensuring connectivity of riparian vegetation and habitats on the banks of streams and rivers crossed by bridges.

    (c) Minimising lighting of the road to reduce attracting and disorientating birds, especially nocturnal species.

    (d) Minimising noise of the road during construction and through low noise roading surfaces, indigenous plantings, and road barriers or bunds.

    (e) Bird surveys to be carried out before any construction work is undertaken during the breeding season.

(f) Plantings of indigenous trees and shrubs that are set back from the road will encourage birds to gain altitude before crossing the road, and minimise direct mortality and injury from road collisions.

Table 8: Species, ecological values, adverse effects, minimisation measures, magnitude of effect, and level of effect for the Ō2NL Project footprint.

<table>
<tr><th>Notable Terrestrial Avian Species</th><th>Avian Ecological Value</th><th>Potential impacts (including cumulative effects, excluding habitat loss)</th><th>Magnitude of Effect in absence of effects management</th><th>Level of Effect in absence of effects management</th><th>Minimisation Measures</th><th>Magnitude of Effect (after Avoidance and Minimisation)</th><th>Level of Effect (after Avoidance and Minimisation)</th></tr>
<tr><td rowspan="5">Kākā
(At Risk - Recovering)</td><td rowspan="5">Moderate</td><td>Direct mortality during vegetation clearance.</td><td>Low</td><td>Low</td><td>Unlikely to be breeding in the Project footprint.</td><td>Negligible-Low</td><td>Very Low</td></tr>
<tr><td>Direct mortality or injury on roads.</td><td>Low-Moderate</td><td>Low-Moderate</td><td>Planting of indigenous trees and shrubs to form a buffer and flight corridor between sites for birds.
Tree height should encourage birds to move between forests above the proposed roadway.
Trees should be set back from the road to allow birds further distance to gain altitude before crossing the roadway
Any planting adjacent to the road alignment should be designed to discourage birds from using the area to minimise potential vehicle strike.</td><td>Negligible-Low</td><td>Very Low</td></tr>
<tr><td>Reduction of habitat connectivity through fragmentation and loss of ‘stepping stones’ that may cause habitat isolation.</td><td>Low</td><td>Low</td><td>Indigenous trees and shrubs should be planted to form a flight corridor between properties, especially areas with indigenous forest fragments.
Riparian offset planting will help to create linkages between isolated remnants.</td><td>Negligible</td><td>Very Low</td></tr>
<tr><td>Fragmentation due to potential road barrier.</td><td>Low</td><td>Low</td><td>Planting should be set back from the road.</td><td>Negligible</td><td>Very Low</td></tr>
<tr><td>Ongoing disturbance from noise.</td><td>Low</td><td>Low</td><td>Planting of indigenous trees and shrubs to form a buffer to noise. The use of a low noise roading surface and road barriers or bunds will also reduce noise disturbance’
The use of a low noise roading surface and road barriers or bunds will also reduce noise disturbance.
Roading noise experts should be consulted prior to the implementation of these measures.</td><td>Negligible-Low</td><td>Very Low</td></tr>
<tr><td rowspan="4">Kārearea/bush falcon
(At Risk - Recovering)</td><td rowspan="4">Moderate</td><td rowspan="2">Direct mortality during vegetation clearance.</td><td rowspan="2">Moderate</td><td rowspan="2">Moderate</td><td>Seasonal restriction and/or bird nesting surveys should be undertaken during the breeding season before the removal of vegetation within each section of the roadway.</td><td rowspan="2">Low</td><td rowspan="2">Low</td></tr>
<tr><td>If chicks or eggs are in nest within the affected construction area, work should not be undertaken until the chicks have fledged or until the eggs have hatched and the chicks have fledged.</td></tr>
<tr><td rowspan="2">Direct mortality or injury on roads.</td><td rowspan="2">Moderate</td><td rowspan="2">Moderate</td><td>Planting of indigenous trees and shrubs to form a buffer and flight corridor between sites for birds.
Tree height should encourage birds to move between forests above the proposed road.</td><td rowspan="2">Low</td><td rowspan="2">Low</td></tr>
<tr><td>Trees should be set back from the roadway to allow birds further distance to gain altitude before crossing the road.</td></tr>
</table>

Notable Terrestrial Avian Species	Avian Ecological Value	Potential impacts (including cumulative effects, excluding habitat loss)	Magnitude of Effect in absence of effects management	Level of Effect in absence of effects management	Minimisation Measures	Magnitude of Effect (after Avoidance and Minimisation)	Level of Effect (after Avoidance and Minimisation)
					Any planting adjacent to the road alignment should be designed to discourage birds from using the area to minimise potential vehicle strike.		
		Reduction of habitat connectivity through fragmentation and loss of 'stepping stones' that may cause habitat isolation.	Low	Low	Indigenous trees and shrubs should be planted to form a flight corridor between properties, especially areas with indigenous forest fragments. Planting should be set back from the road.	Negligible	Very Low
		Creation of edge effects such as modifying the microclimates within created edge habitats.	Low	Low	Establish indigenous vegetation to buffer and increase the size of forest areas to aid connectivity.	Negligible	Very Low
		Ongoing disturbance from noise.	Low	Low	Planting of indigenous trees and shrubs to form a buffer to noise. The use of a low noise roading surface and road barriers or bunds will also reduce noise disturbance. Roading noise experts should be consulted prior to the implementation of these measures.	Negligible	Very Low
Kawau/black shag (At Risk - Relict)	Moderate	Direct mortality during vegetation clearance.	Moderate	Moderate	Seasonal restriction and/or preconstruction surveys should be undertaken to identify nesting sites within trees that are overhanging water that may be affected during construction. If chicks or eggs are in nest within the affected construction area, work should not be undertaken until the chicks have fledged or until the eggs have hatched and the chicks have fledged.	Negligible-Low	Low
		Reduction of habitat connectivity through fragmentation and the removal of open water that may cause habitat isolation.	Moderate	Moderate	Replacement open water and stormwater pond areas should be established only on one side of the road at any one location to reduce birds overflying the proposed road.	Low	Low
		Direct mortality or injury on roads.	Low-Moderate	Low-Moderate	Planting of indigenous shrubs and riparian areas to form a buffer between sites and the road. Plant height should encourage birds to move between areas above the proposed roadway. Planted areas should be set back from the roading to allow birds further distance to gain altitude before crossing the road.	Negligible-Low	Very Low
		Ongoing disturbance from noise.	Low-Moderate	Low-Moderate	Planting of indigenous trees and shrubs to form a buffer to noise. The use of a low noise roading surface and road barriers or bunds will also reduce noise disturbance. Roading noise experts should be consulted prior to the implementation of these measures.	Negligible-Low	Very Low

Notable Terrestrial Avian Species	Avian Ecological Value	Potential impacts (including cumulative effects, excluding habitat loss)	Magnitude of Effect in absence of effects management	Level of Effect in absence of effects management	Minimisation Measures	Magnitude of Effect (after Avoidance and Minimisation)	Level of Effect (after Avoidance and Minimisation)
Koitareke/marsh crake (At Risk-Declining	High	Direct mortality during vegetation clearance.	Very High	Very High	Seasonal restriction and/or preconstruction surveys should be undertaken during the breeding season (August to March) to identify nesting sites that may be affected during construction. If chicks or eggs are in nest within the affected construction area, work should not be undertaken until the chicks have fledged or until the eggs have hatched and the chicks have fledged.	Low	Low
		Reduction of habitat connectivity through fragmentation that may cause habitat isolation.	High	High	Restoration of raupō reedland near to the existing area in the footprint should be undertaken before habitat removal.	Low	Low
		Direct mortality or injury on roads.	Very High	Very High	Planting of indigenous shrubs and riparian areas to form a buffer between sites and the road. Plant height should encourage birds to move between areas above the proposed roadway. Planted areas should be set back from the road to allow birds further distance to gain altitude before crossing the roadway.	Low	Low
		Mortality due to road lighting	High	High	Nocturnal flying birds may be disorientated by artificial lighting and are at risk of bird strike with cars; however, indigenous planting will increase flight height.	Low	Low
		Ongoing disturbance from noise.	High	High	Planting of indigenous trees and shrubs to form a buffer to noise. The use of a low noise roading surface and road barriers or bunds will also reduce noise disturbance. Roading noise experts should be consulted prior to the implementation of these measures.	Negligible-Low	Low-Very Low
Pūweto/spotless crake (At Risk - Declining)	High	Direct mortality during vegetation clearance.	Very High	Very High	Seasonal restriction and/or preconstruction surveys should be undertaken during the breeding season (August to March) to identify nesting sites that may be affected during construction. If chicks or eggs are in nest within the affected construction area, work should not be undertaken until the chicks have fledged or until the eggs have hatched and the chicks have fledged.	Low	Low
		Reduction of habitat connectivity through fragmentation that may cause habitat isolation.	High	High	Restoration of raupō reedland near to the existing area in the footprint should be undertaken before habitat removal.	Low	Low

Notable Terrestrial Avian Species	Avian Ecological Value	Potential impacts (including cumulative effects, excluding habitat loss)	Magnitude of Effect in absence of effects management	Level of Effect in absence of effects management	Minimisation Measures	Magnitude of Effect (after Avoidance and Minimisation)	Level of Effect (after Avoidance and Minimisation)
		Direct mortality or injury on roads.	Very High	Very High	Planting of indigenous shrubs and riparian areas to form a buffer between sites and the road. Plant height should encourage birds to move between areas above the proposed roadway. Planted areas should be set back from the road to allow birds further distance to gain altitude before crossing the roadway.	Low	Low
		Mortality due to road lighting	High	High	Nocturnal flying birds may be disorientated by artificial lighting and are at risk of bird strike with cars; however, indigenous planting will increase flight height.	Low	Low
		Ongoing disturbance from noise.	High	High	Planting of indigenous trees and shrubs to form a buffer to noise. The use of a low noise roading surface and road barriers or bunds will also reduce noise disturbance. Roading noise experts should be consulted prior to the implementation of these measures.	Negligible-Low	Low-Very Low
Other forest birds, e.g. kākāriki/yellow-crowned parakeet (At Risk-Declining), andkorimako/bellbird; tūī; kererū (all Not Threatened)	Low	Direct mortality during vegetation clearance.	Moderate	Low	Seasonal restriction and/or bird nesting surveys should be undertaken during the breeding season before the removal of vegetation within each section of the roadway. If nests contain chicks or eggs within the Project alignment, work should not be undertaken until the chicks have fledged or until the eggs have hatched and the chicks have fledged.	Negligible	Very Low
		Reduction of habitat connectivity through fragmentation and loss of ‘stepping stones’ that may cause habitat isolation.	Moderate	Low	Indigenous trees and shrubs should be planted to form a flight corridor between properties, especially areas with indigenous forest fragments. Planting should be set back from the roadway.	Negligible-Low	Very Low
		Ongoing disturbance from noise	Moderate	Low	Planting of indigenous trees and shrubs to form a buffer to noise. The use of a low noise roading surface and road barriers or bunds will also reduce noise disturbance. Roading noise experts should be consulted prior to the implementation of these measures.	Negligible-Low	Very Low
		Direct mortality or injury on roads.	Moderate	Low	Planting of indigenous trees and shrubs to form a buffer and flight corridor between sites for birds. Tree height should encourage birds to move between forests above the proposed roadway. Trees should be set back from the road to allow birds further distance to gain altitude before crossing the road.	Negligible-Low	Very Low

Notable Terrestrial Avian Species	Avian Ecological Value	Potential impacts (including cumulative effects, excluding habitat loss)	Magnitude of Effect in absence of effects management	Level of Effect in absence of effects management	Minimisation Measures	Magnitude of Effect (after Avoidance and Minimisation)	Level of Effect (after Avoidance and Minimisation)
					Any planting adjacent to the road alignment should be designed to discourage birds from using the area to minimise potential vehicle strike.		
Other wetland bird species: e.g. matuku/Australasian bittern (Threatened - Nationally Critical)	Very High	Direct mortality during vegetation clearance.	High	Very High	Preconstruction surveys should be undertaken at properties #19, 20 and 21 (Paruauku Swamp) and #493 to identify whether birds are present. If birds are detected within the affected construction area, work should not be undertaken until the birds have left the area.	Low	Moderate
		Reduction of habitat connectivity through fragmentation that may cause habitat isolation.	High	High	Replacement open water and stormwater pond areas should be established only on one side of the road at any one location (i.e. not paired on either side of the road) to reduce the frequency of birds overflying the proposed road.	Low	Moderate
		Direct mortality or injury on roads.	High	Very High	Planting of indigenous shrubs and riparian areas to form a buffer between sites and the road. Plant height should encourage birds to move between areas above the proposed roading. Planted areas should be set back from the roading to allow birds further distance to gain altitude before crossing the roadway.	Low	Moderate
		Mortality due to road lighting	High	High	Nocturnal flying birds may be disorientated by artificial lighting and are at risk of bird strike with cars; however, indigenous planting will increase flight height.	Low	Moderate
		Ongoing disturbance from noise.	High	High	Planting of indigenous trees and shrubs to form a buffer to noise. The use of a low noise roading surface and road barriers or bunds will also reduce noise disturbance. Roading noise experts should be consulted prior to the implementation of these measures.	Low	Moderate
Indigenous birds of pasture habitat: e.g pihoihoi/New Zealand pipit (At Risk - Declining)	High	Direct mortality during earthworks and vegetation clearance.	High	High	Implement a grazing and/or mowing regime across the pasture areas in the Project footprint to reduce the suitability of the area as nesting habitat prior to construction commencing.	Low	Low

Notable Terrestrial Avian Species	Avian Ecological Value	Potential impacts (including cumulative effects, excluding habitat loss)	Magnitude of Effect in absence of effects management	Level of Effect in absence of effects management	Minimisation Measures	Magnitude of Effect (after Avoidance and Minimisation)	Level of Effect (after Avoidance and Minimisation)
Indigenous birds of river habitat: e.g. tūturiwhatu/banded dotterel, (Threatened - Nationally Vulnerable); Black-fronted dotterel (At Risk-Naturally Uncommon), pihoihoi/New Zealand pipit (At Risk - Declining); torea/South Island pied oystercatcher (At Risk - Declining)	High-Very High	Direct mortality during riverbed modification, earthworks and vegetation clearance.	High-Very High	High-Very High	Before riverbed modification and earthworks, clear vegetation within the riverbed at a distance from the construction site to provide alternative roosting and breeding areas.	Low-Negligible	Moderate-Low
					Seasonal restriction and/or preconstruction surveys should be undertaken during the breeding season (August to March) to identify nesting sites that may be affected during construction. If chicks or eggs are in nest within the affected construction area, work should not be undertaken until the chicks have fledged or until the eggs have hatched and the chicks have fledged.		
		Direct mortality or injury on roads.	Moderate	High	Planting of shrubland and groundcover on the banks adjacent to the bridge will provide a connection between the existing areas and will allow a corridor for birds to fly below the bridge. Plant height should encourage birds to move between areas above the proposed road. Planted areas should be set back from the roadway to allow birds further distance to gain altitude before crossing the road.	Low-Negligible	Moderate-Low
		Ongoing disturbance from noise	Moderate	High	Planting of indigenous trees and shrubs to form a buffer to noise.	Low-Negligible	Moderate-Low
					The use of a low noise roading surface and road barriers or bunds will also reduce noise disturbance.		
					Roading noise experts should be consulted prior to the implementation of these measures.		
Indigenous birds of open water: e.g. weweia/New Zealand dabchick (At Risk - Recovering); Tete/grey teal (Not Threatened); Australasian coot (At Risk - Naturally Uncommon)	Moderate	Direct mortality during waterbody modification and clearance.	Very High	High	Seasonal restriction and/or bird nesting surveys should be undertaken during the breeding season before the removal of floating vegetation within weweia breeding habitat. If nests contain chicks or eggs within the affected construction area, work should not be undertaken until the chicks have fledged or until the eggs have hatched and the chicks have fledged.	Low	Low
		Ongoing disturbance from noise.	Moderate-High	Moderate	Planting of indigenous trees and shrubs to form a buffer to noise. The use of a low noise roading surface and road barriers or bunds will also reduce noise disturbance. Roading noise experts should be consulted prior to the implementation of these measures.	Low-Negligible	Low-Very Low

CONCLUSION AND RECOMMENDATIONS

71. An assessment of habitat values for birds within the Ō2NL Project footprint was undertaken by:

    (a) Reviewing bird distribution in the area surrounding the Ō2NL Project footprint through five-minute bird counts, transects surveys, and incidental bird surveys.

    (b) Undertaking playback calls to assess the presence of wetland birds.

    (c) Identifying potential bird habitat within the Ō2NL Project footprint as a desktop exercise using aerial photographs in Google Earth.

72. The review of eBird and iNaturalist identified bird species which may be present within the Project footprint but that were not identified during field surveys.

73. Six 'At Risk' species (tūturiwhatu/black-fronted dotterel, koitareke/marsh crake, pihoihoi/New Zealand pipit, pūweto/spotless crake, weweia/New Zealand dabchick and kawau/black shag) were confirmed within the Project footprint. Two 'Threatened' species were also identified during field surveys (koekoeā/long-tailed cuckoo, karakahia/grey duck,). However, desktop assessments show that several 'Threatened' or 'At Risk' species may be present within the Project footprint. It is likely that other species may be present but due to low numbers, mobility of species and time of year, these birds were not present during field surveys.

74. Notable species that may be present include matuku/Australasian bitttern, kākā, tūturiwhatu/banded dotterel, karearea/bush falcon, pōpokatea/whitehead, kākāriki/yellow-crowned parakeet, and torea/South Island pied oystercatcher. A single kākāriki/yellow-crowned parakeet was detected overflying property #212; a species that typically occurs in podocarp and beech forests.

75. To minimise adverse effects associated with the Project, vegetation clearance and earthworks should be undertaken outside of the breeding period and/or preconstruction surveys should be undertaken to avoid impacting breeding success.

76. Habitat planting and landscaping with indigenous plant species will provide a buffer against noise, aid bird movement between isolated fragments and increase flight height of birds before they fly over the road. This will help to reduce injury or mortality.

77. Restoration of wetlands and the establishment of open water and stormwater ponds should be undertaken in areas away from the Project footprint. Wetland restoration should be completed before construction works to provide habitats for displaced birds to relocate to.

78. Road lighting should be as minimal as possible to reduce attracting or disorientating birds, especially nocturnal species.

79. A best practice mitigation programme delivered through a Bird Management Plan for the Ō2NL Project is likely to result in a net gain for birds, as there are opportunities to create a significant amount of new bird habitat through ecological restoration.

Dr Della Bennet

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BIRD SPECIES IDENTIFIED THROUGH A DESKTOP REVIEW OF EBIRD, NEW ZEALAND BIRD ATLAS AND INATURALIST WEBSITES

Table 9: Bird species identified through a desktop review of eBird, New Zealand Bird Atlas and iNaturalist websites.

Common Name	Scientific Name	Threat Classification 2016	Status
Australasian bittern	*Botaurus poiciloptilus*	Threatened - Nationally Critical	Indigenous
Australasian shoveler	*Anas rhynchotis*	Not Threatened	Indigenous
Australian coot	*Fulica atra australis*	At Risk - Naturally Uncommon	Indigenous
Australian magpie	*Gymnorhina tibicen*	Introduced and Naturalised	Exotic
Banded dotterel	*Charadrius bicinctus bicinctus*	At Risk-Declining	Indigenous
Barbary dove	*Streptopelia risoria*	Introduced and Naturalised	Exotic
Bellbird	*Anthornis melanura melanura*	Not Threatened	Indigenous
Black shag	*Phalacrocorax carbo novaehollandiae*	At Risk - Relict	Indigenous
Black swan	*Cygnus atratus*	Not Threatened	Indigenous
Black-billed gull	*Larus bulleri*	At Risk-Declining	Indigenous
Blackbird	*Turdus merula*	Introduced and Naturalised	Exotic
Black-fronted tern	*Chlidonias albostriatus*	Threatened - Nationally Endangered	Indigenous
Brown teal	*Anas chlorotis*	At Risk - Recovering	Indigenous
Bush falcon	*Falco novaeseelandiae ferox*	At Risk - Recovering	Indigenous
California quail	*Callipepla californica*	Introduced and Naturalised	Exotic
Canada goose	*Branta canadensis*	Introduced and Naturalised	Exotic
Cape Barren goose	*Cereopsis novaehollandiae*	Introduced and Naturalised	Exotic
Caspian tern	*Hydroprogne caspia*	Threatened - Nationally Vulnerable	Indigenous
Chaffinch	*Fringilla coelebs*	Introduced and Naturalised	Exotic
Common pheasant	*Phasianus colchicus*	Introduced and Naturalised	Exotic
Dunnock	*Prunella modularis*	Introduced and Naturalised	Exotic
Eastern rosella	*Platycercus eximius*	Introduced and Naturalised	Exotic
Feral (greylag) goose	*Anser anser*	Introduced and Naturalised	Exotic
Goldfinch	*Carduelis carduelis*	Introduced and Naturalised	Exotic
Grey teal	*Anas gracilis*	Not Threatened	Indigenous
Greenfinch	*Carduelis chloris*	Introduced and Naturalised	Exotic
Grey warbler	*Gerygone igata*	Not Threatened	Indigenous
Hoary-headed grebe	*Poliocephalus poliocephalus*	Non-resident Native – Coloniser	Indigenous
House sparrow	*Passer domesticus*	Introduced and Naturalised	Exotic
Indian peafowl	*Pavo cristatus*	Introduced and Naturalised	Exotic
Little pied cormorant	*Phalacrocorax melanoleucos melanoleucos*	Non-resident Native – Vagrant	Indigenous

Common Name	Scientific Name	Threat Classification 2016	Status
Mallard	*Anas platyrhynchos*	Introduced and Naturalised	Exotic
Morepork	*Ninox novaeseelandiae novaeseelandiae*	Not Threatened	Indigenous
Mute swan	*Cygnus olor*	Introduced and Naturalised	Exotic
Myna	*Acridotheres tristis*	Introduced and Naturalised	Exotic
New Zealand kingfisher	*Todiramphus sanctus vagans*	Not Threatened	Indigenous
New Zealand pigeon, kererū	*Hemiphaga novaeseelandiae*	Not Threatened	Indigenous
New Zealand pipit	*Anthus novaeseelandiae novaeseelandiae*	At Risk - Declining	Indigenous
New Zealand scaup	*Aythya novaeseelandiae*	Not Threatened	Indigenous
North Island fantail	*Rhipidura fuliginosa placabilis*	Not Threatened	Indigenous
North Island rifleman	*Acanthisitta chloris granti*	At Risk - Declining	Indigenous
Northern New Zealand dotterel	*Charadrius obscurus aquilonius*	At Risk - Recovering	Indigenous
Northern shoveler	*Anas clypeata*	Non-resident Native – Vagrant	Indigenous
Paradise shelduck	*Tadorna variegata*	Not Threatened	Indigenous
Pied shag	*Phalacrocorax varius varius*	At Risk - Recovering	Indigenous
Pied stilt	*Himantopus himantopus leucocephalus*	Not Threatened	Indigenous
Pied tomtit	*Petroica macrocephala toitoi*	Not Threatened	Indigenous
Pūkeko	*Porphyrio melanotus melanotus*	Not Threatened	Indigenous
Red-billed gull	*Larus novaehollandiae scopulinus*	At Risk - Declining	Indigenous
Redpoll	*Carduelis flammea*	Introduced and Naturalised	Exotic
Rock pigeon	*Columba livia*	Introduced and Naturalised	Exotic
Rook	*Corvus frugilegus*	Introduced and Naturalised	Exotic
Royal spoonbill	*Platalea regia*	At Risk - Naturally Uncommon	Indigenous
Shining cuckoo	*Chrysococcyx lucidus lucidus*	Not Threatened	Indigenous
Silvereye	*Zosterops lateralis lateralis*	Not Threatened	Indigenous
Skylark	*Alauda arvensis*	Introduced and Naturalised	Exotic
Song thrush	*Turdus philomelos*	Introduced and Naturalised	Exotic
South Island pied oystercatcher	*Haematopus finschi*	At Risk - Declining	Indigenous
Southern black-backed gull	*Larus dominicanus dominicanus*	Not Threatened	Indigenous
Southern crested grebe	*Podiceps cristatus australis*	Threatened - Nationally Vulnerable	Indigenous
Spotless crake	*Porzana tabuensis tabuensis*	At Risk - Declining	Indigenous
Spur-winged plover	*Vanellus miles novaehollandiae*	Not Threatened	Indigenous
Starling	*Sturnus vulgaris*	Introduced and Naturalised	Exotic
Sulphur-crested cockatoo	*Cacatua galerita*	Introduced and Naturalised	Exotic

Common Name	Scientific Name	Threat Classification 2016	Status
Swamp harrier	*Circus approximans*	Not Threatened	Indigenous
Tūī	*Prosthemadera novaeseelandiae novaeseelandiae*	Not Threatened	Indigenous
Welcome swallow	*Hirundo neoxena neoxena*	Not Threatened	Indigenous
White-faced heron	*Egretta novaehollandiae*	Not Threatened	Indigenous
White-fronted tern	*Sterna striata striata*	At Risk - Declining	Indigenous
Whitehead	*Mohoua albicilla*	At Risk - Declining	Indigenous
Wrybill	*Anarhynchus frontalis*	Threatened - Nationally Increasing	Indigenous
Yellowhammer	*Emberiza citrinella*	Introduced and Naturalised	Exotic

SITE PHOTOGRAPHS

Plate 1: A patch of exotic forest at property #212. 22 March 2021.

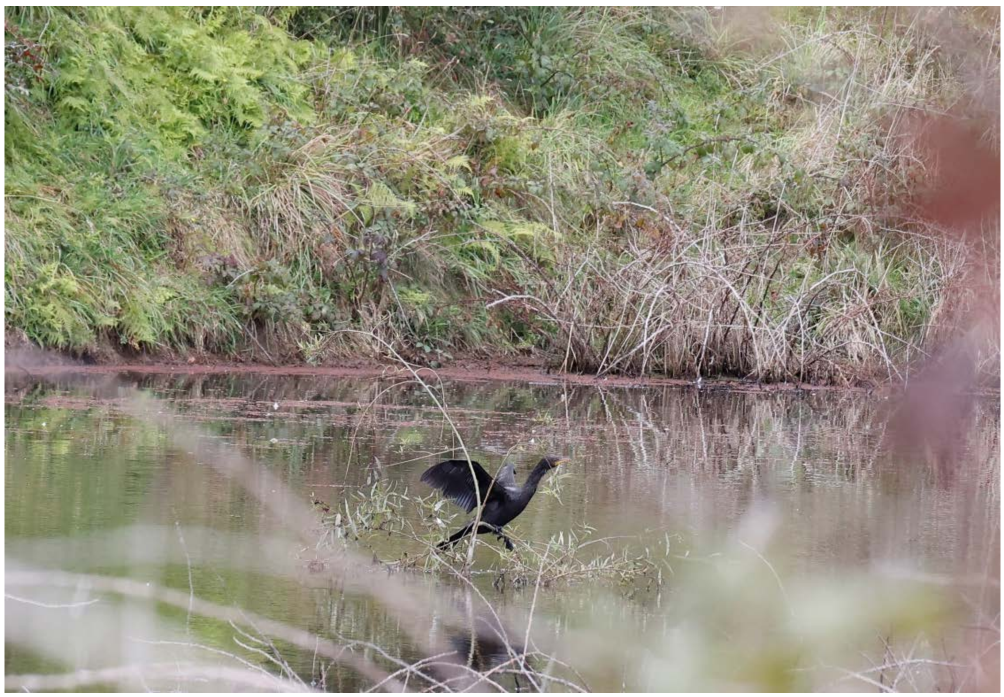

Plate 2: Black shag drying wings after foraging (property #461). 25 March 2021.

APPENDIX J.6

TECHNICAL ASSESSMENT FOR EFFECTS ON LIZARDS FOR THE Ō2NL PROJECT AREA

IN THE MATTER OF	the Resource Management Act 1991
AND	
IN THE MATTER OF	applications for resource consents and notices of requirement in relation to the Ōtaki to North of Levin Project
BY	**WAKA KOTAHI NZ TRANSPORT AGENCY** Applicant

ŌTAKI TO NORTH OF LEVIN:

TECHNICAL ASSESSMENT OF EFFECTS

ON LIZARDS

TABLE OF CONTENTS

EXECUTIVE SUMMARY

1. This report provides an assessment of potential effects of the Ōtaki to North of Levin Project (the Ō2NL Project) on lizards to inform resource consent applications for the Project 'Main Works'.

2. The Ō2NL Project's designation corridor lizard fauna is characterised by low diversity and abundance of lizards. This is due to the highly degraded environment that likely contain high numbers of predatory mammals and birds.

3. A desktop assessment was carried out before targeted lizard surveys and showed that several species and their habitats may be present within the Project footprint, including species classified as At Risk under the Department of Conservation's New Zealand Threat Classification System.

4. Following the desktop assessment, a lizard survey was carried out in selected properties and habitat types within the Project's designation corridor. The ornate skink (*Oligosoma ornatum*, At Risk – Declining) and northern grass skink (*Oligosoma polychroma*, Not Threatened) were detected during the survey.

5. Notable species that may be present but were not recorded during the survey include copper skink (*O. aeneum*, At Risk – Declining), and glossy brown skink (*O. zelandicum*, At Risk – Declining). Associated lizard habitats that will be impacted include the edges and interiors of remnant indigenous tawa (*Beilschmiedia tawa*) and tītoki (*Alectryon excelsus* subsp. *excelsus*) forest as well as exotic grasslands and gardens.

6. Ecological values have been assigned to all of the notable taxa identified in the desktop assessment and survey using the Ecological Impact Assessment Guidelines (EcIAG) prepared by the Environment Institute of Australia and New Zealand (EIANZ). The habitats on the site have also been assigned a value using the EcIAG methodology based on their value to lizard species. All lizard species potentially present within the Project's designation corridor have also been conservatively assessed as being present.

7. A conservative effects assessment has been undertaken based on the lizard species found and those presumed present. The overall level of effect of the Project on present or potentially present At Risk lizards, and on habitat values is assessed as being Low to High (varying by species/habitat).

8. Most of the areas of remnant indigenous forest within the proposed designation boundaries which provide high value habitat for lizard species, including for arboreal geckos, are being avoided in the current alignment.

9. Based on the presence and/or presumed presence of At Risk terrestrial lizard species, a number of minimisation and effects avoidance measures are proposed. Recommended activities include search and relocation of affected individuals, release site identification and preparation (habitat enhancement and pest management), post-release site and population monitoring, and possible creation of new lizard habitat along the Ō2NL Project designation corridor. Adaptive management should be required. These activities are proposed to be delivered either as part of a Lizard Management Plan (LMP) that is a component of a wider Ecological Management Plan (EMP) or through other EMP requirements.

10. If a best practice mitigation programme is delivered through a Lizard Management Plan for the Project, this is likely to result in a net gain for lizards.,

11. Consequently, I consider that the avoidance and mitigation measures mentioned above will appropriately address the potential effects of the Project on terrestrial lizards.

INTRODUCTION

12. My full name is Trent Peter Bell. I have prepared this technical assessment which specifically addresses the lizard aspects of the Ō2NL Project.

Qualifications and experience

13. I have the following qualifications and experience relevant to this assessment:

14. In 2004, I graduated with a BSc in Biology from Victoria University of Wellington.

15. I am a Principal Ecologist (Herpetology) at Wildland Consultants Ltd, an ecological consultancy company specialising in ecological assessments, ecological restoration, ecological survey and monitoring, and ecological research. I have been employed as a consultant ecologist with Wildland Consultants since 2019. Previous to this, I was Director and Principal Herpetologist at EcoGecko Consultants Ltd (2009-2019), and Herpetologist at Manaaki Whenua Landcare Research (2004-2009). I have been a full-time professional herpetologist for 18 years.

16. As a professional herpetologist, my work has involved lizard surveys, assessments of ecological effects (AEEs)/impact assessments (IAs), management planning, lizard salvage and relocation operations, population monitoring studies, translocations, post-translocation monitoring, and discovery and description of new lizard species. The nature of land development projects that I have been involved with include single-lot and multiple lot housing and subdivisions, motorways, dams and wind farms. I have also been involved in Plan Change processes and presented a Statement of Evidence to the Environment Court for the Mt Cass Wind Farm.

17. I am a Certified Environmental Practitioner – Ecology Specialist (CEnvP-ES) (Registration Number 22014), specialising in herpetology. This is a certification provided by EIANZ. Certification as an 'Ecology Specialist' requires independent appraisal of professional and ethical performance at a high level in a specialist field for a period of at least 10 years. Recertification is based on meeting a minimum number of Professional Development credits recorded annually through an audited log. I have now held this Ecology Specialist certification since 2015 (seven years).

18. I have undertaken surveys and population monitoring studies for indigenous lizards throughout New Zealand, including offshore islands. My work with lizards has frequently involved Threatened and At Risk lizard species.

19. My survey and monitoring work with lizards has involved a very wide range of habitat types, including alpine zones, forests, shrublands, grasslands, dunelands, and islands.

20. I have published >20 scientific papers in peer reviewed journals and also >100 technical reports relating to New Zealand herpetology. With colleagues, I formally named (described) 15 new lizard species, re-described four species and I am currently assessing the taxonomic status of another 19 species. I have also presented my research at national and international scientific conferences; including three full talks at the World Congress of Herpetology held in Dunedin, January 2020.

21. I am highly experienced in the use of detection tools for lizards and have developed novel ways for recording the presence of highly cryptic herpetofauna. These tools include closed-cell foam covers for arboreal geckos, a novel multiple-entrance funnel trap, and a capture-pole for lizards in trees.

22. I have provided lizard expertise for a number of large roading projects for Waka Kotahi NZ Transport Agency (Waka Kotahi), and other roading stakeholders: Tauranga's Takitimu North Link (2021); State Highway 58 Safety Improvements Project (2019-2021); Hamilton's Southern Links (2019); Huntly Expressway (Taupiri) (2015); Christchurch Southern Motorway Stage Two and Main South Road Four Lane (2013); and Transmission Gully (2013). I have also consulted on a number of smaller roads in the Wellington Region, such as Ohariu Valley Road (2018) and Ngaio Gorge (2019). My work in these projects involved lizard surveys, lizard impact assessments, lizard mitigation planning, lizard management planning, and lizard salvage and release programmes.

23. I was also part of Wildland Consultants' expert team that undertook a major research review of transport-related ecological interventions and outcomes for Waka Kotahi (2021), which also developed a framework to guide best practice.

24. Using geographic information systems (GIS), I analysed various Ō2NL Project alignment options within the Project's designation corridor that were overlaid on aerial imagery and potential ecology intersection polygons.

25. I have also viewed digital and printed Ō2NL Preferred Alignment maps.

26. I undertook lizard surveys for the Ō2NL Project during March and April 2021, accompanied by Cameron Thorp and Jina Sagar (Ecologists, Wildland Consultants, Wellington).

27. I continue to be involved in lizard survey, impact assessment and mitigation planning for the Ō2NL Project.

Code of conduct

28. I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2014. This assessment has been prepared in compliance with that Code, as if it were evidence being given in Environment Court proceedings. In particular, unless I state otherwise, this assessment is within my area of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

Purpose and scope of assessment

29. The purpose of the assessment was to determine the presence of lizards within the Ō2NL Project designation corridor and the effects of the proposed road on this fauna in order to inform the notice of requirement and resource consent applications.

30. The scope of the assessment was to:

(a) Compile and review existing information regarding lizard records within and around the Ō2NL Project's designation corridor. Sources of information include:

(i) Department of Conservation BioWeb Herpetofauna Database (accessed July 2021).

(ii) iNaturalist (www.inaturalist.nz, accessed July 2021).

(b) Review literature, such as the Department of Conservation's Protected Natural Areas Programme (PNAP)'s Manawatū Plains Ecological District report (Ravine 1995), and Gill (1975, 1976).

(c) Determine the potential lizard species and sites where these were likely to be present within the full extent of the proposed designation of the Ō2NL Project All potential habitats for lizards will be identified, including forests, grasslands, wetlands and riparian margins.

(d) Carry out targeted lizard surveys, using a range of lizard survey methodology. The lizard survey targeted all terrestrial and arboreal species known to be present in the ecological district.

(e) Pitfall traps, Onduline artificial cover objects (ACOs) and closed-cell foam covers (CFCs) were used to catch lizards.

(f) Detection devices were supplemented with day-time searches and night-time spotlighting effort.

(g) Provide an assessment of the potential adverse ecological effects on lizards utilizing EIANZ's guidance on Ecological Impact Assessments (EcIAG, 2018).

(h) Outline management measures proposed to avoid and/or minimise potential impacts on lizards.

31. Engagement with iwi and stakeholders is described in Technical Assessment J – Terrestrial Ecology.

Assumptions and exclusions in this assessment

32. When using databases to evaluate the potential presence of lizards at a specific location, it is important to remember that the records accessed do not capture the true extent of distribution, nor do they indicate the full diversity of species that may be present. Lizard distributional data was sourced from the July 2021 version of the Department of Conservation BioWeb Herpetofauna Database. The information in this database comes from a number of different sources including: Department of Conservation-led survey and monitoring projects, local and regional councils, ecological consultants, community groups and casual observations. Databases are heavily reliant on lizard sightings being reported, and records may be incomplete due to lack of reporting.

33. This assessment addresses the effects on lizards anticipated from the 'Main Works' of the Project as detailed on the Project plans (provided in Volume III of the resource consent application) and summarised in the Design Construction Report.

34. Lizard habitat values are incorporated into the vegetation and habitat values described in Technical Assessment J – Terrestrial Ecology. As such, the assessment of the level of effect associated with vegetation loss will also account for the loss of these habitat values. The loss of lizard habitat is therefore appropriately covered in the terrestrial ecology report. While habitat values within the Project's designation corridor are described below, effects associated with habitat loss are not discussed further in this report.

PROJECT DESCRIPTION

Overview

35. The proposed alignment falls almost entirely in the southern Manawatū Plains Ecological District, in the Manawatū Ecological Region. A small section of the proposed route, near Manakau, lies within the western edge of the Tararua Ecological District.

36. The southern parts of the Manawatū Plains Ecological District lie between the coastal sands of the Foxton Ecological District to the west and the ranges of the Manawatū Gorge South and Tararua Ecological Districts to the east.

Detailed descriptions of the Manawatū Plains and Tararua Ecological Districts are provided in Technical Assessment J – Terrestrial Ecology.

37. The landscape within the Project's designation corridor comprises a mosaic of agricultural and horticultural land, fragments of indigenous and exotic forest, shelterbelts, and riparian corridors, and rural housing.

38. The Project's designation corridor contains potential habitat for lizards, which are recorded throughout the Manawatū Plains and Tararua Ecological Districts. Therefore, the Project required a lizard impact assessment.

METHODOLOGY

Introduction

39. I have adopted a best practice approach to my assessment of ecological effects on the basis that:

    (a) My assessment broadly follows the EIANZ EcIAG (Roper-Lindsay *et al.* 2018). The EcIAG provides a systematic approach to assessing ecological effects.

    (b) Where indigenous lizards have been previously found within the Ecological District but were not recorded during targeted surveys, they have been assumed present.

    (c) Where site surveys could not be carried out (due to time constraints and/or landowner permission delays) potential lizard habitat values were informed by the detailed vegetation and habitat assessments included in Technical Assessment J, or by interpretation of aerial imagery.

40. The Project iwi partners were involved in setting up lizard survey equipment, and checking of lizard traps during Spring 2021 and Summer 2022.

Desktop review

41. The Department of Conservation's BioWeb Herpetofauna Database records were mapped in GIS (Google Earth Pro) against a 5-kilometre radius surrounding the entire Ō2NL Project.

42. These records were also mapped against an Ecological Districts layer in GIS.

43. A literature search was undertaken using the latest version of the New Zealand Lizards Database's annotated bibliography, currently stored in LaTeX format

(T. Bell and F. Kelly, unpub.). This revealed only three reports that were relevant to Manawatū (Gill 1975 and 1976, Ravine 1995). It is possible that there are other unpublished reports that are not easy to find (such as old hard copy reports held in Department of Conservation archives).

Site surveys

44. The Project's designation corridor, including the preferred alignment was assessed using Google Earth imagery to identify all properties that may contain lizard habitats (whether indigenous or exotic). In doing so, a total of 33 properties were identified for field survey. The remaining properties only comprised pasture, cropland, or house and garden habitats. Where the desktop analysis was unable to determine if indigenous woody vegetation and/or wetland habitats were present, a conservative approach was taken and the property was identified for field surveys.

45. Permission was granted to survey 29 sites that were identified as providing potential lizard habitat during the desktop assessment. These were Properties #19, 20, 21, 28, 30, 37, 38, 40, 42, 43, 87, 114, 119, 151, 158, 162, 163, 209, 212, 287, 367, 461, 465, 470, 473, 479, 493, 499, and 501. The survey locations are illustrated in Figure 1 in the Appendices.

46. Permission to access Properties #164, 167, 207, and 462 was difficult to obtain and these properties were not surveyed.

47. Permission to access Properties #30, 43, and 279 were initially granted and one pitfall survey in April 2021 was conducted. Licenses to Occupy (LTOs) were not subsequently re-signed and equipment (ACOs and pitfalls) were removed in early 2022.

48. The LTO for Property #87 specified no invasive surveys so day-searching was the only survey method used at this site

49. Surveys were undertaken at these 29 sites between March 2021 and March 2022 to determine the presence, composition and abundance of the lizard fauna within and across different habitat types along the Project's designation corridor.

50. Survey methods used were as follows:

    (a) A range of lizard survey methodologies were used at these 29 properties: day searches, night searches, pitfall traps, and artificial refugia (i.e., "lizard homes") on the ground (as Onduline ACOs) and on tree trunks (as closed-cell foam covers). These methods are outlined below.

(a) Pitfall traps. Pitfall traps are widely used in New Zealand to survey and monitor lizards. In the context of the Project, this method would potentially detect the presence of copper skink (*Oligosoma aeneum*), glossy brown skink (*O. zelandicum*), northern grass skink (*O. polychroma*), ornate skink (*O. ornatum*), and Raukawa gecko (*Woodworthia maculata*) (five of the seven target species potentially present). This method is usually deployed both in open (grassy or scrubland) and forested habitats.

(b) Onduline ACOs. Onduline ACOs are also widely used in New Zealand to survey and monitor lizards. This method would potentially detect the presence of copper skink, glossy brown skink, northern grass skink, ornate skink, and Raukawa gecko (five of the seven target species potentially present). This method is usually deployed both in open (grassy or scrubland) and forested habitats.

(c) Closed-cell foam covers. CFCs have been used to survey and monitor ngahere geckos (*Mokopirirakau* “southern North Island”) and Raukawa geckos in forested habitats (two of the seven target species potentially present).

(d) Day searching. Day searching has the potential to detect any of the seven lizard species potentially present, but effectiveness of day searching varies due to animal crypsis and environmental factors, and often lizards have been found instead via other methodologies. Day searching can be used in any habitat type but effectiveness varies.

(e) Spotlighting. This method has the potential to detect arboreal lizard species, such as ngahere gecko, barking gecko (*Naultinus punctatus*) and Raukawa gecko, in forest and scrubland habitats (three of the seven potentially present species). It is one of the only two consistently proven sampling methods for barking gecko (the other is day searching).

(f) The number of units (traps, artificial refugia) or day searching and spotlighting effort varied between the properties according to habitat types and habitat availability at each. It is important to note that many of the habitats present at the properties are often small in size, and this is why the number of sampling units appears to be low per site.

(g) Pitfall traps, ACOs and CFCs at 24 sites were set up at the same time during mid-March 2021. Sites in which LTOs later became available (properties #19, 162, 367, and 499) were set up with pitfalls in January 2022.

(h) Day searching, pitfall trapping and spotlighting work were undertaken during March-April 2021 and February 2022. Refugia checks (ACOs, CFCs) were undertaken during 10-11 November 2021, 1-3 December 2021, 20 and 27 January 2022, 4 February 2022, and 11 March 2022. ACOs were checked three times each over the course of the survey period and then removed.

(i) Pitfall traps were set-up and left in situ for at least a two month period.

(j) Four consecutive days of pitfall trapping using 147 × 4L trap units were then completed during 15-19 April 2021 (588 trap nights). The weather conditions were variable during April. Weather conditions were moderate, with some sunny days (3 of 5 days) but characterised by cooler temperatures (10-16°C), no wind, varying levels of cloud cover and infrequent showers. These weather conditions were not optimal for trapping lizards.

(k) In order to capture more optimal survey conditions for pitfall trapping, trapping effort was repeated at the same and new sites between 21-25 February 2022 (four consecutive days, 195 × 4L trap units, 780 trap nights). Trapping was undertaken during hot and dry conditions (20-22°C), no wind and partly sunny skies with no rain. These conditions were considered optimal for a survey using live capture traps such as pitfall traps.

(l) Eighteen person hours of spotlighting effort were achieved by experienced herpetologists during 22-24 March 2021 and four person hours during 22 February 2022. Weather conditions during these spotlighting evenings were mainly warm (11-15°C, mostly 13-15°C), with no wind or rain, and clear nights (1-2/ 8ths cloud cover). These conditions were optimal for spotlighting surveys.

(m) One-hundred and ninety-three units of Onduline ACOs were checked three times between November 2021 and March 2022 (for a total of ~579 checks).

(n) Fifty-seven units of closed-cell foam covers were checked three times between November 2021 and March 2022 (for a total of ~159 checks).

(o) ACO and CFC checks were undertaken during cool-warm weather conditions, in both the cooler months of October-November 2021 and on cool days throughout the remainder of the survey period (to March 2022). ACO and CFC checks during hot or warm weather are not recommended, as lizards are not likely to occupy the ACOs and CFCs in these conditions.

(p) Thirty-six person hours of day searching effort undertaken by experienced herpetologists commenced in March and April 2021 and finished in March 2022.

(q) Habitat types in which the lizards are observed was noted, and individual lizard capture locations recorded on a handheld Garmin 64s global positioning unit.

(r) Data was collected for individual lizards, including sex/life stage, morphometric measurements, and capture method. Identification photographs were taken.

(s) Trap return or lizards captured per person hour was recorded, giving an indication of local and overall abundance for each species.

51. Ideally, surveys should be undertaken in conditions appropriate for lizard work (warm, dry, settled weather conditions between September-April). For trapping operations, warm to hot weather is required for lizards to be active and trappable. The weather conditions encountered during the period of the first pitfall trapping (April 2021) was not ideal for surveying lizard populations. A second round of pitfall trapping (21-25 February 2022) was undertaken in optimal weather conditions. This round included additional survey sites.

52. For artificial refugia (Onduline ACOs and CFCs), checks should be undertaken during cool periods (either at cooler times of the day, or on cool days), as lizards need to be inactive. These refuges were checked between October 2021 - March 2022 at times where the weather conditions were cooler than normal.

53. The survey method and effort at each property is outlined in Table 1. Pitfall traps were checked during 15-19 April 2021 and 21-25 February 2022 while Onduline ACOs and closed cell foam covers were checked over multiple visits over a five-month period (November 2021-March 2022) for a total of three checks each. Properties that lacked sufficiently-sized trees had no closed-cell foam covers deployed. Spotlighting occurred wherever there were shrubs or trees present. Day searching was performed across all sites.

54. Table 1: Allocation of lizard survey effort at the 29 properties. Habitat follows the vegetation habitat classes in Technical Assessment J – Terrestrial Ecology. Some of the equipment was lost between checks due to stream erosion, cattle trampling, flooding, marking poles taken, or the area had overgrown with vegetation. These losses are given in the table below with a slash (/) and the revised number.

Table 1: Allocation of lizard survey effort at the 29 properties.

Property ID	Habitat (Veg. classes)	Pitfall Traps	Onduline ACOs	Closed-Cell Foam Covers	Spotlighting (person hours)
19*	ITFn01, ETV1	15			
20	EHG, MTS1, ETP, EWRs3, EWH4, IWSe6	8/7	12	8	
21	ETF4	Removed			
28	ETP	8	10		
30	ETF4, ETP	6	10		
37	ITF	5	5		3
38	ITF2	6	6		
40	ITF6	6	6		10
42	ITF2	8	8		
43	ITF2, ETF2, ETP	10	18	14	4
87	ETV1, EHG	Day searching only			
114	ETP	2	3		
119	ETP	3	2		
151	ETG1	8/4	8		
158	ETP	6			
162*	ETG1	8/5			
163	ITF1	6	6		
209	QRY	Day searching only			
212	ETG1, ETV1	10/9	10		
287	ITF1	5	15	11	
367*	ETG1	25			
461	ETP		6/5		
465	ITF7, MTF3, MTF9, MTF10, ETF6, ETP	16	20	12	2.5
470	ETF4	3	4	6/5	
473	ITS1, MTF6, ETP	4	4		
479	ETF7, ETF8, EHG	20	26		2.5
493	ITF4, ETF4, EWG2	4	14	6	
499*	ETF4	20/12			
501	ETP	3/0			
		147/195	**193/192**	**57/56**	**22**

* Indicates new site, included only in the second pitfall trapping survey.

55. Issues encountered:

    (a) Property #21 – all three Onduline ACOs had to be removed due to livestock trampling, thus this site was completely removed.

    (b) Properties #114 and 119 – all pitfall traps and Onduline ACOs were removed after the second ACO check and first pitfall check due to cattle getting into electric fence and trampling equipment.

    (c) Property #461 – pitfalls were not used at the property at the request of the landowner.

    (d) Property #470 – lost one pitfall due to flooding.

    (e) Property #473 – lost two pitfalls due to flooding.

56. Experienced herpetologists and ecologists conducted the surveys. Trent Bell (myself) was the lead herpetologist and was supported by Cameron Thorp (Ecologist, Wildlands Wellington) and Jina Sagar (Ecologist, Wildlands Wellington).

57. In addition, the invertebrate survey team has been recording lizards as they surveyed for *Powelliphanta* spp. snails. There is some overlap in effectiveness of day searching methods that may lead to discovery of either lizards or snails.

National and international best practice criteria

58. In implementing the lizard surveys, we followed Department of Conservation's Inventorying and Monitoring Toolbox, particularly the resources for pitfall trapping (Hare 2012a), artificial refugia (Lettink 2012) and systematic searching (i.e., day searching and spotlighting) (Hare 2012b).

Application of the EcIAG

59. I have assessed the lizard values, and the 'Level of Effects' of the Project on these values, using the guidelines provided by the EcIAG (2018). As discussed above, effects associated with habitat loss are appropriately addressed in Technical Assessment J – Terrestrial Ecology, and are not discussed further here. This report focuses on all other potential effects on lizards.

60. The EcIAG was prepared to provide direction on the general approach to be adopted when assessing ecological impacts. In brief, the EcIAG approach involves the following steps:

(a) Assigning the ‘Ecological Value’ of the species likely to be impacted within the Project footprint and immediate surrounds. The ‘Ecological Value’ of a species is scored on a scale of ‘Negligible’ to ‘Very High’ and is assessed in terms of threat status as described in Table 2.

(b) The 'Magnitude of Effect' from a proposed activity on the environment is assigned after all efforts to avoid, remedy, or minimise potential adverse effects have been implemented. The 'Magnitude of Effect' is a measure of the extent or scale of the effect of an activity and the predicted degree of change that it will cause. The 'Magnitude of Effect' is scored on a scale of 'Negligible' to 'Very High' and is assessed in terms of:

   (i) Level of confidence in understanding the expected effect.

   (ii) Spatial scale of the effect.

   (iii) Duration and timescale of the effect.

   (iv) The relative permanence of the effect.

   (v) Timing of the effect in respect of key ecological factors.

(c) An overall level of residual effects that cannot be avoided or minimised for each species value is determined using a matrix approach that combines the 'Ecological Values' with the 'Magnitude of Effects' resulting from the activity. The matrix describes an overall 'Level of Effect' on a scale from 'Negligible' to 'Very High'.

61. The level of residual effect that cannot be avoided or minimised is then used to guide the type and quantum of mitigation, offsetting, or compensation measures that are proposed to adequately address residual adverse effects associated with the Project. I note under the Proposed Greater Wellington Regional Plan (Policy 41), where adverse effects on ecosystems or habitats cannot be avoided, more than minor adverse effects should be remedied, and where residual adverse effects remain, the use of biodiversity offsets may be proposed or agreed by the Applicant. Similarly, in the Horizons One Plan (Policy 13-5), consents within significant habitats should not be granted unless any effects that are more than minor are avoided, remedied, mitigated, or offset to result in a net indigenous biodiversity gain.

62. The EcIAG (p. 84) equates 'not more than minor' effects to a 'Very Low' level of effect, and suggest that 'Low or Very Low' levels of effect are not normally of concern. The EcIAG also notes that effects that are of 'High' or 'Moderate' level require further management, including offsetting (where relevant).

Table 2: Factors considered when assigning value to lizard species.

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

STATUTORY CONSIDERATIONS, INCLUDING NATIONAL STANDARDS, REGIONAL AND DISTRICT PLANS, AND OTHER RELEVANT POLICIES

63. An overview of the statutory consideration relevant to ecological effects is provided in Technical Assessment J. Statutory considerations that are relevant specifically to indigenous lizards are described below.

Wildlife Act 1953

64. All indigenous lizards are afforded absolute legal protection under the Wildlife Act 1953. It is an offence to kill or have in possession absolutely protected wildlife without a Wildlife Act Authorisation (also known as a Wildlife Permit) issued by the Department of Conservation.

New Zealand Threat Classification System (NZTCS) lists: reptiles

65. All known and putative lizard taxa have been assigned a national threat classification. The current threat classification is Hitchmough *et al.* (2021.)

Greater Wellington Regional Threat Classification: lizards

66. All known lizard taxa present in the Wellington Region have been assigned a regional threat classification (Crisp 2020). This threat classification is based on Hitchmough *et al.* (2016), but is applied regionally.

67. There is no corresponding regional threat classification for lizard species that are present in the Manawatū-Whanganui Region.

RESULTS

Desktop assessment

68. Prior known lizard records in the Department of Conservation BioWeb Herpetofauna Database that are within a five-kilometre radius of the Project include:

(a) A single record of ngahere gecko in the Tararua Ranges from 1990.

(b) A single historical record of barking gecko from Waikawa Beach, 13 kilometres south-west of Levin from 1972.

(c) An unidentified gecko species found at a property on Roslyn Road in Levin from 2020.

(d) A single record of copper skink at the Otaki Racecourse from 1997.

(e) A single historical record of glossy brown skink 1.6 kilometres east of Levin from 1965 (it is possible that this could be northern grass skink).

(f) Numerous records of ornate skink exist throughout Ōtaki to north of Levin. Five of the seven records are of individual animals, while two of the seven consist of a total of 16 animals found at Property #287 (one-hectare Brown's Bush), which is itself not affected by the Project's designation corridor. All these records are either historical (two records from 1970s) to relatively historical (pre-1995, including the two Brown's Bush records).

(g) Regarding the two records at Brown's Bush, these represent a regionally significant population of ornate skink. The records were made by Mr Andrew Townsend (n=6 individuals, August 1993) and Dr Colin Miskelly (n=10 individuals, September 1994). In addition to the ornate skink, two northern grass skinks were also found by Colin. Both Andrew and Colin are highly respected current and ex- Department of Conservation staff, respectively, and their records are reliable. Brown's Bush (comprising tawa/kawakawa (*Piper excelsum* subsp. *excelsum*) forest) is the same site as 67C in Ravine's (1995) Manawatū Plains Ecological District PNAP report (Appendix II, p.198), which mentions the high numbers of skinks.

(h) Some records of northern grass skink. Two were located at Property #287 (Brown's Bush) in 1994 (see above). An historical record (1950) for the species exists for Te Hori, south of the Ōtaki River, and two historical records for a total of seven individuals for Ōtaki Beach (1969, 1972).

69. There were no records from iNaturalist within a 5-kilometre radius of the Project.

70. Another record for a glossy brown skink, located at or north of Levin, was found in the literature (Gill 1975, 1976), but no details (e.g., precise location, dates, or observer name) were presented.

71. There are no prior known lizard records on the Project's designation corridor itself. The closest record for lizards is Property #287, located 170 metres west of the designation corridor.

72. Known lizard species in the Manawatū Plains and Foxton Ecological Districts include: Pacific gecko (*Dactylocnemis pacificus*), ngahere gecko, barking gecko, Raukawa gecko, copper skink, ornate skink, northern grass skink, and glossy brown skink. In the northern extent of the Manawatū Plains ecological district, the forest gecko (*Mokopirirakau granulatus*) and elegant gecko (*Naultinus elegans*) likely supplants ngahere gecko and barking gecko, respectively. Pacific gecko may have historically been present around Palmerston North, but it appears the species is locally extinct. Plague skink (*Lampropholis delicata*) is an introduced skink species that is also present in Manawatū.

73. The threat status of these species is tabulated in Table 3 below.

Table 3: Lizard species present in the Manawatū Plains Ecological District within the immediate vicinity of the Project and their threat status (Hitchmough et al. 2016, Crisp 2020), and habitat requirements. *In this table, species are ordered first by geckos and skinks, then by their scientific name.*

Species	Conservation status	Habit and habitat requirements
Ngahere gecko *Mokopirirakau* "Southern North Island"	At Risk – Declining (Hitchmough *et al*. 2021). Regionally Declining in Greater Wellington (Crisp 2020).	Arboreal. Indigenous mature and secondary forest and scrubland (ITF/ITS), mixed forest (MTF), indigenous vineland (ITV).
Barking gecko *Naultinus punctatus*	At Risk – Declining (Hitchmough *et al*. 2021). Regionally Vulnerable in Greater Wellington (Crisp 2020).	Arboreal. Indigenous mature and secondary forest (ITF/ITS), mixed forest (MTF), scrubland (ITS), indigenous vineland (ITV).

Species	Conservation status	Habit and habitat requirements
Raukawa gecko *Woodworthia maculata*	Not Threatened (Hitchmough *et al*. 2021).	Semi-arboreal. Indigenous mature and secondary forest (ITF/ITS), mixed forest (MTF), scrubland (ITS), indigenous vineland (ITV), rock (TG1).
Copper skink *Oligosoma aeneum*	At Risk – Declining (Hitchmough *et al*. 2021). Regionally Critical in Greater Wellington (Crisp 2020).	Terrestrial. Indigenous mature and secondary forest (ITF/ITS), mixed forest (MTF), scrubland (ITS), indigenous fernland (IFn) indigenous grassland (ITG), rough grassland (ETG), indigenous sedgeland (ITSe), indigenous herbfield (ITH), indigenous rushland (ITRs), house and gardens (EHG), rock (TG1). Damp leaf-litter and understorey vegetation such as *Tradescantia*.
Ornate skink *Oligosoma ornatum*	At Risk – Declining (Hitchmough *et al*. 2021). Regionally Declining in Greater Wellington (Crisp 2020).	Terrestrial. Indigenous mature and secondary forest (ITF/ITS), mixed forest (MTF), scrubland (ITS), indigenous fernland (IFn), indigenous grassland (ITG), rough grassland (ETG), indigenous sedgeland (ITSe), indigenous herbfield (ITH), indigenous rushland (ITRs), house and gardens (EHG), rock (TG1). Damp leaf-litter and understorey vegetation such as *Tradescantia*.
Northern grass skink *Oligosoma polychroma*	Not Threatened	Terrestrial. Indigenous scrubland (ITS), indigenous grassland (ITG), indigenous fernland (IFn), rough grassland (ETG), indigenous sedgeland (ITSe), indigenous herbfield (ITH), indigenous rushland (ITRs), house and gardens (EHG), rock (TG1).
Glossy brown skink *Oligosoma zelandicum*	At Risk – Declining (Hitchmough *et al*. 2021). Regionally Declining in Greater Wellington (Crisp 2020).	Terrestrial. Indigenous scrubland (ITS), indigenous fernland (IFn), indigenous grassland (ITG), rough grassland (ETG), indigenous sedgeland (ITSe), indigenous herbfield (ITH), indigenous rushland (ITRs), house and gardens (EHG), rock (TG1). Damp leaf-litter and understorey vegetation such as *Tradescantia*.

74. The desktop review and database search has indicated the presence of seven lizard species within the immediate vicinity (five kilometres) of the Project.

75. There is therefore potential for the presence of up to seven lizard species within the Project’s designation corridor, providing their habitat requirements are met.

Survey results

76. Surveys consisted of day-searches, spotlighting, pitfall trapping, and checks of ACOs and CFCs.

77. Two lizard species were recorded during the surveys.

78. The ornate skink was recorded at four of 28 properties surveyed: Properties #42, 287, 465, and 479. At properties #42 and 287, the ornate skinks were found in Onduline ACOs; one individual on each property. Six ornate skinks were found on Properties #465 (two individuals found) and 479 (four individuals found) located off Arapaepae Road South and Queen Street East, Levin, respectively. These skinks were found either under artificial cover objects (corrugated iron) in rank kikuyu (*Cenchrus clandestinus*) grassland on farmland (habitat type: ETG/EHG), or in tradescantia (*Tradescantia fluminensis*) or under fallen logs in the forest (habitat type MTF). Property #42 is characterised as tawa-kohekohe (*Dysoxylum spectabile*) forest, while #287 is tawa forest. Property #465 is characterised as tītoki-false acacia (*Robinia pseudoacacia*) forest, while #479 is false acacia – indigenous forest. Refer to Figure 1 in Appendixes for illustrative map. The rank kikuyu grassland and tradescantia present at Property #479 has likely been a significant factor in protecting and sustaining the ornate skink population. Kikuyu offers thermal and microhabitat benefits that are significant for ornate skinks. Tradescantia provides complex ground cover under both indigenous and mixed forest canopy. Elsewhere, indigenous lizards throughout New Zealand have had to utilise a range of exotic (including pest) plants in response to the loss of original indigenous habitats. These are known as surrogate habitats. Lizards may be found utilising gorse (*Ulex europaeus*), pampas (*Cortaderia* spp.) and exotic grasslands, due to the complex and protective refuges they can provide. In some cases, indigenous lizards can occur in high densities within these habitats.

79. Ornate skink is classified as At Risk – Declining in the national threat classification lists (Hitchmough *et al.* 2021). This species meets Criterion C(2/1) where the total area of occupancy is >10,000 hectares (100 km^2) nationally and the species is predicted to undergo annual population declines of 10-70%. As a result, it has been qualified as Conservation Dependent, meaning that habitat protection and predator control are essential requirements for the persistence of remnant populations.

80. The ornate skink is only known from the North Island and has a wide but highly localised distribution.

81. It is likely that ornate skink was once more widespread and abundant throughout the North Island but the loss of original forest and associated microhabitats along with the arrival of predatory mammals has led to significant population declines. The current distribution of ornate skink is therefore likely relictual, confined to habitat refuges that provide the necessary microhabitat features (providing stable thermal and humidity characteristics) along with the protective qualities essential for survival from predatory mammals (Porter 1987d).

82. At Property #287 (Brown's Bush, located on McLeavey Road, Ōhau, outside the Project's designation corridor), a total of 16 ornate skinks were recorded by Department of Conservation in 1993-1994. This population was first discovered in August 1993 by Mr Andrew Townsend (Department of Conservation), when six individuals were found. In September of the following year, 10 individuals of ornate skink and two individuals of northern grass skink were recorded at Brown's Bush by Dr Colin Miskelly (then of the Department of Conservation). This was considered a locally significant population of ornate skink.

83. After intensive day searches and pitfall traps at Property #287 as part of the Project investigations during March 2021 and February 2022, no ornate skinks were found. However, the 27 January ACO check found one individual skink, indicating that the species is still present but likely comprise a much smaller population today, than that recorded during the 1990s. The serious decline of the Brown's Bush population may be irreversible and adds a greater weight to the significance of the populations still persisting at Properties #42, 479, and 465.

84. The northern grass skink was found at one of 29 properties: Property #367 (one individual found during pitfall trapping). This site is characterised by mixed species rank exotic grassland and blackberry shrubs (*Rubus australis*) and is surrounded by agricultural fields and pasture. One unidentified skink was sighted during a day search at Property #209, an operational quarry. The skink was seen on some rock piles but was not caught and identified. The northern grass skink is classified as Not Threatened (Hitchmough *et al.* 2021) and occurs widely, often abundant, throughout its range (central and lower North Island and upper and western South Island).

ASSESSMENT OF ECOLOGICAL VALUES

Habitat values

85. Table 4 below provides a summary of the lizard habitat values for each vegetation/habitat type within the Project's designation corridor. Some habitats beyond but adjacent to the Project's designation corridor have also been included in the assessment on the following basis:

    (a) The habitat is of moderate to high ecological value for lizards or has previously been recognised as a natural area.

    (b) The habitat is of a type that may be subject to adverse effects other than direct clearance or loss, due to its proximity to the footprint (e.g., increased isolation of resident terrestrial fauna).

86. The habitat values described in Table 4 have been incorporated into the overall ecological values assessment described in Technical Assessment J – Terrestrial Ecology for all habitat types within the Project's designation corridor.

87. Site specific information for some species is limited. Lizard surveys were carried out in high quality representative habitats along the route rather than for every habitat type. Therefore, species that may be present (based on habitat preference and known distribution) are assumed to be potentially present for the purposes of this habitat values assessment.

88. The lizard habitats (ETG, EHG, and MTF) at Properties #42, 465, and 479 should be considered of **high ecological value** due to the presence of a population of ornate skink. Some of these properties contain exotic habitat types (e.g., containing kikuyu and tradescantia) that are currently supporting these populations.

Fauna values

89. The relative value of the ornate skink population at Properties #42, 465, and 479 should also be viewed in the context of the severe decline of a significant population of the same species over the past two decades at Property #287.

90. It is evident that the current alignment is characterised by low lizard species diversity and abundance. This is likely due to the degraded ecological values throughout the highly developed landscape, where there are limited natural ecological sites, and likely a high number of exotic mammalian and avian predator species present (Ravine 1995).

91. The lizard species likely to be present throughout the Project's designation corridor are the ornate skink and northern grass skink (Table 5). Copper skink and glossy brown skink are also possibly present.

92. Lizards are likely to be concentrated around rank exotic grasslands and in gardens throughout the Project's designation corridor. These habitats may include wide grass margins along farm tracks, hedges, forest edges, wetlands, and around farm buildings. Amenity plants (such as flax (*Phormium* spp.) and agapanthus (*Agapanthus* spp.)), rough grasslands (e.g., kikuyu), weeds (e.g., tradescantia) and artificial cover objects (such as corrugated roofing iron, firewood stacks, bricks and pavers) in gardens provide hiding places for lizards. Rough grassland provides considerable and diverse food sources for lizards as these habitats support a significant invertebrate biomass[1]), thermal and humidity benefits (through provision of a range of open basking sites and micro-climates), and protective cover from a range of potential predators.

93. It is unlikely that arboreal geckos are present within the Project's designation corridor. There is only one identified site where indigenous forest is present and affected by the Project's preferred alignment. This is located on Property #40. This forest was likely planted during the 1970s or 1980s. Spotlighting effort at this site did not detect arboreal lizard species. It is difficult for arboreal lizards to colonise isolated habitat patches where there is a hard edge between habitats (e.g., from isolated forest patches to pasture), and thus it is likely this site was never colonised by geckos.

94. If any additional species or populations are found, the assessment of ecological effects will be updated and revised accordingly.

95. The ecological value of lizard habitat and lizard species are indicated in Tables 4 and 5 respectively.

[1] This invertebrate biomass includes lizard prey items such as flies, moths, butterflies, cockroaches, beetles, earwigs, aphids, leaf hoppers, ants, bees, wasps, crickets, grasshoppers, spiders, springtails, booklice, woodlice, amphipods, snails, slugs, and earthworms.

ASSESSMENT OF EFFECTS

Overview

96. Potential adverse effects of the Project on indigenous lizards during construction include:

    (a) Permanent habitat loss (as discussed in Technical Assessment J – Terrestrial Ecology).

    (b) Injuries to and/or mortalities of indigenous lizards.

    (c) Disturbance.

    (d) Modification of remaining habitat, including:

        (i) Reduction of habitat connectivity through fragmentation and the introduction of new barriers (e.g., road) that may cause habitat isolation.

        (ii) Creation of edge effects including altering the composition and habitat value of adjacent vegetation and modifying the microclimates within edge habitats. For example, forest edges are drier than interior forest habitats and are less likely to support lizards that require moist environments.

97. The potential ongoing adverse ecological effects of the Project on indigenous lizards once operational include:

    (a) Ongoing disturbance of indigenous lizards (by streetlight, vibration, movement, dust and/or noise).

    (b) Mortality or injury on roads through road kill.

    (c) Increased presence of and likelihood of invasion by non-native plant and animal species.

98. Each of these effects is described and assessed in detail below. The magnitude of each effect has been defined as outlined in the EcIAG and is presented in Table 6.

Permanent habitat loss

99. Loss of lizard habitat may occur due to the loss of indigenous and exotic vegetation, including rough exotic grassland (EG) and gardens (EHG).

100. Lizard habitat values are incorporated into the vegetation and habitat values described in Technical Assessment J – Terrestrial Ecology. As such, the assessment of the level of effect associated with vegetation loss will also account for the loss of these habitat values. The loss of lizard habitat is therefore appropriately covered in the terrestrial ecology report.

Injuries to and/or mortalities of indigenous lizards during construction

101. Vegetation removal and earthworks during construction of the Project is likely to result in the injury or death of some lizards. Lizards are less mobile and their first response is to "hide" when disturbed, and therefore become injured or killed when clearance occurs.

102. This impact can be locally and regionally significant, due to the high abundances that lizards can reach in some habitat types.

Disturbance (temporary and ongoing)

103. Temporal or ongoing disturbance of indigenous lizards can occur in several ways: by light/streetlight, vibration, movement (including visual disturbance from moving vehicles) and/or noise (Brehme *et al*. 2013). However, no research has been conducted on the effects of these potential disturbances on New Zealand lizards.

104. Anecdotal records appear to indicate that many small lizard species have been found in suitable habitat types within roadsides, including urban centres. These include the grass skink (any member of the *Oligosoma* aff. *polychroma* species-complex), copper skink, and McCann's skink (*O. maccanni*). Terrestrial and semi-arboreal geckos (e.g., *Dactylocnemis* and *Woodworthia* spp.) have been found in rocky and clay road cuttings. There appear to be fewer arboreal gecko species than terrestrial species recorded adjacent to roads; however, such records of arboreal geckos are not unknown.

105. However, this disturbance could still affect lizard behaviour, resulting in changes in:

(a) Home range.

(b) Movement.

(c) Reproduction.

(d) Physiological state.

Mortality or injury on roads through road kill

106. Direct mortality of lizards may occur through collisions with vehicles using the road once operational.

107. There are some records of lizards basking on or crossing sealed roads in New Zealand. Road surfaces are known to absorb solar radiation, which can increase ground and air temperatures and thus become attractive to thermoregulating lizards (Haskell 2000). In addition, road margins have provided new lizard habitat, through creation of creviced road cuttings, boulderfields, or opening up sites to rough grassland.

108. There are accounts of lizards seen or killed on roads, including Threatened species, in the Department of Conservation's BioWeb database. In addition, lizards are commonly recorded in roadside habitats. Notably, and locally relevant to the Project, the ornate skink has been found in rough grassland during road widening of Kimberley Rd, Levin (BioWeb).

Modification of remaining habitat

109. Reduced habitat connectivity through fragmentation and modification of remaining habitat of indigenous lizards, and introduction of new barriers that cause habitat isolation for indigenous lizards, which have limited mobility.

110. The proposed road alignment falls between Properties #465 and 479 off Arapaepae Road South and Queen Street East, Levin (Figure 2 in the Appendix), which support ornate skink populations and could therefore further isolate these populations. The potential movement of less mobile species across pasture gaps (e.g., ornate skink crossing 110 metres of pasture between forest habitats at Properties #465 and 479) is less well understood. Greater movement of lizards may occur when the grass is long (e.g., when the grass hasn't been grazed in some time). Permanent slivers of rough grassland (i.e., farm track and road verges) are also likely to act as corridors for dispersal and genetic interchange between subpopulations.

Increased presence and likelihood of non-native plants and animals

111. Construction can result in arrival of new pest plant species to a site (e.g., earthworks machinery acting as vectors) and the facilitation of pest establishment by providing bare surfaces for colonisation. Effects on pest abundance can persist into the operational phase.

112. Some pest plant species may not benefit lizards, as they may smother more beneficial habitat types. These pest plants include blackberry (*Rubus fruticosus*) and radiata pine (*Pinus radiata*).

113. Pest animals such as rodents are detrimental to lizards, and introduced predatory mammals are considered one of two main causes of declines in lizards in New Zealand (the other is habitat loss).

114. It is likely that increased numbers of predatory mammals and birds are using roads (including powerlines) as corridors and are impacting on lizard numbers as a result.

MEASURES TO REMEDY OR MITIGATE ACTUAL OR POTENTIAL ADVERSE EFFECTS ON LIZARDS

115. An Ecological Management Plan (EMP) will be prepared, as discussed by Nick Goldwater. The EMP will include a Lizard Management Plan (LMP) as a subplan. The LMP will address the impact and minimisation measures on lizards and outline the key mitigation measures to reduce the level of adverse ecological effects (as described below).

116. The key minimisation measures to be included in the LMP, and considered in the Magnitude of Effects in Table 6 are as follows:

(a) Avoidance of lizard populations and habitat, where they are known to be present, should take priority. This should be followed by mitigation where avoidance cannot be achieved, and any residual effects addressed through ecological offsetting and / or compensation (including via funding mechanisms).

(b) Lizard salvage and relocation programmes could potentially be implemented, where avoidance is not possible, to limit injuries and/or mortality of lizards during vegetation clearance. As seen in the Project investigations, the number of lizards recorded was low overall, despite the considerable effort expended in lizard surveys. It is therefore suggested that a salvage programme should be relatively limited in and targeted to sites where successful recovery of lizards is more likely. Sites selected for salvage operations should contain the following habitat types: ITF, MTF, MTS, ETF, EHG, ETG1, ETS, RRR, and QRY. However, the main focus of lizard mitigation effort should be through ecological compensation, as this is more likely to address adverse effects on lizards, and lead to tangible, measurable outcomes for lizards. A sufficiently robust LMP will fully describe in detail the following requirement of a lizard salvage and relocation programme:

(i) Identification of specific search sites and target habitat types.

(ii) Search methodology and minimum search effort.

(iii) Identification of designated relocation site(s) (see 117 (c) below).

(iv) Pre-release habitat enhancement at relocation site(s).

(v) Pest management at relocation site(s), also supporting resident lizard populations, such as ornate skink (see 117 (e) below).

(vi) Habitat enhancement monitoring programme.

(vii) Post-release lizard population monitoring programme.

(viii) Adaptive management.

(ix) Reporting of outcomes.

(c) Waiopehu Bush Reserve is a recommended site, into which salvaged lizards, such as ornate skink, could potentially be relocated, and where site management and monitoring at the Reserve is feasible and can be effectively implemented. Local iwi appear to support the concept of a Waiopehu Sanctuary for mokomoko (lizards) and ngata (snails).

(d) A salvage programme is unable to capture and relocate all individuals within any population at target salvage sites, and it is not possible to cover all sites that contain potential lizard populations along the entire alignment. Therefore, there will be some residual effects on lizards that need to be addressed.

(e) Development of a predator-exclusion-fenced sanctuary at Waiopehu Bush Reserve would address the losses of ornate skink that would likely still be incurred as a result of the Project, due to partial efficiency of direct mitigation activity (residual effects). There is strong evidence that ornate skink populations respond well within predator-excluded sanctuaries (e.g., ZEALANDIA, see Nelson *et al.* 2016).

Comparatively, it is very difficult to demonstrate positive responses (i.e., population increases) in most species of lizards under non-fenced pest management regimes on the New Zealand mainland (Nelson *et al.* 2016), unless these were large scale (Reardon *et al.* 2012). As demonstrated by Nelson *et al.* (2016), a significant population increase was recorded in an ornate skink population located within an exclusion-fenced site. Based on the results of Nelson *et al.* 2016, effective compensation could potentially be achieved for ornate skinks within a 10-20 year timeframe, through the creation of a predator-excluded sanctuary. A lizard survey would be required at Waiopehu Bush Reserve. This would help confirm whether or not a population of ornate skink is present there which could potentially respond positively at a population-level to effects management through compensation mechanisms.

(f) Good landscaping design has the potential to create significant lizard habitat along roads. Permanent habitat loss for northern grass skink could be addressed through establishment of new habitat prior to and during construction of the Project. It is recommended that such work could be implemented at bridge abutments of Ohau and Waikawa Streams, by establishing creating rip rap rock fields (rock size graded 20-40mm; see Lennon *et al.* 2021) above gabion baskets on north facing contoured batters, and establishing scrambling vine (e.g., *Muehlenbeckia*), low ground cover plants (e.g. *Coprosma propinqua*, *Phormium tenax*) and indigenous grasses (such as *Anemanthele lessoniana, Austroderia splendens, Chionochloa flavicans* and *Microlaena stipoides*) within and on the periphery of these batters. Habitat could be further supplemented by wood cuts and logs, and other novel ground cover supplements. There should be a minimum target (in hectares) set for habitat creation for northern grass skink.

(g) New habitat should be created at locations where northern grass skink populations are known; or could be released into (such as via a lizard salvage and relocation programme undertaken for the Project). This is because for northern grass skink to utilize the new habitat, they need to be able to colonise this new habitat. Either they need to be already present on site, or located in adjacent habitat. Introduction of lizards from elsewhere (such as from other land development projects) may be needed to establish new populations at the new sites. The presence of a population is a key requirement for a lizard monitoring programme, which is needed to establish actual outcomes from the effects management work.

(h) The establishment of new habitat and colonisation of this habitat by lizards should be formally monitored, such as assessment by using a time-bound four stages of success framework established by Herbert (2020, in prep.): (1) use of enhanced habitat by lizards; (2) reproduction in enhanced habitat; (3) increased abundance, survival or birth in enhanced habitat; and (4) self-sustaining lizard population.

(i) Successfully achieving creation of new lizard habitat would require close collaboration between environmental planners, landscape architects and lizard ecologists when developing revegetation/ restoration plans along the proposed road alignment. The Construction Environmental Management Plan, Cultural and Environmental Design Framework and the Lizard Management Plan (as part of the overall Ecology Management Plan) all need to be well aligned. This habitat creation should be guided by detailed ecological restoration plans.

(j) These actions are required to restore habitat for northern grass skink that is lost within the Project footprint. Ornate skinks are not likely to benefit from such work to the same extent, as their habitat requirements are more difficult to recreate, and there may be no resident populations at Ohau and Waikawa Streams, or elsewhere, where the proposed habitat creation is to occur. Ornate skinks therefore should be managed separately through measures as described in 117(e).

(k) Addressing modification of remaining habitat, by minimising habitat fragmentation and isolation through suitable engineering and landscape planning, including ecological restoration plans. Landscaping and revegetation along the edges of the highway to create habitat suitable for northern grass skink and ornate skink could help to secure and expand populations, particularly for ornate skink at Properties #42, 479 and 465. Both species of skink require open rank grassland and scrub, with plenty of ground cover. There are significant opportunities for the creation of new terrestrial habitat for lizards through this project. Considering Properties #479 and 465, the ornate skink population at these two sites could be permanently bisected and fragmented by the highway. Increasing habitat at these sites and implementing pest control will assist in reducing these impacts. These actions are required to maximise potential habitat availability and connectivity for less mobile fauna such as lizards.

(l) The effectiveness of habitat creation for lizards remains largely unknown (although some initial work with rock stacks have been successful for New Zealand lizards; see Lennon 2019, Lennon *et al.* 2021, and Herbert *et al.* in prep). However, practical and scalable solutions are required to address habitat losses for lizards.

(m) Effects management (through avoidance, mitigation and compensatory measures) for lizards will require a scientific research element, where the outcomes of management activities are investigated (i.e., monitored and reported) (Herbert 2020). This is required to address the current unknowns in effects management solutions. This scientific research work should be undertaken in partnership by scientists and ecological practitioners, and include opportunities for kaitiaki and iwi-affiliated scientists or students.

(n) An adaptive management element will need to be included in lizard management planning where outcome monitoring indicates failure to address the adverse effects on lizards. Adaptive management will involve measures that address the failure(s) and be able to demonstrate an eventual successful outcome through monitoring/ scientific research.

117. A Wildlife Act Authority is required from the Department of Conservation in order to undertake any works that affect lizard populations, including both impact and mitigation activities. A LMP within a wider EMP will be required for securing the required Wildlife Act Authority.

118. The LMP/EMP should focus on protecting ornate skink populations, including avoidance of sites where the species is known along with management measures potentially implemented at Waiopehu Bush Reserve; and also establishing new habitat for northern grass skink to offset habitat losses for that species. Design guidance could involve avoidance of impacts on Properties #42, 479, and 465. These activities combined will assist in

avoidance, mitigation and compensation of adverse impacts on ornate skink and northern grass skink populations.

119. Currently there is little knowledge of how lizards respond to mitigation as a result of roading projects. Population monitoring should be undertaken to determine whether mitigation activities, such as habitat enhancement, implemented through the management plan has been effective for lizards (Herbert 2020). Science-based research would contribute to the development of both adaptive management for the Project and would also inform future road transport projects.

Table 4: Habitat types, description of lizard habitat values, and assigned habitat value for lizards.

Habitat Type	Vegetation Type	Code	Property ID	Description of Lizard Habitat Values	Assigned Value
Indigenous forest	Tawa forest	ITF1	87, 163, 287	• Ornate skink and northern grass skink present at #287. • Potential habitat for arboreal geckos and terrestrial skinks. • Good quality habitat comprising complex groundcover and vegetation, including dense leaf-litter and debris that provides high value habitats. These provide high quality shelter and food resources for lizards.	High
	Tawa-kohekohe Forest	ITF2	38, 42	• Potential for arboreal geckos and terrestrial skinks. • Good quality habitat comprising complex groundcover and vegetation, including dense leaf-litter and debris that provides high value habitats. These provide high quality shelter and food resources for lizards.	High
	Kohekohe-tītoki-karamū-large bindweed forest	ITF3	151	• Potential habitat for arboreal geckos and terrestrial skinks.	High
	Māhoe forest and scrub Planted indigenous forest	ITF4, ITF5, ITF6	40, 39, 167, 493	• Planted indigenous forest and scrub is unlikely to provide high value habitat for arboreal geckos, but terrestrial skinks may be present.	Low – High
	Tītoki forest	ITF7	465	• Potential habitat for arboreal geckos and terrestrial skinks.	High
Indigenous treeland	(all)	ITT1 – ITT7	207, 55, 465, 61, 42, 91, 307, 459	• Arboreal geckos unlikely to be present (arboreal lizards struggle to persist in open treeland), but terrestrial skinks may occur at site if areas of rough grassland are present.	Low - Moderate
Indigenous scrub	(all)	ITS1	207, 455, 459, 461, 472, 473 and 493	• Arboreal geckos and terrestrial skinks may be present. • Potential areas of complex groundcover including dense leaf-litter, debris and vegetation that may provide shelter and food resources for lizards.	High
Indigenous fernland	Kiokio fernland	ITFn01	19	• Terrestrial skinks likely present • *Blechnum* spp. ferns are known to provide shelter and food resources for lizards.	Moderate - High
Mixed indigenous-exotic forest	False acacia-tītoki-cherry forest Tītoki-karaka forest Tītoki-false acacia-poataniwha-karaka forest	MTF3, MTF6, MTF7, MTF8	465, 479	• Ornate skink present. • Potential areas of complex groundcover including dense leaf-litter, debris and vegetation that may provide shelter and food resources for lizards.	High
Mixed indigenous-exotic forest	(other)	MTF1, MTF2, MTF5, MTF6	212, 207, 20, 151, 472,19, 40, 42, 47, 52, 307, 311, 326, 473, 484, 488	• Arboreal geckos may be present in some habitat types (e.g., MFT1 containing māhoe and *Muehlenbeckia* forest and scrub on Property #212). • Terrestrial skinks may be present in most areas of mixed exotic forest or scrub.	Low - High
Mixed indigenous-exotic scrub	(all)	MTS1 - MTS4,			
Crack willow forest and scrub.	Crack willow forest/scrub Crack willow-brush wattle-tree lucerne scrub	ETF1, ETS1	19, 151, 158, 209, 212, 459, 659	• Riparian vegetation exposed to periodic flooding (as evidenced by flooding debris) is unlikely to be colonised by lizards.	Negligible
Exotic Forest	Sweet cherry forest Redwood forest False acacia-karaka forest Macrocarpa-radiata pine-false acacia forest	ETF5, ETF6, ETF7, ETF8	465, 479	• Ornate skink present.	High
Exotic forest (other)	Eucalyptus forest Radiata pine forest Exotic treeland and forest	ETF2, ETF3, ETF4	167, 158, 207, 209, 221, 472, 493, 9, 12, 14, 19, 21, 28, 29, 30, 31, 33, 43, 53, 57, 88, 91, 125, 132, 264, 273, 282, 286, 330, 337, 342, 349, 360, 363, 418, 421, 470, 472, 473, 485, 490, 493, 498, 499, 519, 535, 544, 550, 555, 586, 599, 134/144	• Exotic forest at these properties is unlikely to support a diverse range of lizards. • Arboreal geckos unlikely. Terrestrial skinks are possible if rough grassland is present in treeland. • Lizards occasionally recorded in pine forest, and most often northern grass skink, ngahere gecko and barking gecko. Northern grass skink is the most likely species to occur within the Project footprint. • Lizards may be present within exotic forest if there is some connectivity to indigenous forest and large areas of decaying woody debris. • Surveys are needed to confirm habitat connectivity and/or the presence of grassland at each site.	Negligible-Low
Exotic scrub and shrubland dominated by gorse	Gorse scrub Gorse-pampas shrubland	ETS2, ETS3	209, 212	• Northern grass skink can occur in moderate numbers in gorse scrub and shrubland.	Low

Habitat Type	Vegetation Type	Code	Property ID	Description of Lizard Habitat Values	Assigned Value
Wetland habitats	Indigenous wetland Mixed indigenous wetland Exotic wetland	IWF1, IWF2, IWRe1, IWSe1, IWSe1-SPG, IWSe2, IWSe3, IWSe4, IWSe5, IWSe6, MWSe1-SPG, MWG1, MWG1d, MWG2, MWSe2, MWSe3, MWV1	19, 21, 493, 47, 207, 519, 455, 461, 38, 52, 472, 134/144, 207, 461, 132, 164, 166, 577, 605	• Wetland habitats do not usually provide high value habitat for lizard species as they are often too wet. However, there are some exceptions. • Bracken-whekī fernland (IWF1 at Property #21) or kiokio fernland (MWFn1 at Properties #19 and 21) may provide habitat for terrestrial skinks. • Northern grass skink, ornate skink and copper skink can be recorded in very high densities in Yorkshire fog or kikuyu grassland, where such habitat is present. Yorkshire fog or kikuyu is included in the following wetland codes: MWFn1, MWG2, MWH1 on Properties #19, 21, and 207. • If ornate skink, copper skink or glossy brown skink are discovered at any of these habitat types in abundance, the value of these habitats should be revised to High.	Negligible-Moderate
Pasture and cropping	Cropping pasture	ETP	Throughout	• No cover/shelter available for lizards in intensively grazed farmland, unless debris present.	Negligible
	Rank grassland	ETG1	151, 158, 162, 212, 367, 479	• Ornate skink found within kikuyu grassland in ETG1 at Property #479. • Terrestrial skinks occur throughout; not just listed properties but any small locations along the entire Project's designation corridor (e.g., ETP). Northern grass skink found in rank grassland at #367.	High
Open water		OW		• Lizards not present in open water	Negligible
Gravelfield		TG1	151, 158, 209	• Lizards not present due to frequent flooding.	Negligible
Exotic vineland	Blackberry vineland	ETV1	19, 21, 25, 119, 207, 212, 459, 461, 472, 493	• Possible northern grass skink populations present.	Low
House, gardens and farm buildings		EHG	14, 15, 19, 20, 21, 25, 29, 33, 40, 41, 42, 47, 53, 57, 58, 61, 64, 70, 88, 91, 99, 104, 137, 139, 143, 153, 158, 182, 185, 190, 197, 203, 207, 249, 253, 271, 272, 273, 297, 298, 304, 307, 311, 316, 326, 328, 330, 337, 342, 345, 346, 349, 355, 360, 363, 374, 387, 392, 394 , 403, 404, 416, 418, 420, 428, 430, 435, 441, 443, 444, 446, 448, 453, 463, 465, 480, 481, 485, 490, 493, 494, 495, 504, 506, 513, 514, 519, 531, 535, 555, 561, 566, 570, 577, 582, 586, 590, 592, 594, 596, 598, 599, 602, 604, 605, 619, 643	• Likely to be a significant source of lizards if a salvage programme is implemented. Likely to recover ornate skink, northern grass skink and possibly copper skink and glossy brown skink. EHG makes up a relatively significant proportion of the Project's designation corridor (19.16 hectares).	Moderate - High
Road and Rail		RRR	14, 52, 53, 55, 203, 207, 209, 403, 404, 405, 411, 413, 416, 418, 419, 420, 421, 425, 428, 430, 453, 594, 600, 605	• Lizards often present in river/road/rail verges, especially northern grass skink, which is likely to be present in moderate numbers • One record of ornate skink found on roadside at Kimberley.	Moderate
Quarry		QRY	209	• Lizards present in retired/inactive parts of quarry, particularly northern grass skink. Unidentified skink seen during day survey.	Low – Moderate

Table 5: Ecological value assessment for lizards known present, or potentially present, within the Project's designation corridor and local area (as per Roper-Lindsay et al. 2018). In this table, species are ordered first by geckos and skinks, then by their scientific name.

Species	Determining Factors	Assigned Value	Presence
Ngahere gecko (*Mokopirirakau* "southern North Island")	At Risk – Declining (Hitchmough *et al*. 2021). Strict legal protection (Wildlife Act 1953).	High	Presence unlikely
Barking gecko (*Naultinus punctatus*)	At Risk – Declining (Hitchmough *et al*. 2021). Nationally and locally uncommon lizard species. Strict legal protection (Wildlife Act 1953).	High	Presence unlikely
Raukawa gecko (*Woodworthia maculata*)	Not Threatened (Hitchmough *et al*. 2021). Nationally and locally common lizard species. Strict legal protection (Wildlife Act 1953).	Moderate	Presence unlikely
Copper skink (*Oligosoma aeneum*)	At Risk – Declining (Hitchmough *et al*. 2021). Regionally Critical (Crisp *et al*. 2020) Major documented decline of >70% in Wellington (Hoare *et al.* 2007). Strict legal protection (Wildlife Act 1953).	High	Presence highly probable
Ornate skink (*Oligosoma ornatum*)	At Risk – Declining (Hitchmough *et al*. 2021). Nationally and locally uncommon lizard species. Strict legal protection (Wildlife Act 1953).	High	Presence confirmed
Northern grass skink (*Oligosoma polychroma*)	Not Threatened Nationally and locally common lizard species. Strict legal protection (Wildlife Act 1953).	Moderate	Presence confirmed
Glossy brown skink (*Oligosoma zelandicum*)	At Risk – Declining (Hitchmough *et al*. 2021). Nationally and locally uncommon lizard species. Strict legal protection (Wildlife Act 1953).	High	Presence highly probable

Table 6a: Ecological values, adverse effects, minimisation measures, magnitude of effect, and level of effect before and after effects management for ornate skink affected by the Ō2NL Project.

Lizard Species	Ecological Value	Impacts (including cumulative effects, excluding habitat loss)	Magnitude of Effect in absence of effects management	Level of Effect in absence of effects management	Avoidance, Mitigation and Compensation Measures	Magnitude of Effect (after Avoidance, Mitigation and Compensation)	Level of Effect (after Avoidance, Mitigation and Compensation)
Species							
Ornate skink *Oligosoma ornatum*	High	Direct injuries and/or mortality of ornate skinks during vegetation clearance.	High	Very high	All indigenous forest remnants have been avoided within the proposed alignment (avoidance). Lizard Management Plan including search and rescue methods and relocation of ornate skinks (mitigation). It will not be possible to capture and relocate all skinks present within the Project designation, as skinks can be elusive (i.e., some residual effects still remain even after avoidance and mitigation). Release of rescued ornate skink into a predator-free sanctuary potentially established at Waiopehu Bush Reserve (mitigation and compensation).	Moderate	Moderate

Lizard Species	Ecological Value	Impacts (including cumulative effects, excluding habitat loss)	Magnitude of Effect in absence of effects management	Level of Effect in absence of effects management	Avoidance, Mitigation and Compensation Measures	Magnitude of Effect (after Avoidance, Mitigation and Compensation)	Level of Effect (after Avoidance, Mitigation and Compensation)
		Reduction of habitat connectivity through fragmentation and introduction of new barriers (i.e., road) that may cause habitat and thus population isolation.	High	Very high	Revegetation to expand size of Arapaepae forest remnant within the project designation, extending the habitat for the ornate skink populations there. Where possible, connecting forest remnants to establish dispersal pathways through an ecological restoration programme. Road and bridge design should allow for creation of new lizard habitat through an ecological restoration programme. It will not be possible to fully address the new permanent barrier for ornate skink that will be formed by the road (i.e., residual effects remain).	Moderate	Moderate
		Creation of edge effects such as modifying the microclimates within created edge habitats.	High	Very high	Establish indigenous vegetation buffers through an ecological restoration programme.	Low	Low
		Increased presence of and likelihood of invasion by non-native plant and animal species.	High	Very high	Pest plant and animal control should be carried out in lizard habitats, particularly in relocation site(s) or compensation site (e.g., Waiopehu Bush Reserve). Establishment of a predator-free sanctuary at Waiopehu is likely to lead to a net gain for ornate skink (both released and resident populations) through measurable population growth in time (see Nelson *et al.* 2016). A sanctuary is proposed to be the main Project effects management action for ornate skink overall (this should address the residual effects that remain after all minimisation actions taken).	Low	Low-Very Low
		Temporary and ongoing disturbance could result in changes to home range, movement, reproduction and physical state from noise, lighting, vibration, dust, and changes to microclimate from factors such as increased temperatures and air pollutants near roads.	High	Very high	Implement dust suppression measures, buffer forest remnants, and incorporate lizard habitat in landscape design.	Moderate	Low
		Direct mortality or injury on roads.	Negligible	Negligible	Unlikely to cross roads. No minimisation required	Negligible	Negligible

Table 6b: Ecological values, adverse effects, minimisation measures, magnitude of effect, and level of effect before and after effects management for northern grass skink affected by the Ō2NL Project.

Lizard Species	Ecological Value	Impacts (including cumulative effects, excluding habitat loss)	Magnitude of Effect in absence of effects management	Level of Effect in absence of effects management	Avoidance, Mitigation and Compensation Measures	Magnitude of Effect (after Avoidance, Mitigation and Compensation)	Level of Effect (after Avoidance, Mitigation and Compensation)
Species							
Northern grass skink *Oligosoma polychroma*	Low	Direct injuries and/or mortality of northern grass skinks during vegetation clearance.	High	Low	Lizard Management Plan including search and rescue methods and relocation of northern grass skinks (mitigation). It will not be possible to capture and relocate all skinks present within the Project designation, as skinks can be elusive (i.e., some residual effects still remain even after avoidance and mitigation). Release of affected northern grass skink into a suitable release site.	Moderate	Low-Very Low
		Reduction of habitat connectivity through fragmentation and introduction of new barriers (i.e., road) that may cause habitat/ population isolation.	High	Low	Creation of new lizard habitat along road and bridges throughout the Project through an ecological restoration programme. It will not be possible to fully address the new permanent barrier for northern grass skink that will be formed by the road (i.e., residual effects remain). However, significant roadside habitat can be created instead.	Moderate	Moderate-Low
		Creation of edge effects such as modifying the microclimates within created edge habitats.	Low	Very low	Establish indigenous vegetation to buffer through ecological restoration programme.	Low	Low
		Increased presence of and likelihood of invasion by non-native plant and animal species.	High	Low	Pest plant and animal control should be carried out in lizard habitats, particularly in relocation site(s).	Low	Low
		Temporary and ongoing disturbance could result in changes to home range, movement, reproduction and physical state from noise, lighting, vibration, dust, and changes to microclimate from factors such as increased temperatures and air pollutants near roads.	High	Low	Implement dust suppression measures, buffer forest remnants, and incorporate lizard habitat in landscape design.	Moderate	Low
		Direct mortality or injury on roads.	Negligible	Negligible	Unlikely to cross roads. No minimisation required	Negligible	Negligible

CONCLUSION AND RECOMMENDATIONS

120. The Ō2NL Project lizard fauna is characterised by low diversity and abundance of lizards. This is due to the highly degraded environment that likely contain high numbers of predatory mammals and birds.

121. To date, one At Risk lizard species has been confirmed as present within the Project’s designation corridor: the terrestrial ornate skink. It is likely to be present in moderate to low abundances within habitat remnants that will be impacted by the Project. The northern grass skink has also been found at one site within the Project footprint, and is likely to be present at other sites. It is usually the more abundant skink species, however, surprisingly, more ornate skinks have been recorded in Project investigations to date. Of the two, it is possible that ornate skinks were historically the more widespread species locally as a result of historical ecosystem patterns in the region (Ravine, 1995). Ornate skinks occupy both indigenous forests and open but humid habitat types, while northern grass skink require open, dry habitats receiving high solar radiation. The ornate skink populations seen today will be small remnants of a previously widespread and abundant population that occurred historically throughout the landscape. Habitat losses and introduced mammalian and avian predators have likely resulted in a marked and serious decline in the species across the landscape. Intensive land clearance, agriculture and horticulture pressures may have suppressed the potential for northern grass skinks to colonise and establish more widely in the open habitats that are now present. Northern grass skink is considered more resilient than ornate skinks to the presence of predatory mammals, and can be abundant elsewhere in open, sunny grassland or shrubland habitat types, especially where there are highly protective habitat elements present, such as rock fields.

122. It is possible that other terrestrial species - copper skink, and glossy brown skinks - are also present. Management should account for the potential presence of these species and respond accordingly, through a discovery protocol and associated mitigation measures. Copper skink and glossy brown skinks could potentially be supported through measures proposed for ornate skinks.

123. These species are likely or probable in indigenous forest (IF), indigenous shrublands (IS), indigenous fernland (IFn), indigenous vineland (IV), exotic grassland (EG), and houses and gardens (EHG). Skinks may also be present at less disturbed edges of the quarry (QRY), where there is a mixed exotic

cover over loose rock, or along habitat edges throughout areas of road/river/rail (RRR).

124. Despite the normally high ecological value attributed to indigenous forest (IF), indigenous shrublands (IS), indigenous fernland (IFn), and indigenous vineland (IV) habitat types due to their potential to support lizards, it is unlikely that arboreal geckos - barking gecko, ngahere gecko and Raukawa gecko - are present in these habitats. This is because these habitats are typically small and very isolated, and not conducive to supporting local populations of these geckos. The one IF site directly impacted by the Project through clearance is a planted isolate at Property #40, and no geckos were detected at that particular location.

125. The highest value sites currently known for lizards are Properties #42, 287, 479, and 465. Note that #287 is outside the Project's designation corridor However, lizards are likely to be present throughout the Project's designation corridor in other habitat types, particularly rank grassland habitat (EG) patches and in gardens (EHG).

126. Rank grassland (EG), and tradescantia in indigenous (IF), mixed forest (MF) and gardens (EHG) should not be undervalued as ecological habitats, as they can be important habitat for lizards, especially in highly developed landscapes.

127. A Wildlife Act Authority and a Lizard Management Plan will be required for the Project.

128. A best practice mitigation programme delivered through a Lizard Management Plan for the Project is likely to result in a net gain for lizards, through a combination of avoidance, mitigation and compensatory mechanisms. There is a potential opportunity to establish a sanctuary at Waiopehu Bush Reserve that would benefit ornate skink (both through mitigation relocation and compensation) – as well as ngata (snails), along with creation of new lizard habitat for northern grass skink through ecological restoration. This work should be supported by robust monitoring programme to infer and report actual outcomes.

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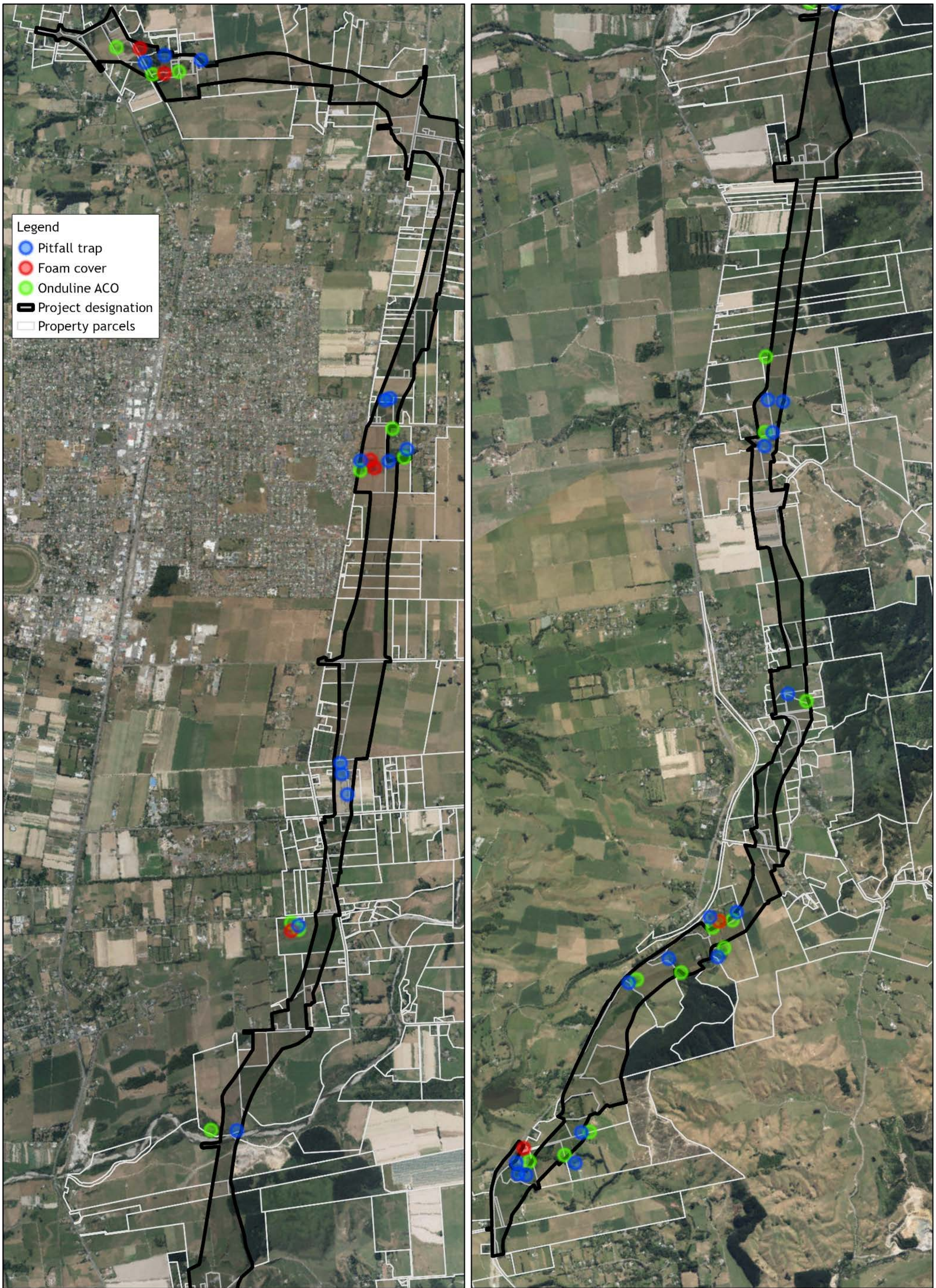
MAP OF SURVEY LOCATIONS FOR LIZARDS



Data Acknowledgment

Report: 5578
Ref: 05 0482
Client: -
Name: OtakiMotorway.aprx
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Figure 1: Lizard survey sites showing locations of pitfall traps, Onduline ACOs and closed-cell foam covers

0 500 1,000 2,000 m

Wildlands
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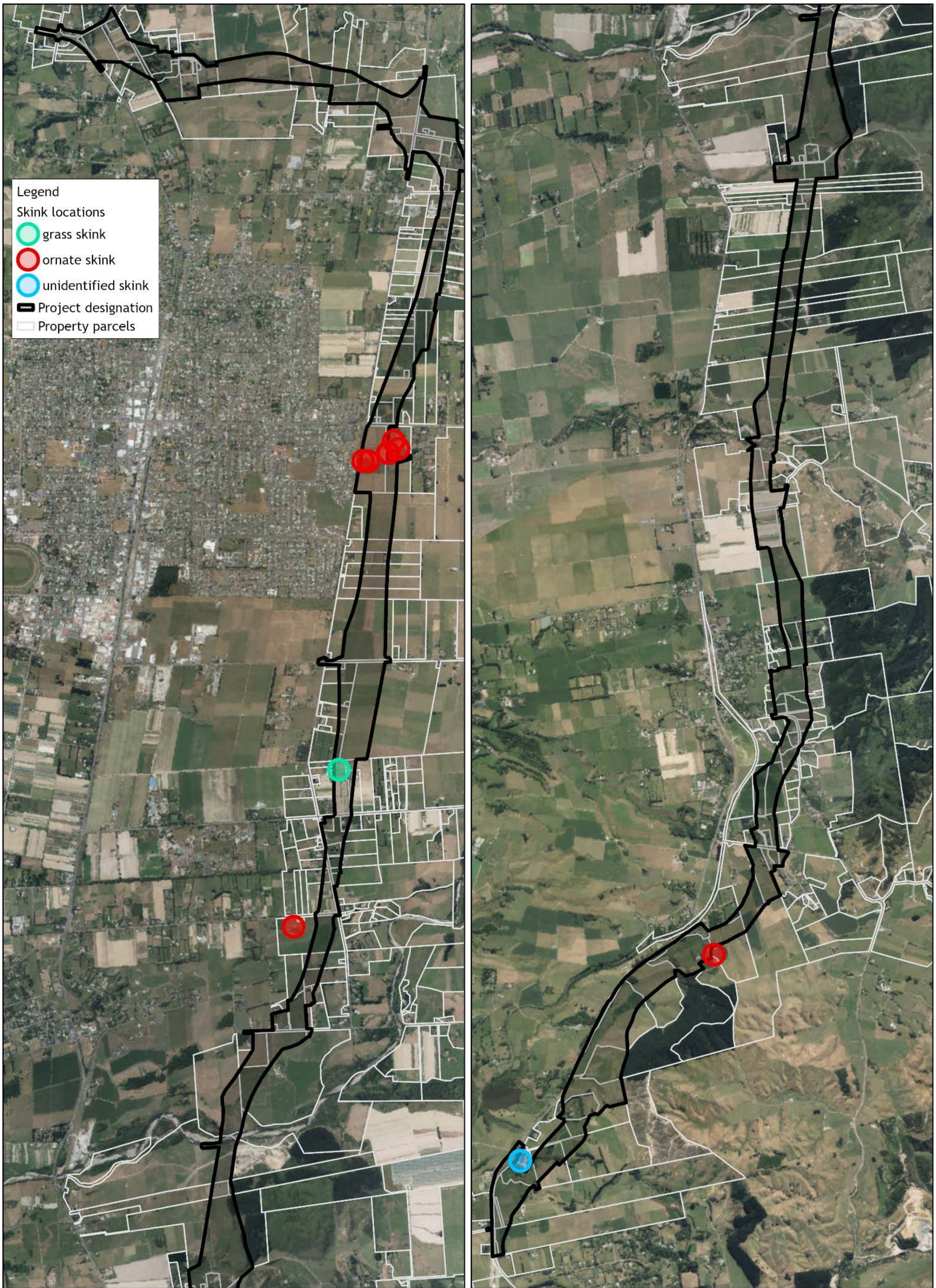
Scale: 1:30,000
Date: 14/03/2022
Cartographer: TP
Format: A3



Data Acknowledgment

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Report: 5578
Ref: 05 0482
Client: -
Name: OtakiMotorway.aprx
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Figure 2. Location of Properties 465 and 479, and ornate skinks found, adjacent to the O2NL Project's designation

0 500 1,000 2,000 m

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Scale: 1:30,000
Date: 3/18/2022
Cartographer: TP
Format: A3

SUMMARY DATA

Table 8: Summary of properties and search effort for lizards between March 2021- March 2022.

Property ID	Survey dates	Survey effort	Results
19, 20, 21, 28, 30, 37, 38, 40, 42, 43, 87, 114, 119, 151, 158, 162, 163, 209, 212, 287, 367, 461, 465, 470, 473, 479, 493, 499, and 501.	22-24 March 2021 (spotlighting); 15-19 April 2021 (pitfall traps); 21-25 February 2022 (pitfall traps); 22 February (spotlighting); November and December 2021 and January, February, March 2022 (ACOs/CFCs)	18 person hours spotlighting (March 2021), four person hours spotlighting (February 2022); 30 person hours spot day searching (March-April 2021, but also undertaken throughout up to March 2022); 4× checks of pitfall traps (588 trap nights, April 2021); 4× checks of pitfall traps (780 trap nights, February 2022); 192 ACOs and 56 CFCs checked (576 ACO checks and 168 cover checks, respectively November 2021-March 2022).	Six ornate skinks at Properties #42, 465 and 479. Northern grass skink at Property #367. Unidentified skink seen at Property #209, most likely northern grass skink.

Table 9: Summary of lizard species that could be present in the project area based on records in the Department of Conservation BioWeb Herpetofauna Database and iNaturalist website.

Species	Common Name	Conservation Status	Habitat Preference	Ecological Value of Species (as per EIANZ guidelines)
Oligosoma ornatum	Ornate skink	At Risk – Declining	Rank grassland, such as kikuyu, terrestrial cover objects, damp leaf-litter and understory vegetation such as tradescantia.	Moderate
Oligosoma polychroma	Northern grass skink	Not Threatened	Rank grassland, including kikuyu	Low

Table 10: Summary of properties and ecological value for lizards.

Property ID	Habitat Type	Ecological Value
42	Tawa-kohekohe forest	High
209	Quarry	Low
367	Rank grassland	High
465	Tītoki-false acacia forest	High
479	False acacia – indigenous forest, kikuyu grassland	High

Table 11: Lizard species identified during field surveys.

Common Name	Scientific Name	Threat Classification	Status
Ornate skink	*Oligosoma ornatum*	At Risk - Declining	Indigenous
Northern grass skink	*Oligosoma polychroma*	Not Threatened	Indigenous

APPENDIX J.7

TECHNICAL ASSESSMENT FOR EFFECTS ON TERRESTRIAL INVERTEBRATES FOR THE Ō2NL PROJECT AREA

IN THE MATTER OF	the Resource Management Act 1991
AND	
IN THE MATTER OF	applications for resource consents and notices of requirement in relation to the Ōtaki to North of Levin Project
BY	**WAKA KOTAHI NZ TRANSPORT AGENCY** Applicant

ŌTAKI TO NORTH OF LEVIN: TECHNICAL ASSESSMENT OF EFFECTS ON TERRESTRIAL INVERTEBRATES

TABLE OF CONTENTS

EXECUTIVE SUMMARY

1. This report provides an assessment of potential effects of the Ōtaki to North of Levin Project (the Ō2NL Project) on terrestrial invertebrates to inform the notice of requirement and resource consent applications for the Project.

2. A desktop invertebrate assessment showed that several species and their habitats may be present within the Project Area, including species classified as Threatened or At Risk under the Department of Conservation's New Zealand Threat Classification System.

3. Following the desktop assessment, a terrestrial invertebrate survey was carried out in selected properties and habitat types within the Project Area. Two notable species were recorded: peripatus (*Peripatoides novaezeelandiae*) and *Wainuia urnula*, a land snail.

4. Notable species that may be present but were not recorded during the survey included *Powelliphanta* spp. (*P. traversi florida, P. traversi otakia*, and *P. traversi traversi*), the spiny longhorn beetle (*Blosyropus spinosus*) and the New Zealand mantis (*Orthodera novaezealandiae*). Further species are likely to be recorded during lizard surveys that will be completed in Spring 2021. Associated habitats that will be impacted include remnant indigenous tawa (*Beilschmiedia tawa*) and tītoki (*Alectryon excelsus* subsp. *excelsus*) forest as well as exotic vegetation such as crack willow (*Salix* ×*fragilis*) forest.

5. Ecological values have been assigned to all of the notable taxa identified in the desktop assessment and survey using the Ecological Impact Assessment Guidelines (EcIAG) prepared by the Environment Institute of Australia and New Zealand (EIANZ). The habitats on the site have also been assigned a value using the EcIAG methodology based on value to terrestrial invertebrate species. All species found during the targeted surveys, as well as those which have been recorded previously within the Project Area, have been conservatively assessed as being present.

6. A conservative effects assessment has been undertaken based on the terrestrial species confirmed and likely to be present. The overall level of effect of the Project on potentially present Threatened or At Risk terrestrial invertebrates, and on the terrestrial invertebrate habitat values, is assessed as being Low to Moderate.

7. Based on the presence and/or presumed presence of Threatened or At Risk terrestrial invertebrates, a number of minimisation and effects avoidance measures are proposed.

8. Most of the areas of remnant indigenous forest, which provide high value habitat for terrestrial invertebrate species, are avoided by the proposed Project alignment. The avoidance and minimisation measures described in this assessment, and the offsets being developed (i.e., habitat restoration) will appropriately address the potential effects of the Project on indigenous terrestrial invertebrates.

INTRODUCTION

9. My name is Brian Hunter Patrick. I have prepared this technical assessment with support from Blair Balsom (Senior Ecologist, Wildland Consultants, Auckland). This technical assessment addresses terrestrial invertebrate surveys undertaken for the Ō2NL Project.

QUALIFICATIONS AND EXPERIENCE

10. I have the following qualifications and experience relevant to this assessment:

    (a) I am a Senior Entomologist and Ecologist with Wildland Consultants Ltd (Wildlands) and I am based in Christchurch. I have been in this position since October 2011.

    (b) I have been a practising scientist (Ecologist and Entomologist) since 1988 and have lectured in entomology and ecology at Otago University. I am essentially self-taught in entomology. I previously worked for the Department of Conservation as a Conservancy Advisory Scientist for Otago and Southland Conservancies, based in Dunedin (1988-1996); Collections and Research Manager at Otago Museum, Dunedin (1996-2006); and Director of Central Stories Museum in Alexandra (2006-2011).

    (c) I specialise in various aspects of entomology and insect-plant relationships including taxonomy, life-histories, biogeography, conservation, and biosecurity. While the Order Lepidoptera (butterflies and moths) is my main speciality, I also have experience with 14 Orders of insect.

(d) My professional memberships include the Entomological Society of New Zealand for which I served as national President from 2000-2002; Moths and Butterflies of New Zealand Trust, for which I currently serve as Scientific Advisor; New Zealand Botanical Society; Dunedin Naturalists' Field Club; Orokonui Eco-Sanctuary; and the Canterbury Botanical Society. I am a past Trustee of the Rod Donald Trust (Christchurch City Council) and former member of the Otago Conservation Board.

(e) Since 1970 I have maintained a diary of over 4,200 expeditions throughout New Zealand. These diaries document the invertebrates and flora, particularly the moths and butterflies, recorded during these trips.

(f) I am author of over 340 scientific publications including eight popular books, four book chapters, articles in scientific journals and popular magazines, and non-published reports. I regularly give public presentations on natural history to local groups including schools, and lead field trips to local areas of interest.

(g) Three of my popular book publications have specifically addressed New Zealand's butterflies including the most recent *Butterflies of the South Pacific* published by the University of Otago Press in 2012. In relation to the butterflies of New Zealand it included descriptions, illustrations, life history, distribution, and threat status and conservation of the forest ringlet butterfly.

(h) I am a member of the Department of Conservation's expert panel on moths and butterflies of conservation interest, and co-author of the regularly updated publication that summarises the conservation status of indigenous Lepidoptera (Hoare *et al.* 2017).

Code of conduct

11. I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2014. This assessment has been prepared in compliance with that Code, as if it were evidence being given in Environment Court proceedings. In particular, unless I state otherwise, this assessment is within my area of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

PURPOSE AND SCOPE OF ASSESSMENT

12. The purpose of this assessment was to determine the presence of threatened terrestrial invertebrate species within the Ō2NL Project footprint, and describe the potential effects of the Project on these species to inform the resource consent applications.

13. The scope of the assessment was to:

    (a) Compile and review existing information regarding notable (i.e., Threatened or At Risk) invertebrate species and their habitats potentially occur within the Project Area. All potential habitats were identified including forests and riparian margins.

    (b) Review relevant literature, such as Department of Conservation's Protected Natural Areas Programme (PNAP)'s Manawatū Plains Ecological District report (Ravine 1995).

    (c) Carry out invertebrate surveys using a range of methods. The surveys specifically targeted threatened species and/or their habitats.

    (d) Provide an assessment of the potential adverse effects of the Project on indigenous terrestrial invertebrates.

    (e) Outline management measures proposed to avoid and/or minimise potential impacts on indigenous terrestrial invertebrates.

14. Engagement with iwi and stakeholders is described in Technical Assessment J – Terrestrial Ecology.

ASSUMPTIONS AND EXCLUSIONS IN THIS ASSESSMENT

15. This assessment addresses the effects on terrestrial invertebrates anticipated from the Project as provided in the Project plans (provided in Volume III of the application) and summarised in the Design Construction Report (DCR).

16. Invertebrate habitat values are incorporated into the vegetation and habitat values described in Technical Assessment J. As such, the assessment of the level of effect associated with vegetation loss will also account for the loss of these habitat values, and is appropriately covered in the report. While habitat values within the Project Area are described below, effects associated with habitat loss are not discussed further in this report.

17. Where threatened indigenous invertebrates have been previously found at specific locations, but were not recorded during our targeted surveys, they have been assumed to be present.

PROJECT DESCRIPTION

18. The Design and Construction Report provides a description of the Ō2NL Project. The components of the Project particularly relevant to terrestrial invertebrates are:

    (a) The earthworks, vegetation clearance and landform modifications required to construct the highway.

    (b) The construction and operational activities that could have adverse effects on terrestrial invertebrates and their habitats, including road lighting and the potential for vehicle collisions.

EXISTING ENVIRONMENT

Overview

19. The proposed Ō2NL Project is located almost entirely in the southern part of the Manawatū Plains Ecological District, in the Manawatū Ecological Region. A small section of the proposed route, near Manakau, lies within the western edge of the Tararua Ecological District.

20. The southern parts of the Manawatū Plains Ecological District lie between the coastal sands of the Foxton Ecological District to the west and the ranges of the Manawatū Gorge South and Tararua Ecological Districts to the east. Detailed descriptions of the Manawatū Plains and Tararua Ecological Districts are provided in Technical Assessment J. The landscape within the Project Area comprises a mosaic of agricultural land, fragments of indigenous and exotic forest, shelterbelts and riparian corridors.

21. Grazed agricultural grasslands provide very little value to indigenous invertebrate species. However, indigenous forest remnants are likely to provide high value habitats for a range of different invertebrate taxa including indigenous land snails, Coleoptera and peripatus species.

22. Riparian corridors within the alignment are likely to provide a moist understory that is suitable for a range of taxa including indigenous land snails.

23. Shrublands and/or treeland that contain open areas within the proposed route of the Project are likely to provide habitat for the indigenous New Zealand mantis (Ramsay 1990).

24. Tree daisies (*Olearia* spp.) recorded within the Manawatu Ecological District (Ravine 1995) support many species of Threatened and At Risk Lepidoptera (Hoare *et al.* 2017, Patrick 2000).

25. Green mistletoe (*Ileostylus micranthus*) recorded within the Manawatu Ecological District (Ravine, 1995) support a number of host-specific Lepidoptera (Hoare *et al.* 2017, Patrick and Dugdale 1997).

METHODOLOGY

Introduction

26. I have adopted a best practice approach to my assessment of ecological effects on the basis that:

    (a) My assessment broadly follows the EIANZ EcIAG (Roper-Lindsay *et al*. 2018). The EcIAG provides a systematic approach to assessing ecological effects.

    (b) Where threatened indigenous invertebrates have been previously found but were not recorded during our targeted surveys, they have been assumed to be present.

    (c) Where site surveys could not be carried out (due to time constraints and/or land owner permission delays), invertebrate values were informed by the detailed vegetation and habitat assessments described in Technical Assessment J (if carried out after the invertebrate survey period), or interpretation of aerial imagery.

Desktop review

27. A desktop review was undertaken to identify existing background information regarding invertebrate species presence, distribution and abundance from within or near the Project footprint. Sources of information include:

    (a) Ecological reports, particularly the PNAP survey for the Manawatū Plains Ecological District (Ravine 1995) and the Department of Conservation recovery plans for indigenous invertebrates (Walker 2003, Stringer and Hitchmough 2012, McGuinness 2001).

(b) A review of plant species within the Project Area to identify key species that have host-specific Lepidoptera and/or support significant numbers of endemic species.

(c) iNaturalist (www.inaturalist.nz, accessed March 2021) is a website that contains indigenous and exotic species records including indigenous Threatened and At Risk species. The iNaturalist database is maintained by the Californian Academy of Sciences and National Geographic.

(d) New Zealand Mollusca (www.mollusca.co.nz, accessed March 2021) is a website that contains records and distribution data for mollusc species throughout New Zealand.

Site surveys

28. The project construction footprint was assessed using Google Earth imagery to identify all properties that may contain high value terrestrial invertebrate habitats (whether indigenous or exotic). By doing so, a total of 13 properties were identified for survey (Table 1). Properties were assessed based on:

(a) Indigenous forest (predominantly remnant).

(b) Riparian vegetation.

(c) Previous records of indigenous snails.

29. Site surveys were undertaken between 22 and 26 March 2021 (inclusive) to determine the presence and composition of terrestrial invertebrate fauna. Surveys were undertaken during fine and calm weather. Survey locations are mapped in Appendix 1.

Table 1: Summary of properties and search effort for terrestrial invertebrates during March 2021.

Property ID	Survey Dates	Lepidoptera Surveys (light trapping, sweep netting, and/or searching for sign)	Hand Searching
20	25/03/2021	Yes	20 minutes
37	23/03/2021	No (no suitable habitat)	30 minutes
38	23/03/2021 26/03/2021	Yes	1 hour 40 minutes
42	23/03/2021 26/03/2021	Yes	3 hours 45 minutes
43	23/03/2021 26/03/2021	Yes	2 hours
158	22/03/2021 24/03/2021	Yes	1 hour 35 minutes
163	25/03/2021	Yes	1 hour
212	22/03/2021	Yes	40 minutes
287	25/03/2021	Yes	1 hour

Property ID	Survey Dates	**Lepidoptera Surveys** (light trapping, sweep netting, and/or searching for sign)	Hand Searching
465	24/03/2021 25/03/2021	Yes	5 hours
479	22/03/2021 24/03/2021 26/03/2021	Yes	2 hours 20 minutes
493	22/03/2021 25/03/2021	Yes	1 hour 5 minutes

30. A combination of surveying techniques was used including hand searching, sweep netting, and light traps:

(a) Hand searching – Included searching through leaf litter and woody material such as fallen logs and old tree stumps, and raking of tradescantia (*Tradescantia fluminensis*) and other ground cover vegetation. Searching also included looking beneath Artificial Cover Objects (ACOs) and Closed Cell Foam Covers (CCFCs) during herpetofauna surveys.

(b) Sweep netting – Involved running a net through areas of vegetation focusing on both known host plant species as well as common plant species to capture both common and Threatened or At Risk insect species from a variety of taxa.

(c) Light trapping – To give the best chance of detecting a range of Lepidoptera species, light trapping was deployed at two locations. These locations were selected based on representativeness. The first site (Property 42) represented intact indigenous forest habitat with a high density of lianes. The second site (Kimberley Reserve) was selected due to the presence of riparian habitats to ensure a diverse range of invertebrate taxa were sampled. A 240v generator-powered 160-Watt UV light was lit over a large white sheet for two hours from dusk. Invertebrates landing on the sheet were captured and identified.

31. Hand searching effort differed on a site-by-site basis and corresponded with available searchable habitat, habitat quality, and records of notable terrestrial invertebrates within each property.

32. Additional lizard monitoring in Spring 2021 will likely result in further invertebrate species records, particularly from ACO occupancy. Additional invertebrate species information will be recorded and added to this report as and when they are identified. ACOs have been installed at all of the above

(Table 1) surveyed sites as well as the below additional properties, which were not surveyed for invertebrates:

(i) 28

(ii) 30

(iii) 38

(iv) 40

(v) 114/119

(vi) 151

(vii) 470

(viii) 473

Application of the EcIAG

33. I have assessed the terrestrial invertebrate values and the ‘Level of Effects’ of the Project on these values using the guidelines provided by the EcIAG (2018). As discussed above, effects associated with habitat loss are addressed in detail in Technical Assessment J, and are therefore not discussed further here. The current report focuses on all other potential effects on terrestrial invertebrates.

34. The EcIAG was prepared to provide direction on the general approach to be adopted when assessing ecological impacts. In brief, the EcIAG approach involves the following steps:

(a) Assigning the ‘Ecological Value’ of the species that is likely to be impacted within the proposed route of the Project and immediate surrounds. The ‘Ecological Value’ of a species is scored on a scale of ‘Negligible’ to ‘Very High’ and is assessed in terms of threat status as described in Table 2.

(b) The 'Magnitude of Effect' from a proposed activity on the environment is assigned after all efforts to avoid, remedy, or minimise potential adverse effects have been implemented. The 'Magnitude of Effect' is a measure of the extent or scale of the effect of an activity and the predicted degree of change that it will cause. The 'Magnitude of Effect' is scored on a scale of 'Negligible' to 'Very High' and is assessed in terms of:

(i) Level of confidence in understanding the expected effect.

(ii) Spatial scale of the effect.

(iii) Duration and timescale of the effect.

(iv) The relative permanence of the effect.

(v) Timing of the effect in respect of key ecological factors.

(c) An overall level of residual effects that cannot be avoided or minimised for each species value is determined using a matrix approach that combines the 'Ecological Values' with the 'Magnitude of Effects' resulting from the activity. The matrix describes an overall 'Level of Effect' on a scale from 'Negligible' to 'Very High'.

35. The level of residual effect that cannot be avoided or minimised is then used to guide the type and quantum of mitigation, offsetting, or compensation measures that are proposed to adequately address residual adverse effects associated with the Project. I note under the Proposed Greater Wellington Regional Plan (Policy 41), where adverse effects on ecosystems or habitats cannot be avoided, more than minor adverse effects should be remedied, and where residual adverse effects remain, the use of biodiversity offsets may be proposed or agreed by the Applicant. Similarly, in the Horizons One Plan (Policy 13-5), consents within significant habitats should not be granted unless any effects that are more than minor are avoided, remedied, mitigated, or offset to result in a net indigenous biodiversity gain.

36. The EcIAG (p. 84) equates ‘not more than minor’ effects to a ‘Very Low’ level of effect, and suggest that ‘Low or Very Low’ levels of effect are not normally of concern. The EcIAG also notes that effects that are of High or Moderate level require further management, including offsetting (where relevant).

Table 2: Factors considered when assigning value to terrestrial invertebrate species.

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

STATUTORY CONSIDERATIONS, INCLUDING NATIONAL STANDARDS, REGIONAL AND DISTRICT PLANS, AND OTHER RELEVANT POLICIES

Resource Management Act 1991

37. Significant habitats of indigenous fauna are to be recognised and provided for as a matter of national importance under section 6(c) of the RMA.

Horizons Regional Council's One Plan

38. Objective 6-1 of the Horizons One Plan for Indigenous Biological Diversity is to:

    (a) Protect areas of significant indigenous vegetation and significant habitats of indigenous fauna and maintain indigenous biological diversity, including enhancement where appropriate.

39. Policy 13-4 states that consent decision making activities are regulated, having regard for significant habitat of indigenous fauna.

40. Under Policy 13-5, consent must not be granted unless:

    (a) Any **more than minor adverse effects** on the habitat's representativeness, rarity, or distinctiveness are avoided.

    (b) Where these effects are not avoided, they are remedied or mitigated.

    (c) Where these effects are not avoided, remedied or mitigated, they are offset to result in a net biological diversity gain.

Greater Wellington Regional Council's Proposed Natural Resources Plan:

41. Indigenous ecosystems and habitats with significant biodiversity values must be maintained and restored to a healthy functioning state (Objective 16) under the Greater Wellington Regional Council's Proposed Natural Resources Plan. In Policy 47 there is a list of effects to be considered when applying for resource consent for works that may affect significant indigenous biodiversity values.

Wildlife Act 1953

42. Within the Wildlife Act (1953) a number of terrestrial invertebrate species are afforded absolute legal protection. This includes all *Powelliphanta* species. It is an offence to kill or have in possession absolutely protected wildlife without

a Wildlife Act Authorisation (also known as a Wildlife Permit) issued by the Department of Conservation.

RESULTS

Desktop assessment

43. The desktop literature review and database search indicated that several Threatened or At Risk terrestrial invertebrate species may be present in the Project Area. Notable species identified are presented in Table 3 below.

<u>Mollusca – land snails</u>

44. Three species of *Powelliphanta* land snail may be present along the proposed route of the Project: *P. traversi florida*, *P. traversi otakia,* and *P. traversi traversi*. *Powelliphanta traversi otakia* is classified as Threatened – Nationally Critical by Walker (2003). *Powelliphanta traversi florida* and *P. traversi traversi* are both classified as Threatened – Nationally Endangered by Walker (2003).

45. *Powelliphanta* are generally associated with forested areas that contain dense moist leaf litter and/or groundcover (Standish *et al.* 2002, and Meads *et al*. 1984).

46. *Powelliphanta traversi traversi* have previously been recorded at three properties within or adjacent to the proposed road alignment (Properties #42 fenced remnant forest off State Highway1, #465 and #479, located off Arapaepae Road South and Queen Street East, respectively).

47. *Wainuia urnula* may also be present within the proposed route of the Project and is currently not classified within the New Zealand Threat Classification System. However, this species is likely to be locally uncommon based on a lack of available habitat within the Project alignment.

48. *Wainuia urnula*, has been recorded within the Wellington and Manawatū Ecological Districts (Efford 1998). At a national level, this species is currently not classified. However, for the purpose of this assessment *Wainuia urnula* has been assigned the threat status of Locally Uncommon.

<u>Coleoptera - beetles</u>

49. There are no specific published lists for Coleoptera within the Manawatū Plains Ecological District.

50. Indigenous forest remnants within and/or adjacent to the proposed route of the Project are likely to provide high value habitat for Coleoptera species.

51. As far as I am aware there are no Coleoptera classified as Threatened or At Risk within the ecological district (Fuller 2013).

52. The spiny longhorn beetle has been recorded within Levin and was previously considered a Category I (indeterminant) species due to a lack of information regarding its distribution (McGuinness, 2001). It is now classified as Not Threatened but is worth noting due to its sparse distribution (McGuinness 2001, Hitchmough *et al*. 2007, and Leschen *et al*. 2012).

53. Remnant tawa forest within the proposed alignment may provide habitat for the spiny longhorn beetle. This species has been recorded within both the Manawatū and Wellington Ecological Districts (iNaturalist observations; McGuinness 2001). For the purposes of this assessment, and on a precautionary basis, the spiny longhorn beetle is considered Locally Uncommon due to a lack of available habitat (decaying tawa, beech (*Fuscopsora* spp.) and *Dracophyllum* spp.) within the proposed route of the Project and the Ecological District.

<u>Mantodea - mantis</u>

54. The New Zealand mantis, classified as At Risk – Declining (Buckley *et al.* 2012), is found throughout the country and has been recorded within the Manawatū Plains Ecological District (iNaturalist observation on 8 March 2019).

<u>Lepidoptera – moths and butterflies</u>

55. There appear to be no published lists of Lepidoptera within the Manawatū Plains Ecological District.

56. Many species of Lepidoptera are host-specific and can therefore be assumed to be present based on the occurrence of host indigenous plant species recorded within the proposed route of the Project.

57. Tree daisies (*Olearia* spp.) recorded within the ecological district (Ravine 1995) support many species of Threatened and At Risk Lepidoptera (Hoare *et al.* 2017). Including *Meterana exquisita* and *M. grandiosa* (both At Risk – Relict).

58. Green mistletoe (*Ileostylus micranthus*) is declining in the Wellington Conservancy (Sawyer and Rebergen 2001) and may be present in the Project Area. Surveys for this species will be undertaken as part of the wider flora surveys that are scheduled for spring 2021. Green mistletoe supports three host-specific moth species (*Declana griseata*, *Tatosoma agrionata*, and the leaf-mining *Zelleria sphenota*), all of which are classified as At Risk – Declining (Hoare *et al.* 2017, Patrick and Dugdale 1997).

59. The Manawatū Plains PNAP (Ravine 1995) report lists many indigenous plants that have a high diversity of host-specific indigenous moth and butterfly species. Species such as tree nettle (*Urtica ferox*) and the square-stemmed small-leaved shrub *Teucrium* sp. may host moths and butterflies that have not been previously recorded in the southern North Island. These previously unrecorded Lepidoptera species may occur within the proposed route of the Project.

<u>Onychophora – peripatus</u>

60. The *Peripatoides* genus includes *Peripatoides novaezealandiae* which is widely distributed throughout New Zealand. However, it is likely a species complex and is currently undergoing a taxonomic revision (Gleeson and Rugberg 2010).

61. *Peripatoides novaezealandiae* has been recorded in the Manawatū Plains Ecological District and is classified as Not Threatened (Trewick *et al.* 2018). Due to the unknown taxonomic status of the populations of this species throughout New Zealand, the effects that the Project could potentially have on this species is difficult to quantify. As such, this species has been included in this assessment as a notable species.

62. Remnant indigenous forest within and/or adjacent to the proposed route of the Project provide high value habitats for indigenous peripatus.

Table 3: Summary of notable invertebrate species that are potentially present in the Project Area based on a literature review.

Species	Conservation Status	Habitat and Host Preference
Wainuia urnula	Not Threatened possibly locally uncommon	Damp leaf-litter and understorey vegetation such as tradescantia.
Powelliphanta traversi traversi	Threatened – Nationally Critical	Indigenous forest areas with moist leaf-litter or understorey vegetation such as tradescantia.
Powelliphanta traversi otakia		
Powelliphanta traversi florida		
Meterana exquisita	At Risk – Relict	Shrublands of divaricating *Olearia* species.
Meterana grandiosa	At Risk – Relict	
Declana griseata	At Risk – Declining	Green mistletoe
Tatosoma agrionata		

Zelleria sphenota		
Blosyropus spinosus	Not Threatened, previously Category I (indeterminate)	Dead, decaying logs of tawa, beech, and *Dracophyllum* spp.
Orthodera novaezealandiae	At Risk – Declining	Shrublands that contain open areas.

Survey results

63. Surveys conducted to date have consisted of hand searching, sweep netting, and light trapping. Photographs of some of the invertebrates recorded are provided in Appendix 2.

64. No Threatened or At Risk species have been found during the surveys to date.

65. A population of the indigenous land snail *Wainuia urnula* was found on property #158 (Located off North Manakau Road) (Appendix 2, Plate 1). This species does not have a conservation classification, but is likely to be locally uncommon due to the limited habitat availability and fragmentation of forest remnants in the Manawatū Ecological District. Three individuals were found within tradescantia along the riparian margin at property #158.

66. No *Powelliphanta* species were recorded within any of the surveyed properties. However, *Powelliphanta traversi florida* were found within Kimberly Reserve and *Powelliphanta traversi traversi.* were recorded within Waiopehu Scenic Reserve and Kimberly Reserve (Appendix 2, Plate 2 and 3). Both of these reserves are located near the Project footprint and the presence of *Powelliphanta* species indicates that they still persist locally (Waiopehu Scenic Reserve is located approximately 1.3 kilometres, and Kimberley Reserve is approximately 2.2 kilometres, from the proposed route of the Project).

67. A total of 84 Lepidoptera species were identified during the surveys. Seventy-six of these species are indigenous to New Zealand.

68. The greatest number of Lepidoptera species recorded at a site was 66 species at property #42 (fenced forest block off State Highway 1), recorded during a daytime survey and one night of light trapping. Light trapping at this property will have led to a greater number of species identified (when compared with sites where light trapping was not used). Vegetation within this property was characterised as tawa-kohekohe (*Dysoxylum spectabile*) forest with a significant cover of lianes on the forest margin, including dense puka (*Muehlenbeckia australis*), a known host of several Lepidoptera species (Henderson and Patrick 2020, Patrick 2016).

69. Five indigenous ground beetle species were identified during surveys. Beetles were generally found beneath objects such as woody debris as they are predominantly nocturnal and actively hunt during the night.

70. *Peripatus novaezealandiae* was identified at properties #42, #43, and #287 (Appendix 2, Plates 2 and 3). These properties contain remnant indigenous forest areas categorised as either lowland tawa-kohekohe forest or lowland tawa forest. Peripatus are generally confined to forested areas with habitat that provides moisture, shade, and cool temperatures as they are prone to desiccation.

71. The Project Area supports a diverse array of typical indigenous invertebrate species that are closely associated with particular habitats and indigenous host plants. A full list of invertebrate species found during the surveys is presented in Appendix 3.

ASSESSMENT OF ECOLOGICAL VALUES

Habitat values

72. Table 4 below provides a summary of the terrestrial invertebrate habitat values for each vegetation/habitat type within the Project Area. Some habitats within the immediate vicinity of the Project footprint have also been included in the assessment based on the following assumptions:

    (a) The habitat is of Moderate to High ecological value for terrestrial invertebrates or has previously been recognised as a natural area.

    (b) The habitat is of a type that may be subject to adverse effects other than direct clearance or loss, due to its proximity to the footprint of the proposed Project (e.g., increased isolation of resident terrestrial fauna).

73. The habitat values described in Table 4 have been incorporated into the overall ecological values assessment described in Technical Assessment J for all habitat types within the Ō2NL Project Area.

74. Site specific information for some species is limited. Terrestrial invertebrate surveys were carried out in high quality representative habitats along the route rather than for every habitat type. Therefore, species that may be present in a habitat (based on habitat preference and known distribution) are assumed to be potentially present for the purposes of this habitat values assessment.

75. Habitat values for pasture, houses and gardens i.e., disturbed environments have not been included within Table 4 for assessment as they provide no to negligible value to indigenous invertebrate species.

Table 4: Habitat types and associated terrestrial invertebrate habitat values within the Ō2NL Project Area.

Habitat Type	Vegetation Type	Code	Property ID	Description of Terrestrial Invertebrate Habitat Values	Assigned Value
Indigenous forest	Tawa forest	ITF1	87, 163, 287	• Peripatus present • Spiny longhorn beetle possibly present • Suite of common indigenous ground beetles present • Good quality habitat comprising complex groundcover including dense leaf-litter, debris and vegetation that provides a moist environment for indigenous snails, Coleoptera and other invertebrate species • The large number of lianes present on property 287 provide high value Lepidoptera habitat.	Moderate
	Tawa-kohekohe Forest	ITF2	38, 42, 42	• Peripatus present • Suite of indigenous Lepidoptera present • *Powelliphanta* recorded historically • Spiny longhorn beetle possibly present • Good quality habitat comprising complex groundcover including dense leaf-litter, debris and vegetation that provides a moist environment for indigenous snails, Coleoptera and other invertebrate species.	Very High
	Kohekohe-tītoki-karamū-large bindweed forest	ITF3	151	• *Wainuia urnula* possibly present • Moderate value riparian vegetation that could potentially support common Coleoptera species and land snails.	Moderate
	Māhoe forest and scrub Planted indigenous forest	ITF4, ITF5, ITF6	40, 39, 167, 493	• Planted indigenous forest and scrub is unlikely to provide high value habitat for indigenous terrestrial invertebrates at this time • New Zealand mantis may utilise this habitat • Property 167 is contiguous with exotic forest which may provide some habitat for invertebrate species such as common Coleoptera species.	Low - Moderate
	Tītoki forest	ITF7	465	• Powelliphanta recorded historically. Possibly present • Peripatus likely present • Good quality habitat comprising complex groundcover including dense leaf-litter, debris and vegetation that provides a moist environment for indigenous snails, Coleoptera and other invertebrate species	Very High
Indigenous treeland	(all)	ITT1 – ITT7	207, 55, 465, 61, 42, 91, 307, 459	• Indigenous treeland is unlikely to support a diverse range of terrestrial invertebrate species • New Zealand mantis is possibly present.	Low - Moderate
Indigenous scrub	(all)	ITS1	207, 455, 459, 461, 472, 473, 493	• New Zealand mantis is possibly present • Potential areas of complex groundcover including dense leaf-litter, debris and vegetation that may provide a moist environment for indigenous snails, Coleoptera and other invertebrate species.	Low - Moderate
Indigenous fernland	Kiokio fernland	ITFn01	19	• Moist understorey may provide habitat for indigenous land snails and common ground beetle species • *Blechnum* sp. provides habitat for a host-specific geometrid moth (*Ischalis galleria,* Brian Patrick pers. obs., 2021).	Low - Moderate
Mixed indigenous-exotic forest	False acacia-tītoki-cherry forest Tītoki-karaka forest Tītoki-false acacia-poataniwha-karaka forest	MTF3, MTF6 MTF7, MTF8	465, 479	• Powelliphanta recorded historically. Possibly present • Peripatus likely present • Good quality habitat comprising complex groundcover including dense leaf-litter, debris and vegetation that provides a moist environment for indigenous snails, Coleoptera and other invertebrate species.	Very High
Mixed indigenous-exotic forest/scrub	(other)	MTF1, MTF2, MTF5, MTF6 MTS1 - MTS4,	212, 207, 20, 151, 472, 19, 40, 42, 47, 52, 307, 311, 326, 473, 484, 488	• New Zealand mantis possibly present in some scrub habitats • *Wainuia urnula* possibly present in riparian habitats (212). However, not recorded during field survey • Common Coleoptera species present in riparian vegetation.	Low - Moderate
Crack willow forest and scrub.	Crack willow forest/scrub Crack willow-brush wattle-tree lucerne scrub	ETF1, ETS1	151, 158, 659	• *Wainuia urnula* recorded at property 158 • Moderate value riparian vegetation that likely supports common Coleoptera species and a moderate size population of land snails • New Zealand mantis possibly present in scrub habitats.	Moderate
	Crack willow forest/scrub (riparian)	ETF1	19, 209, 212, 459	• *Wainuia urnula* possibly present in riparian vegetation • New Zealand mantis possibly present in scrub habitats • Common Coleoptera species present in riparian vegetation.	Moderate
Exotic Forest	Sweet cherry forest Redwood forest False acacia-karaka forest Macrocarpa-radiata pine-false acacia forest	ETF5, ETF6, ETF7, ETF8	465, 479	• Powelliphanta recorded historically. Possibly present • Peripatus likely present • Good quality habitat comprising complex groundcover including dense leaf-litter, debris and vegetation that provides a moist environment for indigenous snails, Coleoptera and other invertebrate species	Very High

Habitat Type	Vegetation Type	Code	Property ID	Description of Terrestrial Invertebrate Habitat Values	Assigned Value
Exotic forest (other)	Eucalyptus forest Radiata pine forest Exotic treeland and forest	ETF2, ETF3, ETF4	167, 158, 207, 209, 221, 472, 493, 9, 12, 14, 19, 21, 28, 29, 30, 31, 33, 43, 53, 57, 88, 91, 125, 132, 264, 273, 282, 286, 330, 337, 342, 349, 360, 363, 418, 421, 470, 472, 473, 485, 490, 493, 498, 499, 519, 535, 544, 550, 555, 586, 599, 134/144	• Exotic forest at these properties is unlikely to support a diverse range of indigenous terrestrial invertebrate species. • Exotic forest may support some common indigenous coleoptera. • Peripatus species may still be present within exotic forest if there is some connectivity to indigenous forest and large areas of decaying woody debris.	Low
Exotic scrub and shrubland dominated by gorse	Gorse scrub Gorse-pampas shrubland	ETS2, ETS3	209, 212	• Exotic scrub/gorseland is unlikely to support a diverse range of indigenous terrestrial invertebrates within the Manawatū Plains Ecological District • Gorse (*Ulex europaeus*) is known to support a limited diversity of terrestrial invertebrates compared to the higher species diversity typically recorded in indigenous vegetation (Munro 1995) • New Zealand mantis is possibly present in scrub habitats.	Negligible
Wetland habitats	Indigenous wetland Mixed indigenous wetland Exotic wetland	IWF1, IWF2, IWRe1, IWSe1, IWSe1-SPG, IWSe2, IWSe3, IWSe4, IWSe5, IWSe6, MWSe1-SPG, MWG1, MWG1d, MWG2, MWSe2, MWSe3, MWV1	19, 21, 493, 47, 207, 519, 455, 461, 38, 52, 472, 134/144, 207, 461, 132, 164, 166, 577, 605	• Wetlands do not provide high value habitat for terrestrial invertebrate species • Indigenous land snails do not typically occur within wetland habitat • Few notable indigenous Lepidoptera are present within wetland environments.	Negligible-Low

Fauna values

76. The following notable indigenous invertebrate fauna have been recorded at properties within and/or adjacent to the Project alignment (during the current surveys or as described in existing literature), and may be affected by the proposed Project:

(a) Wainuia urnula (land snail).

(b) Peripatoides novaezealandiae (peripatus).

(c) Powelliphanta. (land snail).

(i) *Powelliphanta traversi otakia.*

(ii) *Powelliphanta traversi traversi.*

(iii) *Powelliphanta traversi florida.*

77. The ecological value of these species is indicated in Table 5.

Table 5: Ecological value assessment for notable indigenous terrestrial invertebrate species seen/recorded within the Project alignment and local area.

Species	Determining Factors	Assigned Value	Presence
Wainuia urnula	Locally (within ecological district) uncommon or distinctive species	Moderate	Confirmed
Powelliphanta traversi traversi	Nationally Threatened species	Very High	Not recorded during targeted surveys. Historically present within properties adjacent to the Project alignment and recorded in local reserves.
Powelliphanta taversi otakia	Nationally Threatened species	Very High	
Powelliphanta traversi florida	Nationally Threatened species	Very High	
Lepidoptera species	Not Threatened' and/or Not Classified	Low	Suite of common indigenous Lepidoptera present.
Blosyropus spinoss	Locally (within ecological district) uncommon or distinctive species	Moderate	Not recorded. Possibly present.
Peripatoides novaezealandiae	Locally uncommon or distinctive species	Moderate	Confirmed
Orthodera novaezealandiae	At Risk-Declining	High	Not recorded. Likely present.
Other terrestrial invertebrates	Not Threatened' and/or Not Classified	Low	Large number of common indigenous species present.

ASSESSMENT OF EFFECTS

Overview

78. Potential adverse ecological effects of the Project on terrestrial invertebrates include:

    (a) Permanent habitat loss (as discussed in Technical Assessment J).

    (b) Mortalities of terrestrial invertebrates such as *Wainuia urnula.*

    (c) Disturbance.

    (d) Modification of remaining habitat, including:

        (i) Reduction of habitat connectivity through fragmentation and the introduction of new barriers (e.g., road) that may cause habitat isolation.

        (ii) Creation of edge effects including altering the composition and habitat value of adjacent vegetation and modifying the microclimates within edge habitats. For example, forest edges are drier than interior forest habitats and are less likely to support indigenous land snail species.

79. Potential ongoing adverse ecological effects of the Ō2NL highway on terrestrial invertebrates include:

    (a) Ongoing disturbance from noise, vibration, dust and light.

    (b) Mortality or injury on roads through road kill.

    (c) Increased presence of and likelihood of invasion by non-native plant and animal species.

80. Each of these effects is described and assessed in detail below. The magnitude of each effect has been defined as outlined in the EcIAG and is presented in Table 6.

Permanent habitat loss

81. Invertebrate habitat values are incorporated into the vegetation and habitat values described in Technical Assessment J. As such, the assessment of the level of effect associated with vegetation loss will also account for the loss of these invertebrate habitat values. The loss of indigenous invertebrate habitat is therefore appropriately covered in Technical Assessment J.

Injury to and/or mortalities of terrestrial invertebrates during construction

82. Vegetation removal during the construction of the Ō2NL Project is likely to result in the injury or death of some terrestrial invertebrates. In particular, *Wainuia urnula* individuals within crack willow forest/scrub habitat on property #158 (a known population) are likely to be disturbed and/or killed during vegetation clearance.

83. Road construction can lead to soil compaction in and near the footprint of the highway which may reduce the presence of terrestrial invertebrate habitat through potential increased run off and decreased soil porosity. This may also result in direct mortality to ground dwelling invertebrates (Tamayo 2014).

84. Numerous common invertebrate species are also likely to be directly impacted by habitat removal including Lepidoptera and Coleoptera.

Disturbance (temporary and ongoing)

85. Temporary disturbance of terrestrial invertebrate species is likely to occur during the construction of the Project. Disturbance could cause changes to terrestrial invertebrate behaviours resulting in changes to:

(a) Home range.

(b) Movement.

(c) Reproduction.

(d) Physiological state.

86. Continual lighting of roads can have adverse effects on terrestrial invertebrates, particularly Lepidoptera species. The nature of these effects is primarily determined by the extent, type, and duration of lighting, and the vulnerability of the fauna present within the immediate area (Wakefield *et al.* 2017, Pawson and Bader 2014). Artificial lighting can cause changes to habitat use by some species (e.g., attraction to or avoidance of lit areas) and can also cause mortality of individuals either through contact with hot lighting surfaces or being struck by vehicles.

87. Research has shown that roads negatively impact both abundance and diversity of invertebrate species (Muñoz *et al.* 2015, Trombulak and Frissell 2000).

88. Road surfaces have been found to absorb solar radiation, which can increase soil and air temperatures (Haskell 2000). This could result in a decrease of available microhabitats, such as the moist environments required by *Powelliphanta* and peripatus.

Modification of remaining habitat

89. Reduction of habitat connectivity through fragmentation and the introduction of new barriers may hinder the movement of terrestrial invertebrates. The proposed road alignment falls between properties 465 and 479 (see below) which have high invertebrate values and could therefore further isolate populations. *Powelliphanta* sp. are unlikely to cross between these forest remnants. However, they have been found to disperse up to ~150 metres and therefore their dispersal across the proposed road alignment cannot be ruled out (Devine 1997).

90. The removal of some vegetation will create new forest edges. Forest edges are exposed to high light levels, large fluctuations in temperature, and low humidity compared to interior forest habitat. These effects may be experienced up to 100 metres from the forest edge and can lead to the enhanced germination of pest plant species, reduced regeneration and survival of indigenous plant species, and reduced habitat quality for terrestrial invertebrates such as snails and peripatus that require moist environments.

91. All of the areas of indigenous forest within and or adjacent to the preferred alignment are less than 50 metres in width at their narrowest point. As such, all of these areas are considered to be edge habitats that are subject to edge effects. However, vegetation clearance is likely to exacerbate the existing edge effects for some areas of forest. For example, tradescantia provides valuable snail habitat within woody vegetation at property 479, but will likely be impacted by the exacerbated edge effects from the proposed alignment running directly adjacent. This will lead to a reduction in quality of potential high value snail habitat.

Injury to and/or mortalities of terrestrial invertebrates through road kill

92. Direct mortality of terrestrial invertebrates is likely to occur through collisions with vehicles using the road following completion of the Project.

93. Research has shown that mortality can be high within invertebrate groups crossing roads, with increasing impacts on populations with high traffic volumes (Muñoz *et al.* 2015).

Increased presence and likelihood of invasion of non-native plants and animals

94. Construction can result in the arrival of new pest species to a site (e.g., earthworks machinery acting as vectors), and the facilitation of pest establishment (by providing bare surfaces for colonisation). The effects of construction on pest abundance can also persist into the operational phase.

95. Pest plant species may not provide the same ecological benefit as indigenous plant species for terrestrial invertebrates. For example, Lepidoptera are often host-specific, and an increased abundance of pest plants may reduce the availability of these hosts and their associated Lepidoptera species.

96. Pest animals such as rodents are detrimental to indigenous invertebrate species. Notably, land snails (*Powelliphanta* and *Wainuia*) are known to be injured and killed by these animals (Meads *et al.* 1984, Turner 2011, Walker 2003).

PROPOSED MEASURES TO REMEDY OR MITIGATE ACTUAL OR POTENTIAL ADVERSE EFFECTS ON TERRESTRIAL INVERTEBRATES

97. An Ecological Management Plan will be prepared prior to the lodgement of the resource consent, and appended to this document. The Ecological

Management Plan will include a subplan for terrestrial invertebrates. The subplan will address the impact and minimisation measures on terrestrial invertebrates and outline the key mitigation measures to reduce the level of adverse ecological effects (as described below).

98. For terrestrial invertebrates, the key minimisation measures to be included in the Ecological Management Plan, and considered in the Magnitude of Effects in Table 6 are as follows:

(a) Where needed, the establishment of alternative habitats close to the footprint of the Project prior to construction. This will provide continuity of habitats for Threatened or At Risk fauna. The suggested habitat restoration measures are as follows:

(i) Indigenous plantings should be established to complement existing remnants, and to link sites that are immediately adjacent to the motorway alignment.

(ii) Rank grass/shrubland corridors and the transfer of soils, coarse woody material (including discs of wood) and leaf-litter should be used within these planting sites to promote invertebrate dispersal and establishment.

(iii) Indigenous plants that are known to provide habitat for insects should be used for these plantings as this will assist the restoration of insect populations as well as wider ecological processes (e.g., pollination, nutrient cycling).

(iv) Development of a Snail Management Plan to minimise mortality of land snails. The plan will include a strategy for the salvage of land snails at key sites in the Project footprint. The snail management plan should consider post-translocation monitoring to ensure continued survival of the species at impacted and/or designated release sites.

(b) Maximising habitat connectivity for less mobile (i.e., non-flying) fauna species by ensuring connectivity of riparian vegetation and habitats on the banks of streams and rivers that are crossed by bridges.

(c) Maximising potential habitat connectivity for terrestrial species by allowing for a dry zone through culverts, where this is technically feasible and of significant ecological benefit.

(d) Minimising lighting of the highway where this is required (i.e., major intersections), specifically:

   (i) Where required, traditional street lighting, with low UV content, should be used rather than light-emitting diode (LED) lights as invertebrates are highly attracted to UV (Barghini and Medeiros 2012).

   (ii) Significantly higher numbers of invertebrates were found to be attracted to white metal halide lighting compared to high-pressure sodium and LED. High pressure sodium and LED were found to attract similar numbers of invertebrates; however, the LED lighting attracted a more diverse range of species (Wakefield *et al.* 2017).

(e) Minimising direct mortality and injury from road collisions by:

   (i) Infill planting along newly created edges of the Project alignment.

   (ii) All lighting along the road corridor should use traditional lighting (as mentioned above) to avoid attracting invertebrates into the road corridor.

   (iii) Roads will likely act as a barrier to land snails, and therefore the risk of indigenous land snails being run over by cars is low (Baur and Baur 1989).

Table 6: Species, ecological values, adverse effects, minimisation measures, magnitude of effect, and level of effect for the Ō2NL Project Area.

Notable Terrestrial Invertebrate Species	Ecological Value	Impacts (including cumulative effects, excluding habitat loss)	Magnitude of Effect in absence of effects management	Level of Effect in absence of effects management	Avoidance and Minimisation Measures	Magnitude of Effect (after Avoidance and Minimisation)	Level of Effect (after Avoidance and Minimisation)
Wainuia urnula	Moderate	Direct mortality during vegetation clearance.	High	Moderate	Snail Management Plan including search and relocation methods and implementation.	Moderate	Moderate
		Reduction of habitat connectivity through fragmentation and introduction of new barriers that may cause habitat isolation. Installation of a bridge may act as a barrier to the movement of the species.	Low	Low	Bridge design should allow for an uninterrupted band of vegetation along the banks of the river. Remedial works will likely be needed to restore vegetation.	Negligible	Very Low
		Temporary and ongoing disturbance could result in changes to home range, movement, reproduction and physical state from noise, lighting, vibration, dust, and changes to microclimate such as increased temperatures around roads and air pollutants.	Low	Low	Implement dust suppression measures, buffer forest remnants.	Negligible	Very Low
		Direct mortality or injury on roads.	Negligible	Very Low	Unlikely to cross roads, no minimisation required.	Negligible	Very Low
		Increased presence of and likelihood of invasion by pest animal species.	Low	Low	Pest animal control carried out in *Wainuia* habitats.	Negligible	Very Low
Powelliphanta sp. • *P. traversi traversi* • *P. traversi otakia* • *P. traversi florida*	Very High	Direct mortality during vegetation clearance.	Low	Moderate	All indigenous forest remnants have been avoided by the proposed alignment.	Negligible	Low
		Reduction of habitat connectivity through fragmentation and introduction of new barriers that may cause habitat isolation.	Negligible	Low	Connecting forest remnants to establish migration pathways. Revegetation planting to expand size of Arapaepae forest remnant.	Positive	Net gain
		Creation of edge effects such as modifying the microclimates within created edge habitats.	Negligible	Low	Establish indigenous vegetation to buffer and increase size of forest area, assess options to supplement soil moisture with treated road runoff. Note that most affected vegetation largely comprises edge habitats.	Negligible	Low
		Temporary and ongoing disturbance could result in changes to home range, movement, reproduction and physical state from noise, lighting, vibration, dust, and changes to microclimate such as increased temperatures around roads and air pollutants.	Low	Moderate	Implement dust suppression measures, buffer forest remnants.	Negligible	Low
		Direct mortality or injury on roads.	Negligible	Low	Unlikely to cross roads, no minimisation required.	Negligible	Low
		Increased presence of and likelihood of invasion by pest animal species.	Low	Moderate	Establish pest animal control in known *Powelliphanta* habitats.	Negligible	Low
Peripatoides novaezealandiae	Moderate	Direct mortality during vegetation clearance.	Negligible	Very Low	All indigenous forest remnants have been avoided within the proposed alignment.	Negligible	Very Low
		Reduction of habitat connectivity through fragmentation and introduction of new barriers that may cause habitat isolation.	Negligible	Very Low	No management required, although populations are likely to benefit from offsetting and natural character planting that will connect forest remnants to establish migration pathways.	Negligible	Very Low
		Creation of edge effects such as modifying the microclimates within created edge habitats.	Low	Low	Establish indigenous vegetation to buffer and increase size of forest area, assess options to supplement soil moisture with treated road runoff.	Negligible	Very Low

Notable Terrestrial Invertebrate Species	Ecological Value	Impacts (including cumulative effects, excluding habitat loss)	Magnitude of Effect in absence of effects management	Level of Effect in absence of effects management	Avoidance and Minimisation Measures	Magnitude of Effect (after Avoidance and Minimisation)	Level of Effect (after Avoidance and Minimisation)
		Temporary and ongoing disturbance could result in changes to home range, movement, reproduction and physical state from noise, lighting, vibration, dust, and changes to microclimate such as increased temperatures around roads and air pollutants.	Low	Low	Implement dust suppression measures, buffer forest remnants.	Negligible	Very Low
Spiny longhorn beetle	Moderate	Direct mortality during vegetation clearance.	Negligible	Very Low	Tawa forest remnants are avoided in the proposed alignment.	Negligible	Very Low
		Reduction of habitat connectivity through fragmentation and introduction of new barriers that may cause habitat isolation.	Negligible	Very Low	Tawa forest remnants are already fragmented and the introduction of new barriers are unlikely to impact this flightless species.	Negligible	Very Low
		Temporary and ongoing disturbance could result in changes to home range, movement, reproduction and physical state from noise, lighting, vibration, dust, and changes to microclimate.	Low	Low	Implement dust suppression measures, buffer forest remnants.	Negligible	Very Low
New Zealand mantis	Moderate	Direct mortality during vegetation clearance.	Low	Low	Any individuals discovered during searching for snails and lizards will be captured and relocated to safe habitats.	Negligible	Very Low
		Temporary and ongoing disturbance could result in changes to home range, movement, reproduction and physical state from noise, lighting, vibration, dust, and changes to microclimate.	Low	Low	Implement dust suppression measures. Note that NZ mantis is a mobile species and is therefore less likely to be affected by dust.	Negligible	Very Low
Lepidoptera (species recorded during surveys)	Low	Direct mortality during vegetation clearance.	Low	Very Low	All mature indigenous forest remnants have been avoided within the proposed alignment. No management required.	Negligible	Very Low
		Reduction of habitat connectivity through fragmentation and introduction of new barriers that may cause habitat isolation.	Low	Very Low	No management required, although populations are likely to benefit from offsetting and natural character planting that will connect forest remnants to establish migration pathways.	Negligible	Very Low
		Creation of edge effects such as modifying the microclimates within created edge habitats.	Low	Very Low	Forest habitats are already subject to edge effects; however, buffer planting to increase the size of forest areas will provide high value habitat for Lepidoptera.	Negligible	Very Low
		Temporary and ongoing disturbance could result in changes to home range, movement, reproduction and physical state from noise, lighting, vibration, dust, and changes to microclimate such as increased temperatures around roads and air pollutants.	Low	Very Low	Implement dust suppression measures, buffer forest remnants	Negligible	Very Low
		Direct mortality or injury on roads.	Moderate	Low	Use traditional street lighting with low UV content. This will reduce invertebrates being attracted to the road corridor.	Low	Very Low
		Increased presence of and likelihood of invasion by non-native plant and animal species.	Negligible	Very Low	No management required. Moths are generally not vulnerable to mammalian predators.	Negligible	Very Low
Other terrestrial invertebrate species	Low	Direct mortality during vegetation clearance.	Low	Very Low	All mature indigenous forest remnants have been avoided within the proposed alignment.	Low	Very Low
		Reduction of habitat connectivity through fragmentation and introduction of new barriers that may cause habitat isolation.	Low	Very Low	No management required, although populations are likely to benefit from offsetting and natural character planting that will connect forest remnants to establish migration pathways.	Negligible	Very Low

Notable Terrestrial Invertebrate Species	Ecological Value	Impacts (including cumulative effects, excluding habitat loss)	Magnitude of Effect in absence of effects management	Level of Effect in absence of effects management	Avoidance and Minimisation Measures	Magnitude of Effect (after Avoidance and Minimisation)	Level of Effect (after Avoidance and Minimisation)
		Creation of edge effects such as modifying the microclimates within created edge habitats.	Low	Very Low	Forest habitats are already subject to edge effects; however, buffer planting to increase the size of forest areas will provide high value habitat for Lepidoptera.	Low	Very Low
		Temporary and ongoing disturbance could result in changes to home range, movement, reproduction and physical state from noise, lighting, vibration, dust, and changes to microclimate such as increased temperatures around roads and air pollutants.	Low	Very Low	Implement dust suppression measures, buffer forest remnants	Low	Very Low
		Direct mortality or injury on roads.	Low	Very Low	Use traditional street lighting with low UV content. This will reduce invertebrates being attracted to the road corridor.	Low	Very Low
		Increased presence of and likelihood of invasion by non-native plant and animal species.	Low	Low	No management required, although invertebrate populations will benefit from targeted pest control.	Negligible	Very Low

CONCLUSION AND RECOMMENDATIONS

99. No Threatened or At Risk invertebrate species were found during the surveys. However, desktop invertebrate assessments show that several species and their habitats may be present within the Project footprint, including species that are classified as Threatened or At Risk.

100. Notable species that may be present include species from the giant land snail genus *Powelliphanta*. These species have been previously recorded from three properties adjacent to the proposed road alignment. However, we found no evidence that these species persist in suitable habitats within the Project Area during targeted terrestrial surveys. Properties within the Project Area provide habitat for these species, and they may still be present albeit in extremely low densities. A further land snail species, *Wainuia urnula,* was recorded during surveying and one species of indigenous peripatus was recorded at three properties. The At Risk New Zealand mantis was not recorded during surveys but is noted from nearby the Project footprint.

101. A suite of common indigenous Lepidoptera and Coleoptera species were recorded during surveying. None of the species identified to date are classified as Threatened or At Risk. The spiny longhorn beetle has been recorded in both the Manawatū and Wellington Ecological Districts and may persist in remnant indigenous tawa forest within the Project Area. This species is currently classified as Not Threatened but is notable as it was previously considered a Category I (Indeterminate) species; for this assessment it has been assessed as of Moderate value. Further, this species is considered locally uncommon due to the small number and extent of forest remnants remaining in both the alignment and wider Ecological Districts.

102. Based upon recorded species and the assumption that historically recorded species are still present, a range of effects avoidance and minimisation measures are proposed. Currently, direct clearance of all indigenous forest remnants within the Project footprint has been avoided. One population of land snail, *Wainuia urnula*, is likely to be directly impacted during the construction of works, and numerous common indigenous species are also likely to be impacted. However, with avoidance and minimisation measures addressed in this report, along with an offset and compensation package, the potential effects of the Project on terrestrial invertebrates can be adequately addressed.

Brian Patrick

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MAP SERIES: INVERTEBRATE FIELD SURVEY LOCATIONS AND IDENTIFIED NOTABLE INVERTEBRATE SPECIES

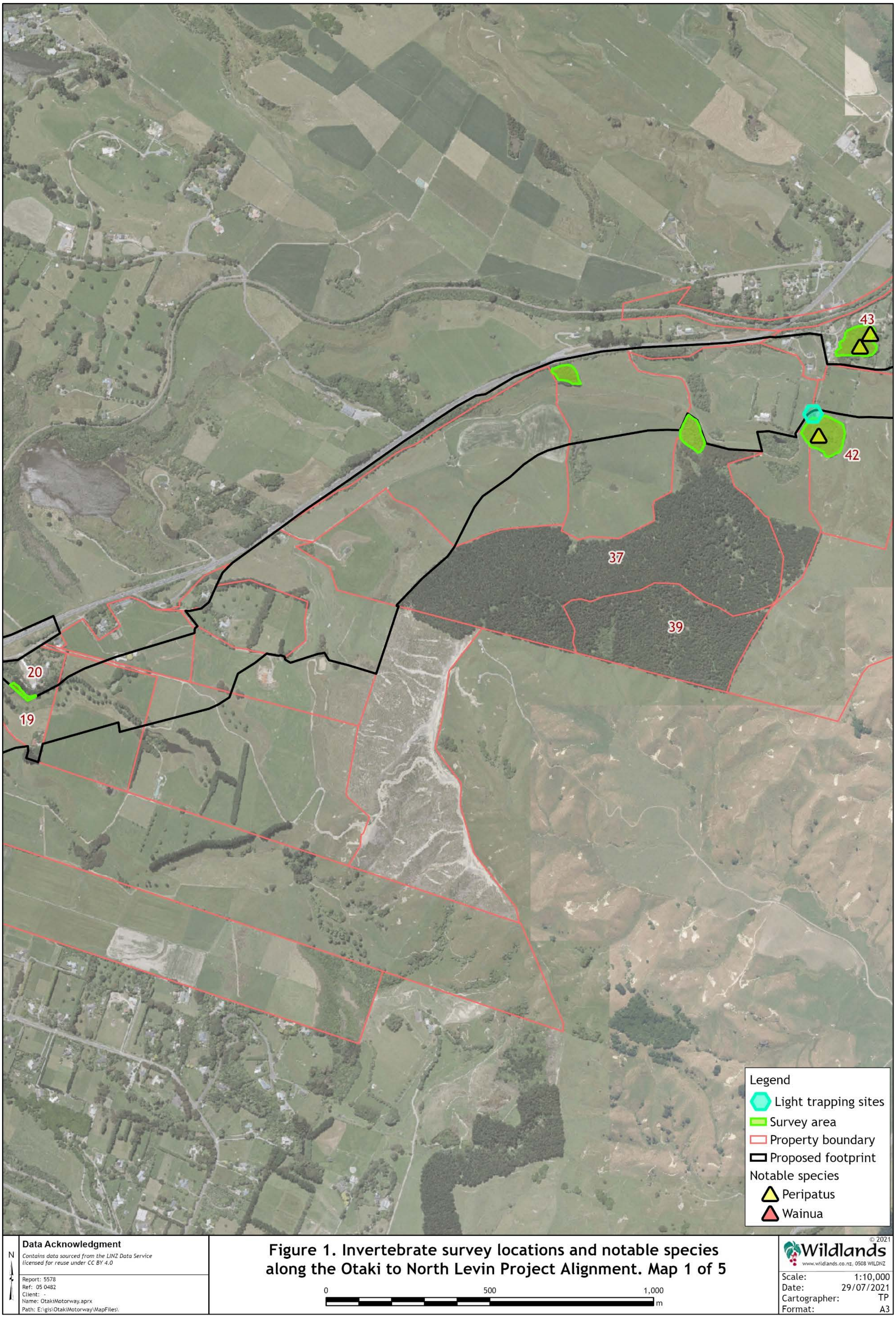

Figure 1. Invertebrate survey locations and notable species along the Otaki to North Levin Project Alignment. Map 1 of 5

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Figure 1. Invertebrate survey locations and notable species along the Otaki to North Levin Project Alignment. Map 2 of 5

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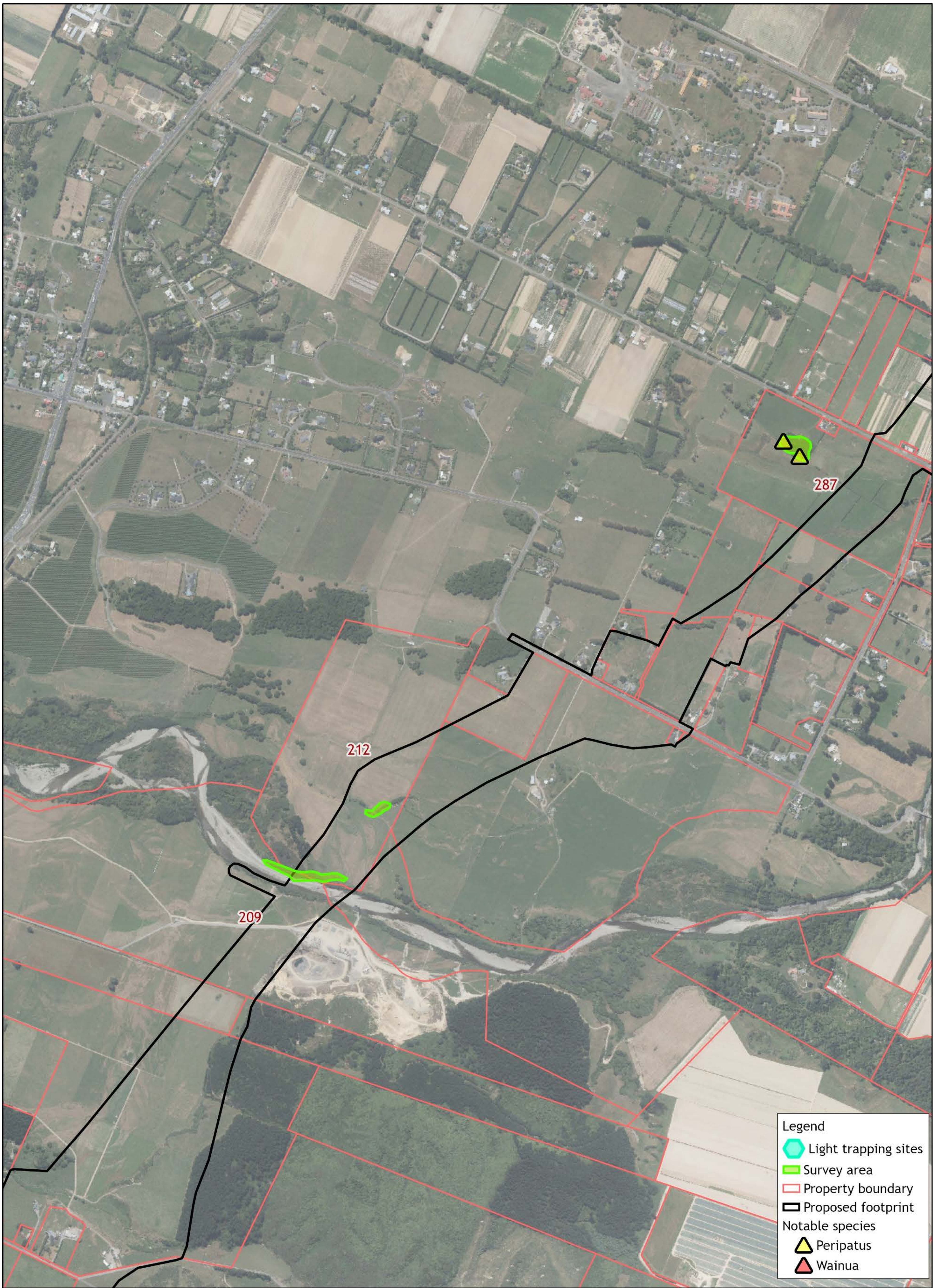

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Figure 1. Invertebrate survey locations and notable species along the Otaki to North Levin Project Alignment. Map 3 of 5

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Figure 1. Invertebrate survey locations and notable species along the Otaki to North Levin Project Alignment. Map 4 of 5

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Figure 1. Invertebrate survey locations and notable species along the Otaki to North Levin Project Alignment. Map 5 of 5

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INVERTEBRATE FIELD SURVEY PHOTOS

Plate 1: *Wainuia urnula* found on property #158 within tradescantia.

Plate 2: *Powelliphanta traversi traversi* found in Waiopehu Scenic Reserve.

Plate 3: *Powelliphanta traversi florida* found in Kimberly Reserve.

Plate 4: *Peripatoides novaezeelandiae* found at property #43 within woody debris.

Plate 5: *Peripatoides novaezeelandiae* found at property #287 within woody debris.

Plate 6: *Porrhothele antipodiana* found at property #163 beneath woody debris.

Plate 7: *Xyridacma ustaria*, an endemic geometrid moth, captured during light trapping near Kimberly Reserve.

INVERTEBRATE SPECIES IDENTIFIED DURING FIELD SURVEYS

Order	Family	Common Name	Scientific Name	Threat Classification	Status
Lepidoptera	Lycaenidae	Common copper butterfly	*Lycaena edna*	Not Classified	Indigenous
		Australian blue butterfly	*Zizina labradus*	N/A	Exotic
	Nymphalidae	Yellow admiral butterfly	*Vanessa itea*	Not Classified	Indigenous
		Red admiral butterfly	*Vanessa gonerilla*	Not Classified	Indigenous
		Monarch butterfly	*Danaus plexippus*	Not Classified	Indigenous
	Pieridae	Cabbage white butterfly	*Pieris rapae*	N/A	Exotic
	Hepialidae	Ghost moth	*Wiseana signata*	Not Classified	Indigenous
		Bog porina moth	*Wiseana umbraculata*	Not Classified	Indigenous
	Psychidae	Common bagmoth	*Liothula omnivora*	Not Classified	Indigenous
	Erebidae	Magpie moth	*Nyctemera annulata*	Not Classified	Indigenous
	Noctuidae	Greasy cutworm	*Agrotis ipsilon*	Not Classified	Indigenous
		Green garden looper	*Chrysodeixis eriosoma*	Not Classified	Indigenous
		Moth	*Bityla defigurata*	Not Classified	Indigenous
		Māhoe stripper	*Feredayia graminosa*	Not Classified	Indigenous
		Cotton bollworm	*Heliothis armigera*	N/A	Exotic
		Cutworm	*Ichneutica atristriga*	Not Classified	Indigenous
		Cutworm	*Ichneutica plena*	Not Classified	Indigenous
		Cutworm	*Ichneutica mutans*	Not Classified	Indigenous
		Cutworm	*Ichneutica propria*	Not Classified	Indigenous
		Cutworm	*Ichneutica sulcana*	Not Classified	Indigenous
		Moth	*Meterana ochthistis*	Not Classified	Indigenous
		Moth	*Meterana stipata*	Not Classified	Indigenous
		Army worm	*Mythimna separata*	Not Classified	Exotic
		Moth	*Rhapsa scotoscialis*	Not Classified	Indigenous
		Moth	*Proteuxoa sanguinipunctata*	Not Classified	Indigenous
	Geometridae	Moth	*Austrocidaria gobiata*	Not Classified	Indigenous
		Australia pugmoth	*Chloroclystis filata*	Not Classified	Indigenous
		Kawakawa looper	*Cleora scriptaria*	Not Classified	Indigenous
		New Zealand looper	*Epyaxa rosearia*	Not Classified	Indigenous
		Cabbage tree moth	*Epiphryne verriculata*	Not Classified	Indigenous
		Forest semi-looper	*Declana floccosa*	Not Classified	Indigenous
		Spotted mānuka moth	*Declana leptomera*	Not Classified	Indigenous
		Small hooked tip looper	*Homodotis megaspilata*	Not Classified	Indigenous
		Brown evening moth	*Gellonia dejectaria*	Not Classified	Indigenous
		Emerald pug moth	*Pasiphila muscosata*	Not Classified	Indigenous
		Moth	*Pasiphila sphragitis*	Not Classified	Indigenous
		Moth	*Pasiphila testulatus*	Not Classified	Indigenous
		Forest looper	*Pseudocoremia indistincta*	Not Classified	Indigenous
		Forest looper	*Pseudocoremia leucelaea*	Not Classified	Indigenous
		Forest looper	*Pseudocoremia suavis*	Not Classified	Indigenous
		Plantain moth	*Scopula rubraria*	Not Classified	Indigenous
		Moth	*Xyridacma ustaria*	Not Classified	Indigenous
	Crambridae	Moth	*Eudonia chlamydota*	Not Classified	Indigenous
		Moth	*Eudonia dinodes*	Not Classified	Indigenous
		Moth	*Eudonia leptalea*	Not Classified	Indigenous
		Moth	*Eudonia minualis*	Not Classified	Indigenous
		Moth	*Eudonia philerga*	Not Classified	Indigenous
		Moth	*Eudonia submarginalis*	Not Classified	Indigenous
		Pond moth	*Hygraula nitens*	Not Classified	Indigenous
		Moth	*Orocrambus flexuosellus*	Not Classified	Indigenous
		Moth	*Orocrambus ramosellus*	Not Classified	Indigenous
		Moth	*Orocrambus vittellus*	Not Classified	Indigenous
		Moth	*Scoparia chimeria*	Not Classified	Indigenous
		Moth	*Scoparia halopis*	Not Classified	Indigenous
		Moth	*Scoparia illota*	Not Classified	Indigenous
		Moth	*Scoparia minusculalis*	Not Classified	Indigenous
		Moth	*Scoparia petrina*	Not Classified	Indigenous
		Moth	*Udea flavidalis*	Not Classified	Indigenous
	Tortricidae	Moth	*Capua semiferana*	Not Classified	Indigenous
		Moth	*Capua intractana*	Not Classified	Indigenous
		Brown-headed leafroller	*Ctenopseustis obliquana*	Not Classified	Indigenous

Order	Family	Common Name	Scientific Name	Threat Classification	Status
		Light brown apple moth	*Epiphyas postvittana*	N/A	Exotic
		Moth	*Harmologa amplexana*	Not Classified	Indigenous
		Moth	*Harmologa scoliastes*	Not Classified	Indigenous
		Green-headed leafroller	*Planotortrix excessana*	Not Classified	Indigenous
		Moth	*Pyrgotis eudorana*	Not Classified	Indigenous
		Guava bud moth	*Strepsicrates ejectana*	Not Classified	Indigenous
	Gelechiidae	Moth	*Aniscoplaca achyrota*	Not Classified	Indigenous
	Oecophoridae	Moth	*Barea exarcha*	N/A	Exotic
		Leather leaf spore eater	*Calicotis crucifera*	Not Classified	Indigenous
		Moth	*Gymnobathra tholodella*	Not Classified	Indigenous
		Lichen moth	*Izatha huttoni*	Not Classified	Indigenous
		Small lichen moth	*Izatha peroneanella*	Not Classified	Indigenous
		Moth	*Scieropepla typhicola*	Not Classified	Indigenous
		Orchard featherfoot moth	*Stathmopoda horticola*	Not Classified	Indigenous
		Kōwhai seed moth	*Stathmopoda aposema*	Not Classified	Indigenous
		Moth	*Tingena armigerella*	Not Classified	Indigenous
		Moth	*Tingena plagiatella*	Not Classified	Indigenous
	Tineidae	Moth	*Opogona comptella*	N/A	Exotic
		Dusky scuttler	*Opogona omoscopa*	N/A	Exotic
	Glyphipterigidae	Sedge moth	*Glyphipterix* sp.	N/A	N/A
	Thyrididae	Muehlenbeckia steam gall moth	*Morova subfasciata*	Not Classified	Indigenous
	Momphidae	Moth	*Zapyrastra calliphana*	Not Classified	Indigenous
	Gracillaridae	N/A	Undescribed species (Brian Patrick pes. obs.)	N/A	N/A
Hemiptera	Pentatomidae	Green vegetable bug	*Nezara viridula*	N/A	Exotic
	Cicadidae	Clapping cicada	*Amphipsalta zealandica*	Not Classified	Indigenous
		Green cicada	*Kikihia* sp.	Not Classified	Indigenous
	Ricaniidae	Passionvine hopper	*Scolypopa australis*	N/A	Exotic
Coleoptera	Scarabaeidae	Striped chafer beetle	*Odontria striata*	Not Classified	Indigenous
		Chafer beetle	*Odontria* sp.	N/A	Exotic
	Carabidae	Beetle	*Mecodema simplex*	Not Classified	Indigenous
		Beetle	*Megadromus vigil*	Not Classified	Indigenous
		Beetle	*Megadromus capito*	Not Classified	Indigenous
		Beetle	*Holcaspis mordax*	Not Classified	Indigenous
	Tenebrionida	False wireworm	*Mimpoeus opaculus*	Not Classified	Indigenous
	Cerambycidae	Longhorn beetle	*Zorion* sp.		
	Coccinellidae	Metallic blue ladybug	*Halmus chalybeus*	Not Classified	Exotic
		Harlequin ladybird	*Harmonia axyridis*	N/A	Exotic
Trichoptera	Leptoceridae		*Triplectides cephalotes*	Not Classified	Indigenous
	Hydrobiosidae	Caddis	*Hydrobiosis* sp.	N/A	N/A
		Caddis	*Psilochorema* sp.	N/A	N/A
	Hydroptilidae	Micro caddis	*Oxyethira albiceps*	Not Classified	Indigenous
	Polycentropodidae		*Polyplectropis puerilis*		
Odonata	Zygoptera	Red damselfly	*Xanthocnemic zealandica*	Not Classified	Indigenous
	Anisoplaca	Dragonfly	*Procodulia grayi*	Not Classified	Indigenous
	Lestidae	Blue damselfly	*Austrolestes colensonis*	Not Classified	Indigenous
Orthoptera	Tettigoniidae	Field grasshopper	*Conocephalus bilineatus*	Not Classified	Indigenous
	Anostostomatidae	Wellington tree weta	*Hemideina crassidens*	Not Threatened	Indigenous
	Anostostomatidae	Auckland tree weta	*Hemideina thoracica*	Not Threatened	Indigenous
	Acrididae	NZ grasshopper	*Phaulacridium marginale*	Not Classified	Indigenous
	Gryllidae	Field cricket	*Teleogryllus commodus*	N/A	Exotic
	Rhaphiophoridae	Cave weta	*Pleioplectron hudsoni*	Not Threatened	Indigenous
Diptera	Culicidae	Mosquito	*Aedes notoscriptus*	N/A	Exotic
Stylommatophora	Arthoracophidae	Leaf-veined slug	*Athoracophorus bitentaculatus*	Not Classified	Indigenous
	Helicidae	Garden snail	*Helix aspersa*	N/A	Exotic
	Limacidae	Leopard slug	*Limax maximus*	N/A	Exotic
	Rhytididae	Land snail	*Wainuia urnula urnula*	Not Threatened	Indigenous
Hymenoptera	Apidae	Bumblebee	*Bombus* sp.	Not Classified	Exotic
	Ichneumonoidea	Ichneumonid wasp	*Netelia ephippiata*	Not Classified	Indigenous
	Vespidae	Common/German wasp	*Vesupula* sp.	N/A	Exotic

Order	Family	Common Name	Scientific Name	Threat Classification	Status
Araneae	Miturgidae	N/A	*Argoctennus* sp	Not Classified	Indigenous
	Araneidae	Green orbweb spider	*Colaranea viriditas*	Not Classified	Indigenous
	Desidae	Sheetweb spider	*Cambridgia* sp.	Not Classified	Indigenous
	Pisauridae	Nursery web spider	*Dolemedes minior*	Not Classified	Indigenous
	Hexathelidae	Banded tunnelweb spider	*Hexathele hochstetteri*	Not Classified	Indigenous
	Gnaphosidae	Ground spider	*Hypodrassodes Māoricus*	Not Threatened	Indigenous
	Porrhothelidae	Black tunnelweb spider	*Porrhothele antipodiana*	Not Classified	Indigenous
	Salticidae	Jumping spider	*Trite planiceps*	Not Classified	Indigenous
	Zoropsidae	Vagrant spider	*Uliodon* sp.	Not Classified	Indigenous
	Theridiidae	False katipō spider	*Steatoda capensis*	N/A	Exotic
Blattodea	Blattidae	Bush cockroach	*Celatoblatta* sp.	Not Classified	Indigenous
Ephemeroptera	Leptophlebiidae	Mayfly	*Deleatidium* spp.	N/A	N/A
Spirostreptida	Cambalidae	Millipede	*Eumastigonus* sp.	N/A	Exotic
Opiliones	Neopilionidae	Harvestman	*Forsteropsalis inconstans*	Not Classified	Indigenous
Chilopoda	Lithobiomorpha	Stone centipede	*Lithobius* sp.	N/A	Exotic
Euonychophora	Peripatidea	Peripatus/velvet worm	*Peripatoides novaezealandiae*	Not Threatened	Indigenous
Phasmida	Phasmatidae	Common stick insect	*Clitarchus hookeri*	Not Threatened	Indigenous
Tricladida	Geoplanidae	N/A	*Newzealandia graffii*	Not Classified	Indigenous

APPENDIX J.8

ANALYSIS OF ECOLOGICAL VALUES OF TERRESTRIAL HABITATS WITHIN THE Ō2NL PROJECT AREA

Appendix J.8: Ecological Values assessment for terrestrial habitats in the Ō2NL Project Area.

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
ITF1 - Tawa forest	0.55 ha (287) 0.66 ha (98, 91, 87, 77) 0.42 ha (154,163, 162) Total area: 1.63 ha	Representativeness – *Comprises a typical diversity of species that are representative of tawa-kohekohe forests that originally occurred within the region.* *The forest at Property #287 is listed as Brown's Bush (67C) within the PNAP report for the Manawatū Plains Ecological District (Ravine 1995).*	High
		Rarity/Distinctiveness – *Indigenous vegetation on an Acutely Threatened Land Environment. Peripatus present. Habitat for ornate skink (At Risk – Declining) in the 1990s but not recorded during more recent field surveys. Spiny longhorn beetle possibly present. Potential habitat for kākā (At Risk – Recovering) but not recorded during field surveys.*	High
		Diversity and Pattern – *Remnants are appropriately fenced to exclude stock and other browsing animals, and a diversity of indigenous plant species occurs across the forest tiers. The diverse floral community provides fruit, seeds, nectar and insects for indigenous birds. Property #287 habitat for northern grass skink in the 1990s but not recorded during more recent field surveys. Suite of common indigenous ground beetles present. Quality habitat comprising complex ground cover including dense leaf-litter, debris and vegetation that provides a moist environment for indigenous snails, Coleoptera and other invertebrate species. Large number of lianes present on Property #287 provide high value Lepidoptera habitat.*	High
		Ecological Context – *Small, relatively isolated forest remnants that provide habitat for indigenous fauna. Very few areas of indigenous forest habitat remain on the Horowhenua Plains, and these remnants provide stepping stone habitat for mobile fauna species.*	Moderate
		Overall Ecological Value: Very high	
ITF2 - Tawa-kohekohe forest remnants	1.06 ha (43) 1.19 ha (42, 39) Total area: 2.27 ha	Representativeness – *Comprises a typical diversity of species that are representative of tawa-kohekohe forests that originally occurred within the region. Forest at Property #42 and #43 is listed as natural areas within the PNAP report for the Manawatū Plains Ecological District (Pukehou (Staples Bush) 47B) (Ravine 1995). Forest at Property 43 is ecological site K016 in the Operative Kāpiti Coast District Plan 2021.*	High
		Rarity/Distinctiveness – *Indigenous vegetation on an Acutely Threatened Land Environment. Peripatus recorded at site. Spiny longhorn beetle possibly present. Powelliphanta spp. recorded historically. Potential habitat for kākā (At Risk – Recovering) and may occasionally be visited by whitehead (At Risk – Declining), but not recorded during field surveys.*	High

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
		Diversity and Pattern – *Remnants are appropriately fenced to exclude stock and other browsing animals, and a diversity of indigenous plant species occurs across the forest tiers. Diverse floral community provides fruit, seeds, nectar and insects for indigenous birds. Suite of indigenous Lepidoptera species present. Complex ground cover including dense leaf-litter, debris, and vegetation that provides a moist environment for indigenous snails, Coleoptera, and other invertebrates.*	High
		Ecological Context – *Small, relatively isolated forest remnant that provide habitat for indigenous fauna. Very few areas of indigenous forest habitat remain on the Horowhenua Plains, and these remnants provide stepping stone habitat for mobile fauna species.*	Moderate
		Overall Ecological Value: Very high	
ITF3 - Kohekohe-tītoki-karamū forest	0.04 ha (151)	Representativeness – *This remnant only contains two trees and associated understorey species, and does not comprise a typical forest structure or composition.*	Low
		Rarity/Distinctiveness – *Indigenous vegetation on an Acutely Threatened Land Environment. Habitat for Wainuia land snails (locally uncommon).*	Moderate
		Diversity and Pattern – *Does not comprise a natural diversity of indigenous plant species. Likely to support common Coleoptera species and land snails.*	Low
		Ecological Context – *Part of vegetation along a tributary of the Waikawa Stream, which provides riparian buffering and habitat for indigenous fauna species.*	Moderate
		Overall Ecological Value: Moderate	
ITF4 - Māhoe forest and scrub	**0.24 ha (493)** **0.058 ha (167, 171)** Total area: 0.30 ha	Representativeness – *Vegetation is dominated by indigenous species and is representative of current vegetation types.*	Moderate
		Rarity/Distinctiveness – *Indigenous vegetation on Acutely Threatened Land Environments.*	Moderate
		Diversity and Pattern – *Supports a moderate diversity of indigenous species. Unlikely to provide high value habitat for indigenous terrestrial invertebrates at this time.*	Moderate
		Ecological Context – *Provides some protection to adjacent wetland/riparian margins. Provides some habitat for indigenous fauna species moving through the local landscape.*	Moderate
		Overall Ecological Value: Moderate	
ITF5 - Puka-kōhūhū forest	0.64 ha (39)	Representativeness – *Restoration plantings, which do not comprise a typical composition, but includes typical regenerating indigenous species within the subcanopy.*	Low
		Rarity/Distinctiveness – *Indigenous vegetation on Acutely Threatened Land Environments. Potential habitat for kākā (At Risk – Recovering) and may occasionally be visited by whitehead (At Risk – Declining), but not recorded during field surveys.*	Moderate

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
		Diversity and Pattern – *Supports a moderate diversity of indigenous plant species. Unlikely to provide high value habitat to indigenous terrestrial invertebrates at this time. Floral community may provide fruit, seeds, and nectar for indigenous birds at times.*	Moderate
		Ecological Context – *Small, relatively isolated forest patches that provide habitat for indigenous fauna, including stepping stone habitat for mobile fauna species.*	Moderate
		Overall Ecological Value: Moderate	
ITF6 - Tarata-rewarewa forest	**0.44 ha (40)**	Representativeness – *Restoration plantings, which do not comprise a typical composition, but includes typical regenerating indigenous species within the subcanopy.*	Low
		Rarity/Distinctiveness – *Indigenous vegetation on Acutely Threatened Land Environments but of lower value for rarity than a natural forest stand. Potential habitat for kākā (At Risk – Recovering) and may occasionally be visited by whitehead (At Risk – Declining), but not recorded during field surveys.*	Moderate
		Diversity and Pattern – *Supports a moderate diversity of indigenous plant species. Unlikely to provide high value habitat for indigenous terrestrial invertebrates at this time. Floral community provides fruit, seeds and nectar for indigenous birds.*	Moderate
		Ecological Context – *Small, relatively isolated forest patches that provide habitat for indigenous fauna, including stepping stone habitat for mobile fauna species.*	Moderate
		Overall Ecological Value: Moderate	
ITF7 - Tītoki forest	0.20 ha (465)	Representativeness – *This vegetation type supports mature indigenous forest species representative of the typical structure and composition of original forests in the area. This forest remnant is listed within the PNAP report (Arapaepae Bush, 77) (Ravine 1995).*	Moderate
		Rarity/Distinctiveness – *Includes indigenous vegetation on an Acutely Threatened Land Environment. Habitat for ornate skink (At Risk – Declining) and historic records of Powelliphanta traversi (Threatened – Nationally Endangered) which may or may not still be present. Peripatus likely to be present. Potential habitat for kākā (At Risk – Recovering), but not recorded during field surveys.*	High
		Diversity and Pattern – *Supports a moderate diversity of indigenous species. Complex ground cover including dense leaf-litter, debris and vegetation that provides a moist environment for indigenous snails, Coleoptera and other invertebrate species. Floral community provides fruit, seeds and nectar for indigenous birds.*	Moderate
		Ecological Context – *Small, relatively isolated forest remnants that provide habitat for indigenous fauna. Very few areas of indigenous forest habitat remain on the Horowhenua Plains, and these remnants provide stepping stone habitat for mobile fauna species.*	Moderate
		Overall Ecological Value: High	

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
ITS1 - Māhoe-karamū scrub	**0.06 ha (207)**	Representativeness – *Vegetation is dominated by indigenous species, but does not comprise a typical structure and composition. One mature tītoki tree present.*	Low
		Rarity/Distinctiveness – *Indigenous vegetation on Acutely Threatened Land Environments.*	High
		Diversity and Pattern – *Supports a moderate diversity of indigenous plant species. Floral community may provide fruit, seeds, and nectar for indigenous birds at times.*	Moderate
		Ecological Context – *Provides a short corridor for the movement of mobile species along the railway.*	Low
		Overall Ecological Value: Moderate	
ITS1 - Māhoe-karamū scrub ITS1d – Māhoe-karamū scrub (desktop only)	ITS1 **0.51 ha (455, 459, 461)** **0.15 ha (473)** **0.06 ha (207)** 0.091 (472, 493) ITS1d 0.35 ha (207) 0.24 ha (207) **0.95 ha (207)** **1.85 ha (35, no property ID)** Total area: 4.11 ha	Representativeness – *Vegetation is dominated by indigenous species, but does not comprise a typical structure and composition.*	Low
		Rarity/Distinctiveness – *Indigenous vegetation on Acutely Threatened Land Environments.*	High
		Diversity and Pattern – *Supports a low diversity of indigenous plant species.*	Low
		Ecological Context – *Provides a short corridor for mobile species along an escarpment.*	Low
		Overall Ecological Value: Moderate	
ITT01 - Kāmahi-kānuka treeland	**0.02 ha (55)**	Representativeness – *Includes some representative indigenous species, but does not comprise a typical structure and composition.*	Low
		Rarity/Distinctiveness – *Includes indigenous trees on an Acutely Threatened Land Environment. Kānuka (Threatened – Nationally Vulnerable) also present.*	High
		Diversity and Pattern – *Supports a low diversity of indigenous plant species. Unlikely to support a diverse range of terrestrial invertebrate species.*	Low
		Ecological Context – *A relatively small area that provides limited ecological context values.*	Low
		Overall Ecological Value: Moderate	

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
ITT02 - Karaka-tawa treeland	**0.16 ha (61)**	Representativeness – *Supports some mature indigenous trees, but does not comprise a typical structure and composition.*	Low
		Rarity/Distinctiveness – *Includes indigenous trees on an Acutely Threatened Land Environment.*	Moderate
		Diversity and Pattern – *Supports a low diversity of indigenous plant species. Unlikely to support a diverse range of terrestrial invertebrate species. Floral community may provide fruit and seeds for indigenous birds at times. Habitat may provide stepping stones for avian species to move between sites.*	Low
		Ecological Context – *Isolated trees within pasture, which may provide some stepping stone habitat for indigenous birds moving through the landscape.*	Moderate
		Overall Ecological Value: Moderate	
ITT03 - Planted indigenous treeland ITT03d – Planted indigenous treeland (desktop only)	ITT03 **0.01 ha (42)** **0.02 ha (91)** 0.11 ha (307) 0.21 ha (459) Total Area: 0.35 ha ITT03d 0.12 ha (33)	Representativeness – *Despite dominance of indigenous species, these plantings do not comprise a typical composition or range of species.*	Low
		Rarity/distinctiveness – *Includes indigenous vegetation on Acutely Threatened Land Environments.*	Moderate
		Diversity and Pattern – *Supports a low diversity of indigenous plant species. Unlikely to support a diverse range of terrestrial invertebrate species. Habitat may provide stepping stones for avian species to move between sites.*	Low
		Ecological Context – *Isolated trees within pasture, which may provide some habitat for indigenous birds.*	Low
		Overall Ecological Value: Low	
ITT04 - Tī kōuka treeland	**0.01 ha (61)**	Representativeness – *Supports some mature indigenous trees, but does not comprise a typical structure and composition*	Low
		Rarity/distinctiveness – *Includes indigenous trees on an Acutely Threatened Land Environment.*	Moderate
		Diversity and Pattern – *Supports a low diversity of indigenous plant species. Unlikely to support a diverse range of terrestrial invertebrate species. Habitat may provide stepping stones for avian species to move between sites.*	Very low
		Ecological Context – *A small cluster of isolated trees within pasture, which may provide some habitat and seasonal fruit supply for indigenous birds.*	Low
		Overall Ecological Value: Low	

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
ITT05 - Tītoki treeland	**0.004 ha (465)**	Representativeness - *One mature indigenous tree in pasture.*	Low
		Rarity/distinctiveness - *Mature indigenous tree on an Acutely Threatened Land Environment.*	Moderate
		Diversity and Pattern - *Supports a low diversity of indigenous plant species. Unlikely to support a diverse range of terrestrial invertebrate species. Single tree may provide a stepping stone for avian species to move between sites.*	Very Low
		Ecological Context - *Isolated tree within pasture, which may provide some habitat for indigenous birds.*	Low
		Overall Ecological Value: Low	
ITT06 - Tītoki-hīnau-maire treeland	**0.03 ha (465)**	Representativeness - *Supports some mature indigenous trees, but does not comprise a typical structure and composition*	Low
		Rarity/Distinctiveness - *Includes indigenous trees on an Acutely Threatened Land environment.*	Moderate
		Diversity and Pattern - *Supports a low diversity of indigenous plant species. Unlikely to support a diverse range of terrestrial invertebrate species. Floral community may provide fruit and seeds for indigenous birds at times. Habitat may provide stepping stones for avian species to move between sites.*	Low
		Ecological Context - *Isolated trees within pasture, which provide some habitat for indigenous birds and a stepping stone between two forest remnants.*	Moderate
		Overall Ecological Value: Moderate	
ITT07 - Tawa-tītoki treeland	0.71 ha (207)	Representativeness - *Supports representative indigenous mature forest tree species, but does not comprise a typical structure and composition*	Moderate
		Rarity/Distinctiveness - *Includes indigenous vegetation on an Acutely Threatened Land Environment. Black beech is present (the only site within the Ō2NL Project Area where this species was recorded).*	High
		Diversity and Pattern - *Supports a moderate diversity of indigenous species. Unlikely to support a diverse range of terrestrial invertebrate species. Floral community may provide fruit and seeds for indigenous birds at times. Habitat may provide stepping stones for avian species to move between sites.*	Moderate
		Ecological Context - *Isolated trees within pasture, which may provide some stepping stone habitat for indigenous birds.*	Moderate
		Overall Ecological Value: High	

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
ITFn01 - Kiokio fernland	**0.01 ha (19)**	Representativeness – *Supports representative indigenous fernland, but does not comprise a typical structure and composition.*	Low
		Rarity/Distinctiveness – *Includes indigenous vegetation on an Acutely Threatened Land Environment.*	High
		Diversity and Pattern – *Supports a low diversity of indigenous plant species.*	Low
		Ecological Context – *Provides some buffering to a wetland, but is relatively small in size.*	Low
		Overall Ecological Value: Moderate	
MTF1 - Māhoe-barberry-*Muehlenbeckia australis* forest and scrub	**0.09 ha (212)**	Representativeness – *Supports representative indigenous mature forest tree species, but lacks an understorey due to grazing. Mature pukatea are present.*	Moderate
		Rarity/distinctiveness – *Includes some indigenous vegetation on an Acutely Threatened Land Environment.*	Moderate
		Diversity and Pattern – *Supports a moderate diversity of indigenous species.*	Moderate
		Ecological Context – *A relatively small area that provides some connectivity and habitat values.*	Low
		Overall Ecological Value: Moderate	
MTF2 - Māhoe-sweet cherry scrub and forest	**0.17 ha (472)**	Representativeness – *Supports some indigenous species, but does not comprise a typical structure and composition.*	Low
		Rarity/Distinctiveness – *Includes some indigenous vegetation on Acutely Threatened Land Environments.*	Moderate
		Diversity and Pattern – *Supports a low diversity of indigenous plant species. Floral community may provide fruit and seeds for indigenous birds at times. Habitat may provide stepping stones for avian species to move between sites.*	Low
		Ecological Context – *A relatively small area that provides some connectivity and habitat values*	Low
		Overall Ecological Value: Low	
MTF3 - False acacia-tītoki-cherry forest	0.35 ha (465)	Representativeness – *Despite the prevalence of false acacia (Robinia pseudoacacia) and cherry (Prunus sp.), this vegetation type supports mature indigenous forest species, representative of the typical structure and composition of original forests in the area. This forest remnant is listed within the PNAP report (Arapaepae Bush, 77) (Ravine 1995).*	Moderate
		Rarity/Distinctiveness – *Includes indigenous vegetation on an Acutely Threatened land environment. Habitat for ornate skink (At Risk – Declining) and historic records of Powelliphanta traversi (Threatened – Nationally Endangered) which may or may not be present. Peripatus likely to be present. Potential provision of fruits and seeds for kākā (At Risk – Recovering).*	High

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		Diversity and Pattern – *Supports a low diversity of indigenous plant species. Complex ground cover including dense leaf-litter, debris and vegetation that provides a moist environment for indigenous snails, Coleoptera and other invertebrate species. Floral community provides fruit, seeds and insects for indigenous birds. Habitat may provide stepping stones for avian species to move between sites.*	Low-moderate
		Ecological Context – *Small, relatively isolated forest remnants that provide habitat for indigenous fauna. Very few areas of indigenous forest habitat remain on the Horowhenua Plains, and these remnants provide stepping stone habitat for mobile fauna species.*	Moderate
		Overall Ecological Value: Moderate	
MTF4 - Crack willow-māhoe forest/scrub	0.08 ha (212)	Representativeness – *Supports some regenerating indigenous broadleaved species; however, exotic species occur frequently and the area does not comprise a typical structure and composition.*	Low
		Rarity/Distinctiveness – *Includes some indigenous vegetation on Acutely Threatened Land Environments.*	Moderate
		Diversity and Pattern – *Supports a low diversity of indigenous plant species.*	Low
		Ecological Context – *Provides some buffering to the Ōhau River, and part of a narrow but extensive corridor of woody vegetation along the banks of the river*	Moderate
		Overall Ecological Value: Moderate	
MTF5 - Mixed indigenous-exotic planted forest	**0.32 ha (473, 484, 488)** **0.31 ha (473)** **0.06 ha (473)** **0.08 ha (473)** 0.52 ha (307, 311, 326) **0.22 ha (47, 52)** **0.07 ha (47, 52)** **0.04 ha (19)** 0.14 ha (40) Total area: 1.75 ha	Representativeness – *Mixed indigenous-exotic plantings do not comprise a typical composition, but includes typical regenerating indigenous species within the subcanopy.*	Low
		Rarity/Distinctiveness – *Includes some indigenous vegetation on Acutely Threatened Land Environments.*	Moderate
		Diversity and Pattern – *Supports a low diversity of indigenous plant species.*	Low
		Ecological Context – *May provide some limited stepping stone habitat for indigenous fauna species as very few areas of indigenous forest habitat remain on the Horowhenua Plains.*	Low
		Overall Ecological Value: Low	

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
MTF6 - Karaka-māhoe-kawakawa forest and scrub	MTF6 0.07 ha (479)	Representativeness – *Supports some indigenous species, including mature species representative of the Horowhenua plains; however, is dominated by exotic and non-local indigenous species.*	Moderate
		Rarity/Distinctiveness – *Includes indigenous vegetation on an Acutely Threatened Land Environment. Habitat for ornate skink (At Risk – Declining) and potential presence of Powelliphanta traversi (Threatened – Nationally Endangered). Potential habitat for kākā (At Risk – Recovering), but not recorded during field surveys.*	High
		Diversity and Pattern – *Supports a low diversity of indigenous plant species. Floral community may provide fruit, seeds and insects for indigenous birds at times.*	Low
		Ecological Context – *Small, relatively isolated forest remnants that provide habitat for indigenous fauna. Very few areas of indigenous forest habitat remain on the Horowhenua Plains, and these remnants provide stepping stone habitat for mobile fauna species.*	Moderate
		Overall Ecological Value: Moderate	
MTF6d - Karaka-māhoe-kawakawa forest and scrub (desktop only)	**0.67 ha (40)**	Representativeness – *Supports some indigenous species, but on a roadside with pest plants common.*	Low
		Rarity/distinctiveness – *Includes indigenous vegetation on an Acutely Threatened Land Environment.*	Moderate
		Diversity and Pattern – *Supports a low diversity of indigenous plant species. Floral community may provide fruit, seeds and insects for indigenous birds at times. Potential habitat for skinks.*	Low
		Ecological Context – *Small, linear area of scrub that may provide some linkage functions between forest remnants in the local area.*	Moderate
		Overall Ecological Value: Moderate	
MTF7 - Tītoki-karaka forest	0.15 ha (465)	Representativeness – *Despite the prevalence of a non-local indigenous species, this vegetation type supports mature indigenous forest species, representative of the typical structure and composition of original forests in the area. This forest remnant is listed within the PNAP report (Arapaepae Bush, 77) (Ravine 1995).*	Moderate
		Rarity/Distinctiveness – *Includes indigenous vegetation on an Acutely Threatened land environment. Habitat for ornate skink (At Risk – Declining) and historic records of Powelliphanta traversi (may or may not still be present). Peripatus likely present. Potential habitat for kākā (At Risk – Recovering), but not recorded during field surveys.*	High
		Diversity and Pattern – *Supports a low diversity of indigenous plant species. Complex ground cover including dense leaf-litter, debris and vegetation that provides a moist environment for indigenous snails, Coleoptera and other invertebrate species. Diverse floral community provides fruit and seeds for indigenous birds.*	Low-Moderate

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		Ecological Context – *Small, relatively isolated forest remnants that provide habitat for indigenous fauna. Very few areas of indigenous forest habitat remain on the Horowhenua Plains, and these remnants provide stepping stone habitat for mobile fauna species.*	Moderate
		Overall Ecological Value: Moderate	
MTF8 - Tītoki-false acacia-poataniwha-karaka forest	0.34 ha (465)	Representativeness – *Despite the prevalence of a non-local indigenous species, this vegetation type supports mature indigenous forest species, representative of the typical structure and composition of original forests in the area. This forest remnant is listed within the PNAP report (Arapaepae Bush, 77) (Ravine 1995).*	Moderate
		Rarity/Distinctiveness – *Includes indigenous vegetation on an Acutely Threatened land environment. Habitat for ornate skink (At Risk – Declining) and historic records of Powelliphanta traversi (may or may not still be present). Peripatus likely present. Potential habitat for kākā (At Risk – Recovering), but not recorded during field surveys.*	High
		Diversity and Pattern – *Supports a low diversity of indigenous plant species. Complex ground cover including dense leaf-litter, debris and vegetation that provides a moist environment for indigenous snails, Coleoptera and other invertebrate species. Diverse floral community provides fruit, seeds, nectar and insects for indigenous birds.*	Low-Moderate
		Ecological Context – *Small, relatively isolated forest remnants that provide habitat for indigenous fauna. Very few areas of indigenous forest habitat remain on the Horowhenua Plains, and these remnants provide stepping stone habitat for mobile fauna species.*	Moderate
		Overall Ecological Value: Moderate	
MTS1 - Māhoe-karo scrub with emergent pine	0.37 ha (20)	Representativeness – *Supports some regenerating indigenous broadleaved species; however, exotic and non-local indigenous species occur frequently and the area does comprise a typical structure and composition.*	Low
		Rarity/Distinctiveness – *Includes some indigenous vegetation on Acutely Threatened Land Environments.*	Moderate
		Diversity and Pattern – *Supports a low diversity of indigenous plant species. Floral community provides some fruit, seeds, nectar and insects for indigenous birds.*	Low
		Ecological Context – *May provide some limited stepping stone habitat for indigenous fauna species as very few areas of indigenous forest habitat remain on the Horowhenua Plains. Provides some buffering to an area of high value wetland habitat.*	Moderate
		Overall Ecological Value: Moderate	
MTS2 - Barberry scrub with emergent tōtara	**0.07 ha (212)**	Representativeness – *Supports some mature indigenous tōtara and tawa trees on an old river scarp. However exotic species are common in the canopy, and due to grazing the area does not comprise a typical structure and composition.*	Moderate
		Rarity/Distinctiveness – *Includes some indigenous vegetation on Acutely Threatened Land Environments.*	Moderate

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		Diversity and Pattern – *Supports a low diversity of indigenous plant species. Floral community provides some fruit, seeds and insects for indigenous birds.*	Low
		Ecological Context – *May provide some limited stepping stone habitat for indigenous fauna species as very few areas of indigenous forest habitat remain on the Horowhenua Plains.*	Low
		Overall Ecological Value: Moderate	
MTS3 - Barberry-blackberry-*Muehlenbeckia australis*-greater bindweed-(māhoe) scrub	**0.09 ha (207)**	Representativeness – *Supports some indigenous species; however, exotic species are dominant and the area does not comprise a typical structure and composition of indigenous scrub ecosystems.*	Low
		Rarity/Distinctiveness – *Includes some indigenous vegetation on Acutely Threatened Land Environments.*	Moderate
		Diversity and Pattern – *Supports a low diversity of indigenous plant species. Floral community provides some fruit, seeds and insects for indigenous birds.*	Low
		Ecological Context – *May provide some limited stepping stone habitat for indigenous fauna species.*	Low
		Overall Ecological Value: Low	
MTS4 - Māhoe-mamaku-blackberry-barberry scrub	**0.06 ha (151)**	Representativeness – *A small area of vegetation is dominated by indigenous species, with a high proportion of non-indigenous species. The scrub does not comprise a typical structure and composition. One mature pukatea tree present.*	Low
		Rarity/Distinctiveness – *Indigenous vegetation on an Acutely Threatened Land Environment.*	High
		Diversity and Pattern – *Supports a low diversity of indigenous plant species. Floral community provides some fruit, seeds and insects for indigenous birds.*	Low
		Ecological Context – *A relatively small area that provides limited ecological value.*	Low
		Overall Ecological Value: Moderate	
ETF1 - Crack willow forest/scrub (riparian)	**0.43 ha (209)** **0.13 ha (212, 209)** Total Area: 0.56 ha	Representativeness – *Dominated by exotic species.*	Very low
		Rarity/Distinctiveness – *No rare features known. Wainuia possibly present in riparian vegetation.*	Low
		Diversity and Pattern – *Supports a low diversity of indigenous plant species.*	Low
		Ecological Context – *Provides riparian buffering to waterways and or wetlands.*	Moderate
		Overall Ecological Value: Low	
ETF1 - Crack willow forest/scrub (riparian area with *Wainuia* land snails)	**0.10 ha (158)** **0.11 ha (158, 151)** 0.05 ha (158) 0.07 ha (158, 151)	Representativeness – *Dominated by exotic species.*	Very low
		Rarity/Distinctiveness – *Likely habitat for Wainuia, a locally uncommon land snail*.	Moderate
		Diversity and Pattern – *Supports a low diversity of indigenous plant species. Riparian vegetation could support common Coleoptera species.*	Low

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
	Total Area: 0.33 ha	Ecological Context – *Provides riparian buffering to the Waikawa Stream and part of a corridor of woody vegetation alongside the stream.*	Moderate
		Overall Ecological Value: Moderate	
ETF1 - Crack willow forest/scrub (other)	**0.23 ha (459)**	Representativeness – *Dominated by exotic species.*	Very low
		Rarity/Distinctiveness – *No rare features known.*	Low
		Diversity and Pattern – *Supports a low diversity of indigenous plant species.*	Low
		Ecological Context – *May provide some limited stepping stone habitat for indigenous fauna species.*	Low
		Overall Ecological Value: Low	
ETF2 - Eucalyptus forest	**1.08 ha (167, 171)**	Representativeness – *Dominated by exotic species, but includes small areas of māhoe scrub, and pūrei sedgeland beneath the exotic canopy.*	Low
		Rarity/Distinctiveness – *No rare features known.*	Very low
		Diversity and Pattern – *Supports a low diversity of indigenous plant species. Floral community may provide seasonal nectar for indigenous birds.*	Low
		Ecological Context – *Likely provides habitat for indigenous fauna species, but does not enhance connectivity for mobile fauna species due to the abundance of exotic vegetation types on the adjacent hills.*	Low
		Overall Ecological Value: Low	
ETF3 - Radiata pine forest	**1.48 ha (221, 207)** **0.23 ha (472, 493)** 0.96 ha (207) 0.05 ha (158) Total Area: 2.96 ha	Representativeness – *Dominated by exotic species, but includes small areas of māhoe beneath the exotic canopy.*	Low
		Rarity/Distinctiveness – *No rare features known. Whitehead (At Risk – Declining) may visit occasionally but not recorded during field surveys.*	Very low
		Diversity and Pattern – *Supports a low diversity of indigenous plant species. Floral community may provide seeds and insects for indigenous birds.*	Low
		Ecological Context – *May provide some limited stepping stone habitat for indigenous fauna species as very few areas of indigenous forest habitat remain on the Horowhenua Plains.*	Low
		Overall Ecological Value: Low	
ETF4 - Exotic treeland and forest	Not listed – throughout. Total Area: 10.39 ha	Representativeness – *Dominated by exotic species.*	Very low
		Rarity/Distinctiveness – *No rare features known.*	Very low
		Diversity and Pattern – *Supports a low diversity of indigenous plant species.*	Low
		Ecological Context – *May provide some limited stepping stone habitat for indigenous fauna species as very few areas of indigenous forest habitat remain on the Horowhenua Plains.*	Low
		Overall Ecological Value: Low	

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
ETF5 - Sweet cherry forest	0.05 ha (465)	Representativeness – *The wider forest remnant within which this habitat is found is listed within the PNAP report (Arapaepae Bush, 77) (Ravine 1995). Dominated by exotic species.*	Low
		Rarity/Distinctiveness – *Habitat for ornate skink (At Risk – Declining) and historic records of Powelliphanta traversi (Threatened – Nationally Endangered) which may or may not still be present. Peripatus likely present.*	High
		Diversity and Pattern – *Supports a low diversity of indigenous plant species. Complex ground cover including dense leaf-litter, debris and vegetation that provides a moist environment for indigenous snails, Coleoptera and other invertebrate species. Floral community may provide fruits and seeds for indigenous birds.*	Low-moderate
		Ecological Context – *May provide some limited stepping stone habitat for indigenous fauna species as very few areas of indigenous forest habitat remain on the Horowhenua Plains.*	Low
		Overall Ecological Value: Moderate	
ETF6 - Redwood forest	0.31 ha (465)	Representativeness – *The wider forest remnant within which this habitat is found is listed within the PNAP report (Arapaepae Bush, 77) (Ravine 1995). Dominated by exotic species, but includes areas of indigenous species beneath the exotic canopy.*	Low
		Rarity/Distinctiveness – *Habitat for ornate skink (At Risk – Declining) and historic records of Powelliphanta traversi (Threatened – Nationally Endangered) which may or may not still be present. Peripatus likely present.*	High
		Diversity and Pattern – *Supports a low diversity of indigenous plant species. Complex ground cover including dense leaf-litter, debris and vegetation that provides a moist environment for indigenous snails, Coleoptera and other invertebrate species. Floral community may provide fruit, seeds, nectar and insects for indigenous birds.*	Low-moderate
		Ecological Context – *May provide some limited stepping stone habitat for indigenous fauna species as very few areas of indigenous forest habitat remain on the Horowhenua Plains.*	Low
		Overall Ecological Value: Moderate	
ETF7 - False acacia-karaka forest	1.24 ha (479)	Representativeness – *Supports some indigenous species, including mature species representative of the Horowhenua Plains, however is dominated by exotic and non-local indigenous species.*	Low
		Rarity/distinctiveness – *Includes indigenous vegetation on an Acutely Threatened Land Environment. Habitat for ornate skink (At Risk – Declining) and potential presence of Powelliphanta traversi. (Threatened – Nationally Endangered). Peripatus likely present.*	High
		Diversity and Pattern – *Supports a moderate diversity of indigenous plant species. Complex ground cover including dense leaf-litter, debris and vegetation that provides a moist environment for indigenous snails, Coleoptera and other invertebrate species. Floral community provides fruit, seeds, nectar and insects for indigenous birds.*	Moderate

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
		Ecological Context – *Small, relatively isolated forest remnants that provide habitat for indigenous fauna. Very few areas of indigenous forest habitat remain on the Horowhenua Plains, and these remnants provide stepping stone habitat for mobile fauna species.*	Moderate
		Overall Ecological Value: Moderate	
ETF8 - Macrocarpa-radiata pine-false acacia forest	1.00 ha (479)	Representativeness – *Supports some indigenous species, including mature species representative of the Horowhenua Plain. However, vegetation is dominated by exotic and non-local indigenous species.*	Moderate
		Rarity/Distinctiveness – *Includes indigenous vegetation on an Acutely Threatened land environment. Habitat for ornate skink (At Risk – Declining) and potential presence of Powelliphanta traversi (Threatened – Nationally Endangered).*	High
		Diversity and Pattern – *Supports a low diversity of indigenous plant species. Complex ground cover including dense leaf-litter, debris and vegetation that provides a moist environment for indigenous snails, Coleoptera and other invertebrate species. Floral community may provide fruit, seeds, nectar and insects for indigenous birds.*	Low
		Ecological Context – *Small, relatively isolated forest remnants that provide habitat for indigenous fauna. Very few areas of indigenous forest habitat remain on the Horowhenua Plains, and these remnants may provide stepping stone habitat for mobile fauna species.*	Moderate
		Overall Ecological Value: Moderate	
ETG1 - Rank grassland	**0.34 ha (212)** **0.38 ha (151, 162, 158)** **0.15 ha (158)** Total Area: 0.87 ha	Representativeness – *Dominated by exotic species.*	Very low
		Rarity/Distinctiveness – *No rare features known. Potential habitat for New Zealand pipit (Anthus novaeseelandiae; At Risk – Declining), but not recorded during field surveys. Supports a Not Threatened species of indigenous skink (northern grass skink).*	Moderate
		Diversity and Pattern – *Supports a low diversity of indigenous plant species.*	Low
		Ecological Context – *Limited ecological context values, but may provide limited infiltration and water filtering.*	Low
		Overall Ecological Value: Low	
ETS1 - Crack willow-brush wattle-tree lucerne scrub	0.10 ha (158) 0.07 ha (158) Total Area: 0.72 ha	Representativeness – *Dominated by exotic species.*	Very low
		Rarity/Distinctiveness – *No rare features known.*	Very low
		Diversity and Pattern – *Supports a very low diversity of indigenous species. Possible habitat for Wainuia land snails.*	Moderate
		Ecological Context – *Provides riparian buffering and part of a corridor of woody vegetation along the banks of the Waikawa Stream.*	Moderate
		Overall Ecological Value: Moderate	

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
ETS2, ETS3 - Gorse scrub, gorse-pampas shrubland	ETS2 **0.10 ha (209, 212)** ETS3 **0.26 ha (209)**	Representativeness – *Dominated by exotic species.*	Very low
		Rarity/distinctiveness – *No rare features known.*	Very low
		Diversity and Pattern – *Supports a low diversity of indigenous plant species.*	Low
		Ecological Context – *Limited ecological values present, but may provide limited infiltration and water filtering.*	Low
		Overall Ecological Value: Low	
ETV1 - Blackberry vineland	**0.02 ha (19)** **0.04 ha (19)** **0.07 ha (21)** **0.02 ha (25)** 0.19 ha (459) **0.07 ha (493)** **0.02 ha (119)** **0.09 ha (207)** **0.03 ha (212)** **0.07 ha (212)** **0.04 ha (212)** **0.07 ha (212)** **0.06 ha (459, 461)** **0.05 ha (461)** **0.48 ha (461)** **Total Area: 1.32 ha**	Representativeness – *Dominated by exotic species.*	Very low
		Rarity/distinctiveness – *No rare features known.*	Very low
		Diversity and Pattern – *Supports a low diversity of indigenous plant species.*	Low
		Ecological Context – *Limited ecological values present, but may provide limited infiltration and water filtering.*	Low
		Overall Ecological Value: Low	

Table J 1b: Ecological Values assessment for wetland habitats in the Ō2NL Project area.

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
IWFn1 - Bracken-whekī fernland on valley floor (Paruauku Swamp)	**0.03 ha (21)**	Representativeness – *Canopy dominated by indigenous species, likely to have formerly been swamp forest prior to human settlement, forest clearance and grazing.*	High
		Rarity/Distinctiveness – *Indigenous wetland vegetation in a land environment with less than 10% of indigenous vegetation cover remaining, classified as Threatened under Schedule F of the One Plan. Potential habitat for wetland birds including spotless crake (At Risk – Declining) and Australasian bittern (Botaurus poiciloptilus; Threatened – Nationally Critical) but not recorded during field surveys.*	High
		Diversity and Pattern – *Retains indigenous vegetation in the canopy (tree ferns) and ground tier layers. Species richness likely much reduced due to history of grazing. Contiguous with other indigenous vegetation types and are reflective of a gradient of increasing soil moisture levels. Part of a larger area of wetland habitat types in an upper arm of the Paruauku Swamp. Habitat may provide a foraging, breeding and roosting area for Threatened and At Risk bird species.*	Moderate
		Ecological Context – *Very few areas of indigenous wetland vegetation remain in natural wetlands on the Horowhenua Plains. However, the habitat at this site is poorly buffered.*	Moderate
		Overall Ecological Value: High	
MWFn1- Kiokio-spike sedge-Yorkshire fog fernland on valley floor (Paruauku Swamp)	**0.08 ha (19, 21)**	Representativeness – *Canopy dominated by indigenous species, likely to have formerly been swamp forest prior to human settlement, forest clearance and grazing.*	Moderate
		Rarity/Distinctiveness – *Indigenous wetland vegetation in a land environment with less than 10% of indigenous vegetation cover remaining, classified as Threatened under Schedule F of the One Plan. Potential habitat for wetland birds including spotless crake (At Risk – Declining) and Australasian bittern (Threatened – Nationally Critical), but not recorded during field surveys.*	High
		Diversity and Pattern – *Species richness likely much reduced due to history of grazing and invasion by pasture grasses. Part of a larger area of wetland habitat types in an upper arm of the Paruauku Swamp. Habitat may provide a foraging, breeding and roosting area for Threatened and At Risk bird species.*	Moderate
		Ecological Context – *Very few areas of indigenous wetland vegetation remain in natural wetlands on the Horowhenua Plains, but the habitat area is poorly buffered.*	Moderate
		Overall Ecological Value: Moderate	
IWRe1 - Raupō reedland on valley floor	**0.12 ha (493, 472)**	Representativeness – *Canopy dominated by indigenous species, likely to have formerly been swamp forest prior to human settlement, forest clearance and grazing.*	High
		Rarity/Distinctiveness – *Provides habitat for spotless crake (At Risk – Declining). Potential habitat for Australasian bittern (Threatened – Nationally Critical).*	High

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
		Diversity and Pattern – *Species richness likely much reduced due to history of human modification.* Grades from reedland to open water habitats. *Provide foraging, breeding and roosting areas for Threatened and At Risk bird species and act as stepping stones for movement between sites.*	Moderate
		Ecological Context – *Very few areas of indigenous wetland vegetation remain in natural wetlands on the Horowhenua Plains, but the habitat area is small and poorly buffered.*	Moderate
		Overall Ecological Value: High	
IWSe1 - *Isolepis prolifera* sedgeland on the valley floor	**0.01 ha (207)** **0.01 ha (47)** Total Area: 0.02 ha	Representativeness – *Canopy dominated by indigenous species, but very modified by grazing. Likely to have formerly been swamp forest prior to human settlement, forest clearance and grazing.*	Moderate
		Rarity/Distinctiveness – *Indigenous-dominant wetlands comprise an ecosystem type that is much reduced; however, this wetland is a very degraded example with no Threatened or At Risk Species, or unusual assemblages.*	Low
		Diversity and Pattern – *The diversity of indigenous plant species has been reduced by grazing.*	Low
		Ecological Context – *Very few areas of indigenous wetland vegetation remain in natural wetlands on the Horowhenua Plains, but the habitat area is small and poorly buffered. Part of a habitat network for common wetland fauna in the local area (e.g. pūkeko*; *Porphyrio porphyrio).*	Moderate
		Overall Ecological Value: Moderate	
IWSe1-SPG - *Isolepis prolifera* sedgeland within a seepage wetland	**0.18 ha (519)** 0.02 ha (519) 0.02 ha (519) 0.02 ha (519) 0.01 ha (519) Total Area: 0.25 ha	Representativeness – *Canopy dominated by indigenous species, but very modified by grazing. Likely to have formerly been swamp forest prior to human settlement, forest clearance and grazing.*	Moderate
		Rarity/Distinctiveness – *Seepage wetlands are an Endangered naturally uncommon ecosystem in New Zealand (Holdaway et al. 2012). However, this wetland is a very degraded example with no Threatened or At Risk Species, or unusual assemblages.*	Moderate
		Diversity and Pattern – *Supports a range of indigenous plant species. However, the overall species diversity has been reduced by grazing.*	Moderate
		Ecological Context – *Very few areas of indigenous wetland vegetation remain in natural wetlands on the Horowhenua Plains, but the habitat area is small and poorly buffered. Part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Moderate	

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
IWSe2 - *Isolepis prolifera*-kiokio-spike sedge sedgeland on valley floor	**0.12 ha (455, 461)**	Representativeness – *Canopy dominated by indigenous species; likely to have formerly been swamp forest prior to human settlement, forest clearance and grazing.*	Moderate
		Rarity/Distinctiveness – *Indigenous-dominant wetlands comprise an ecosystem type that is much reduced; however, this wetland is a very degraded example. Potential habitat for wetland birds including spotless crake (At Risk – Declining).*	Moderate
		Diversity and Pattern – *The diversity of indigenous plant species has been reduced by grazing. Habitat may provide a foraging or roosting area for Threatened and At Risk bird species and provide a stepping stone for the movement of fauna between sites.*	Low
		Ecological Context – *Very few areas of indigenous wetland vegetation remain in natural wetlands on the Horowhenua Plains, but the habitat area is small and poorly buffered. Part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Moderate	
IWSe3 - Rautahi sedgeland on valley floor (Paruauku Swamp)	**0.05 ha (21)**	Representativeness – *Canopy dominated by indigenous species, likely to have formerly been swamp forest prior to human settlement, forest clearance and grazing.*	Moderate
		Rarity/Distinctiveness – *Indigenous wetland vegetation in a land environment with less than 10% of indigenous vegetation cover remaining, classified as Threatened under Schedule F of the One Plan. Potential habitat for wetland birds including spotless crake (At Risk – Declining) and Australasian bittern (Threatened – Nationally Critical).*	High
		Diversity and Pattern – *Species richness likely much reduced due to history of grazing. Part of a larger area of wetland habitat types in an upper arm of the Paruauku Swamp. Habitat may provide foraging, breeding and roosting area for bird species.*	Moderate
		Ecological Context – *Very few areas of indigenous wetland vegetation remain in natural wetlands on the Horowhenua Plains, but the habitat area is small and poorly buffered.*	Moderate
		Overall Ecological Value: Moderate	
IWSe4 - *Isolepis prolifera-Juncus planifolius* sedgeland on valley floor (Paruauku Swamp)	0.001 ha (19)	Representativeness – *Canopy dominated by indigenous species, likely to have formerly been swamp forest prior to human settlement, forest clearance and grazing.*	Moderate
		Rarity/Distinctiveness – *Indigenous wetland vegetation in a land environment with less than 10% of indigenous vegetation cover remaining. Potential habitat for wetland birds including spotless crake (At Risk – Declining) and Australasian bittern (Threatened – Nationally Critical), but not recorded during field surveys.*	High
		Diversity and Pattern – *Species richness much reduced. Part of a larger area of wetland habitat types in an upper arm of the Paruauku Swamp. Habitat may provide foraging, breeding and roosting area for bird species.*	Moderate

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
		Ecological Context – *Very few areas of indigenous wetland vegetation remain in natural wetlands on the Horowhenua Plains, but the habitat area is small.*	Moderate
		Overall Ecological Value: Moderate	
IWSe5 - Kiokio-spike sedge- kāpūngāwhā sedgeland on valley floor (Paruauku Swamp)	**0.05 ha (19, 21)**	Representativeness – *Canopy dominated by indigenous species; likely to have formerly been swamp forest prior to human settlement, forest clearance and grazing.*	Moderate
		Rarity/Distinctiveness – *Indigenous wetland vegetation in a land environment with less than 10% of indigenous vegetation cover remaining. Potential habitat for wetland birds including spotless crake (At Risk – Declining) and Australasian bittern (Threatened – Nationally Critical), but not recorded during field surveys.*	High
		Diversity and Pattern – *Moderate diversity of indigenous wetland species. Part of a larger area of wetland habitat types in an upper arm of the Paruauku Swamp. Habitat may provide foraging, breeding and roosting area for bird species.*	Moderate
		Ecological Context – *Very few areas of indigenous wetland vegetation remain in natural wetlands on the Horowhenua Plains, but the habitat area is small.*	Moderate
		Overall Ecological Value: Moderate	
MWSe1-SPG - *Isolepis prolifera*-soft rush sedgeland within a seepage wetland	MWSe1-SPG **0.06 ha (38)** MWSe1-SPGd 0.02 ha (40)	Representativeness – *Canopy dominated by indigenous species, likely to have formerly been swamp forest prior to human settlement, forest clearance and grazing.*	Moderate
		Rarity/Distinctiveness – *Seepage wetlands comprise an Endangered naturally uncommon ecosystem in New Zealand (Holdaway et al. 2012). However, this wetland is a very degraded example with no Threatened or At Risk species, or unusual assemblages.*	Moderate
		Diversity and Pattern – *Supports a diversity of indigenous plant species, but reduced by grazing.*	Moderate
		Ecological Context – *Very few areas of indigenous wetland vegetation remain in natural wetlands on the Horowhenua Plains, but the habitat area is small and poorly buffered. Part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Moderate	
MWSe2 - *Isolepis prolifera*-floating sweet grass sedgeland on valley floor	**0.02 ha (134)** **0.01 ha (207)** Total Area: 0.03 ha	Representativeness – *Canopy dominated by indigenous species; likely to have formerly been swamp forest prior to human settlement, forest clearance and grazing.*	Moderate
		Rarity/Distinctiveness – *Indigenous-dominant wetlands comprise an ecosystem type that is much reduced; however, this wetland is a very degraded example with no Threatened or At Risk species, or unusual assemblages.*	Low
		Diversity and Pattern – *Species richness likely much reduced due to history of grazing.*	Low
		Ecological Context - *Very few areas of indigenous wetland vegetation remain in natural wetlands on the Horowhenua Plains. However, the habitat area is small and poorly buffered. Part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
		Overall Ecological Value: Moderate	
MWSe3 - *Isolepis prolifera*-Mercer grass sedgeland on valley floor	**0.01 ha (472)**	Representativeness – *Dominated by indigenous species, likely to have formerly been swamp forest prior to human settlement, forest clearance and grazing.*	Moderate
		Rarity/Distinctiveness – *Indigenous-dominant wetlands comprise an ecosystem type that is much reduced; however, this wetland is a very degraded example with no Threatened or At Risk species, or unusual assemblages, that includes exotic species.*	Low
		Diversity and Pattern – *Species richness likely much reduced due to history of grazing.*	Low
		Ecological Context – *Very few areas of indigenous wetland vegetation remain in natural wetlands on the Horowhenua Plains, but the habitat area is small and poorly buffered. Part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Moderate	
MWSe3 - *Isolepis prolifera*-Mercer grass sedgeland on oxbow wetland	**0.04 ha (47)** **0.05 ha (52, 47)** Total Area: 0.09 ha	Representativeness – *Indigenous-dominant wetlands comprise an ecosystem type that is much reduced; however, this wetland supports no Threatened or At Risk species, or unusual assemblages, and includes a high proportion of exotic species. Vegetation is representative of a recently formed oxbow ecosystem type.*	Moderate
		Rarity/Distinctiveness – *Indigenous-dominant wetlands comprise an ecosystem type that is much reduced, and oxbow wetlands comprise a distinctive ecosystem type. However, this wetland is a very degraded example with no Threatened or At Risk Species, or unusual assemblages, that includes exotic species.*	Moderate
		Diversity and Pattern – *Species richness likely much reduced due to history of grazing.*	Low
		Ecological Context - *Very few areas of indigenous wetland vegetation remain in natural wetlands on the Horowhenua Plains, but the habitat area is small and poorly buffered. Part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Moderate	
MWSe4 - Pūrei-spike sedge-Yorkshire fog sedgeland on valley floor (Paruauku Swamp)	**0.01 ha (19)**	Representativeness – *Canopy dominated by indigenous species, likely to have formerly been swamp forest prior to human settlement, forest clearance and grazing.*	Moderate
		Rarity/Distinctiveness – *Indigenous wetland vegetation in a land environment with less than 10% of indigenous vegetation cover remaining. Potential habitat for wetland birds including spotless crake (At Risk – Declining) and Australasian bittern (Threatened – Nationally Critical), but not recorded during field surveys.*	High
		Diversity and Pattern – *Species richness much reduced. Part of a larger area of wetland habitat types in an upper arm of the Paruauku Swamp. Habitat may provide a foraging, breeding and roosting area for Threatened and At Risk bird species and act as a stepping stone for the movement of fauna between sites.*	Moderate

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
		Ecological Context – *Very few areas of indigenous wetland vegetation remain in natural wetlands on the Horowhenua Plains. However, the area of habitat at this site is small.*	Moderate
		Overall Ecological Value: Moderate	
MWG1 - Yorkshire fog-*Isolepis prolifera*-spike sedge grassland on valley floor	**0.01 ha (461)** **0.01 ha (461)** **0.01 ha (461)** Total Area: 0.03 ha	Representativeness – *Canopy includes a high proportion of indigenous species, but is likely to have formerly been swamp forest prior to human settlement, forest clearance and grazing.*	Moderate
		Rarity/Distinctiveness – *Indigenous-dominant wetlands comprise an ecosystem type that is much reduced; however, this wetland is a very degraded example with no Threatened or At Risk species, or unusual assemblages, and includes a significant proportion of exotic species.*	Moderate
		Diversity and Pattern – *Supports a low diversity of indigenous plant species but grades into areas of open water habitat.*	Moderate
		Ecological Context – *Very few areas of indigenous wetland vegetation remain in natural wetlands on the Horowhenua Plains, but the habitat area is relatively small. Part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Moderate	
MWG2 - Yorkshire fog-spike sedge grassland on valley floor (Paruauku Swamp)	**0.32 ha (21, 19)**	Representativeness – *Canopy supports some indigenous species, but likely to have formerly been swamp forest prior to human settlement, forest clearance and grazing.*	Moderate
		Rarity/Distinctiveness – *Wetlands comprise an ecosystem type that is much reduced; however, this wetland is a very degraded example. Potential habitat for wetland birds including spotless crake (At Risk – Declining) and Australasian bittern (Threatened – Nationally Critical), but not recorded during field surveys.*	Moderate
		Diversity and Pattern – *Supports some indigenous plant species, but reduced by grazing. Part of a larger area of wetland habitat types in an upper arm of the Paruauku Swamp. Habitat may provide foraging, breeding and roosting area for bird species.*	Moderate
		Ecological Context – *Very few areas of indigenous wetland vegetation remain in natural wetlands on the Horowhenua Plains. However, the area of this habitat is relatively small. Part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Moderate	
MWG1d – Mixed wetland species grassland on valley floor	**0.32 ha (577)** **0.12 ha (132, 134)** **0.15 ha (164)** 0.07 ha (605) 0.04 ha (605) **0.04 ha (164)**	Representativeness – *Likely dominated by exotic wetland plants with few indigenous species present.*	Low
		Rarity/Distinctiveness – *Wetlands comprise an ecosystem type that is much reduced; however, these wetlands are likely degraded and contain no Threatened or At Risk Species, or unusual assemblages, and a high proportion of exotic species.*	Low
		Diversity and Pattern – *Likely dominated by exotic plant species, with little diversity of indigenous species.*	Low

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
	Total Area: 0.76 ha	Ecological Context – *Very few areas of indigenous wetland vegetation remain in natural wetlands on the Horowhenua Plains. However, the habitat area is relatively small. Part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Low	
MWG3 - Yorkshire fog-*Isolepis prolifera* grassland on valley floor	**0.13 ha (287)**	Representativeness – *Dominated by exotic wetland plants with few indigenous species.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area.*	Low
		Diversity and Pattern – *Wetland dominated by exotic plant species, but does include several indigenous plant species.*	Low
		Ecological Context – *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Low	
MWV1 - Blackberry-spike sedge vineland on valley floor	**0.02 ha (461)**	Representativeness – *Dominated by exotic wetland plants with few indigenous species.*	Low
		Rarity/Distinctiveness – *Wetlands comprise an ecosystem type that is much reduced; however, this wetland is a very degraded example. Possible habitat for spotless crake (At Risk – Declining).*	Moderate
		Diversity and Pattern – *Dominated by an exotic plant species, with little diversity of indigenous species. Habitat may provide a foraging, breeding and roosting area for bird species and may act as a stepping stone for the movement of fauna between sites.*	Low
		Ecological Context – *Provides a buffer between hillslope pasture and higher value indigenous wetland vegetation. Part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Moderate	
EWF1 - Crack willow forest on valley floor (Paruauku Swamp)	**0.03 ha (19)**	Representativeness – *Whilst the canopy of this vegetation type is dominated by exotic wetland plants, a number of indigenous wetland species occur in the understorey. This site is likely to have formerly been swamp forest prior to human settlement, forest clearance and grazing.*	Low
		Rarity/Distinctiveness – *Wetlands comprise an ecosystem type that is much reduced; however, this wetland is a very degraded example. Potential habitat for wetland birds including spotless crake (At Risk – Declining) and Australasian bittern (Threatened – Nationally Critical), but not recorded during field surveys.*	Moderate
		Diversity and Pattern – *Despite supporting a number of indigenous wetland species in the understorey, a significant proportion of exotic wetland plants occur. Part of a larger area of wetland habitat types in an upper arm of the Paruauku Swamp. Habitat may provide a foraging, breeding and roosting area for bird species.*	Moderate

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
		Ecological Context – *Very few areas of indigenous wetland vegetation remain in natural wetlands on the Horowhenua Plains, but the habitat area is small and poorly buffered. Part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Moderate	
EWG1 - Floating sweet grass grassland on valley floor	**0.05 ha (573)**	**Representativeness – *Dominated by exotic wetland plants with few indigenous species.***	**Low**
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area.*	Low
		Diversity and Pattern – *Wetland dominated by exotic plant species with some indigenous plants present.*	Low
		Ecological Context – *Provides infiltration for water; however, is isolated from the waterway.*	Low
		Overall Ecological Value: Low	
EWG2 - Mercer grass grassland on valley floor	**0.002 ha (134)** **0.11 ha (472, 493)** Total Area: 0.12 ha	Representativeness – *Dominated by exotic wetland plants with few indigenous species*.	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area.*	Low
		Diversity and Pattern – *Wetland dominated by exotic plant species with only one indigenous species present.*	Low
		Ecological Context – *Provides a buffer between hillslope pasture and higher value indigenous wetland vegetation. Part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Low	
EWG3 - Blue sweetgrass-creeping buttercup grassland on valley floor	0.01 ha (499)	Representativeness – *Dominated by exotic wetland plants with few indigenous species.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands are dominated by exotic grasses and herbs.*	Low
		Diversity and Pattern – *Wetland dominated by exotic plant species with little variation due to changes in soil moisture.*	Low
		Ecological Context – *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Low	
EWG4 - Mercer grass-water pepper grassland on valley floor	**0.05 ha (40)**	Representativeness – *Dominated by exotic wetland plants with few indigenous species present.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area.*	Low
		Diversity and Pattern – *Wetland dominated by exotic plant species with little variation due to changes in soil moisture.*	Low
		Ecological Context – *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Low	

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
EWG5 - Yorkshire fog-creeping buttercup grassland on valley floor	0.01 ha (30)	Representativeness – *Dominated by exotic wetland plants with few indigenous species.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area.*	Low
		Diversity and Pattern – *Wetland dominated by exotic plant species with little variation due to changes in soil moisture.*	Low
		Ecological Context – *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Low	
EWG6 - Yorkshire fog-creeping buttercup-Mercer grass grassland on valley floor	**0.02 ha (117)** **0.04 ha (117)** Total Area: 0.06 ha	Representativeness – *Dominated by exotic wetland plants.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area.*	Low
		Diversity and Pattern – *Wetland dominated by exotic plant species with little variation due to changes in soil moisture.*	Low
		Ecological Context – *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Low	
EWG7 - Creeping bent grassland on valley floor	**0.10 ha (550, 535)**	Representativeness – *Dominated by exotic wetland plants with few indigenous species.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area.*	Low
		Diversity and Pattern – *Wetland dominated by one exotic plant species with little variation due to changes in soil moisture.*	Low
		Ecological Context – *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Low	
EWG8 – Soft rush/Yorkshire fog-creeping buttercup grassland on valley floor	**0.02 ha (131)**	Representativeness – *Dominated by exotic wetland plants.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area.*	Low
		Diversity and Pattern – *Wetland dominated by exotic plant species. Only limited zonation of vegetation due to changes in soil moisture is apparent.*	Low
		Ecological Context – *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Low	

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
EWG9 - Mercer grass-open water grassland on valley floor	**0.02 ha (209)**	Representativeness – *Dominated by exotic wetland plants with few indigenous species.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area.*	Low
		Diversity and Pattern – *Wetland dominated by mostly exotic plant species with little variation due to changes in soil moisture.*	Low
		Ecological Context – *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Low	
EWG1d - Exotic grassland in wetland on valley floor	**0.13 ha (592)**	Representativeness – *Dominated by exotic wetland plants with few indigenous species present.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area.*	Low
		Diversity and Pattern – *Wetland dominated by mostly exotic plant species with little variation due to changes in soil moisture.*	Low
		Ecological Context – *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Low	
MWH1 - Water celery-kikuyu-*Isolepis prolifera* herbfield on valley floor	**0.01 ha (207)**	Representativeness – *Dominated by exotic wetland plants with few indigenous species present.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area. Oxbow wetlands comprise a distinctive ecosystem type.*	Moderate
		Diversity and Pattern – *Wetland dominated by exotic plant species with few indigenous species present.*	Low
		Ecological Context – *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Moderate	
EWH1 - Creeping buttercup herbfield on valley floor (Paruauku Swamp)	**0.01 ha (25, 28)** **0.06 ha (21)** Total Area: 0.07 ha	Representativeness – *Dominated by exotic wetland plants.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area.*	Low
		Diversity and Pattern – *Wetland dominated by exotic plant species. Part of a larger area of wetland habitat types in an upper arm of the Paruauku Swamp.*	Moderate
		Ecological Context – *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Moderate	

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
EWH1d - Creeping buttercup herbfield on valley floor (desktop only)	**0.22 ha (501)** 0.52 ha (463) 0.03 ha (no property ID) Total Area: 0.77 ha	Representativeness – *Dominated by exotic wetland plants.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area.*	Low
		Diversity and Pattern – *Wetland dominated by exotic plant species.*	Moderate
		Ecological Context – *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Moderate	
EWH2 - Creeping buttercup-water pepper herbfield on valley floor	**0.09 ha (472)**	Representativeness – *Dominated by exotic wetland plants.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area.*	Low
		Diversity and Pattern – *Wetland dominated by exotic plant species; however, several indigenous plant species are still present.*	Low
		Ecological Context – *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Low	
EWH3 - Water celery herbfield on valley floor (Paruauku Swamp)	**0.02 ha (21,19)** **0.20 ha (21, 19)** **0.08 ha (21, 19)** Total Area: 1.02 ha	Representativeness – *Dominated by exotic wetland plants with few indigenous species present.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area*.	Low
		Diversity and Pattern – *Wetland dominated by exotic plant species with only one indigenous species present. Part of a larger area of wetland habitat types in an upper arm of the Paruauku Swamp.*	Moderate
		Ecological Context – *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Moderate	
EWH3, EWH4 – Herbfields dominated by water celery on valley floor	EWH3 0.01 ha (470) **0.07 ha (459)** **0.03 ha (473)** **0.09 ha (493)** **0.01 ha (472)**	Representativeness – *Dominated by exotic wetland plants with few indigenous species present*.	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area*.	Low
		Diversity and Pattern – *Wetland dominated by exotic plant species.*	Low
		Ecological Context – *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
	Total Area: 0.21 ha EWH4 **0.03 ha (461)** **0.03 ha (461)** Total Area: 0.06 ha	**Overall Ecological Value: Low**	
EWH5 - Water pepper herbfield on valley floor (Paruauku Swamp)	**0.03 ha (21)** **0.04 ha (21)** Total Area: 0.07 ha	Representativeness – *Dominated by exotic wetland plants with few indigenous species present.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area. Potential habitat for wetland birds including spotless crake (At Risk – Declining) and Australasian bittern (Threatened – Nationally Critical), but not recorded during field surveys.*	Moderate
		Diversity and Pattern – *Wetland dominated by exotic plant species and occasional indigenous species. Part of a larger area of wetland habitat types in an upper arm of the Paruauku Swamp.*	Moderate
		Ecological Context – *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Moderate	
EWH5, EWH6 – Herbfield dominated by water pepper on valley floor	EWH5 **0.002 ha (481)** 0.003 ha (531) Total Area: 0.01 ha EWH6 0.003 ha (40) 0.03 ha (40) Total Area: 0.03 ha	Representativeness – *Dominated by exotic wetland plants with few indigenous species present.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area*.	Low
		Diversity and Pattern – *Wetland dominated by exotic plant species with few indigenous species present.*	Low
		Ecological Context – *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Low	
EWH7 - Water pepper-Mercer grass herbfield on valley floor	**0.01 ha (47, 44)**	Representativeness – *Dominated by exotic wetland plants with few indigenous species present.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area*.	Low

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
		Diversity and Pattern – *Wetland dominated by exotic plant species with few indigenous species present.*	Low
		Ecological Context – *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Low	
EWH8 - Broadleaved fleabane/Yorkshire fog herbfield on valley floor (Paruauku Swamp)	**0.01 ha (19)**	Representativeness – *Dominated by exotic wetland plants with few indigenous species present.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area. Potential habitat for wetland birds including spotless crake (At Risk –Declining) and Australasian bittern (Threatened – Nationally Critical), but not recorded during field surveys.*	Moderate
		Diversity and Pattern – *Wetland dominated by exotic plant species with few indigenous species present. Part of a larger area of wetland habitat types in an upper arm of the Paruauku Swamp.*	Low
		Ecological Context – *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Moderate	
EWH9, EWH9d - Exotic dominant wetland on valley floor	EWH9 **0.44 ha (207)** EWH9d 0.32 ha (485)	Representativeness – *Predicted to comprise a wetland dominated by exotic wetland plants with few indigenous species present.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area*.	Low
		Diversity and Pattern – *Predicted to comprise a wetland dominated by exotic plant species with few indigenous species present.*	Low
		Ecological Context – *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Low	
EWH10, EWH10d – Soft rush/creeping buttercup-Yorkshire fog-mercer grass herbfield on valley floor	EWH10 **0.06 ha (131)** EWH10d 0.12 ha (38)	Representativeness – *Dominated by exotic wetland plants with few indigenous species present.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area*.	Low
		Diversity and Pattern – *Wetland dominated by exotic plant species with few indigenous species present.*	Low
		Ecological Context – *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Low	

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
MWRs1 - Soft rush/Yorkshire fog-spike sedge rushland (Paruauku Swamp)	**0.01 ha (19)**	Representativeness – *Supports some indigenous species, but likely to have formerly been swamp forest prior to human settlement, forest clearance and grazing.*	Low
		Rarity/Distinctiveness – *Wetlands comprise an ecosystem type that is much reduced; however, this wetland is a very degraded example. Potential habitat for wetland birds including spotless crake (At Risk – Declining) and Australasian bittern (Threatened – Nationally Critical), but not recorded during field surveys.*	Moderate
		Diversity and Pattern – *Supports a low diversity of indigenous plant species, but reduced by grazing. Part of a larger area of wetland habitat types in an upper arm of the Paruauku Swamp. Habitat may provide a foraging, breeding and roosting area for Threatened and At Risk bird species and possibly act as a stepping stone for the movement of fauna between sites.*	Low
		Ecological Context – *Very few areas of indigenous wetland vegetation remain in natural wetlands on the Horowhenua Plains; however, the habitat area is relatively small. Part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Moderate	
EWRs1, EWRs1d - Soft rush rushland on valley floor	EWRs1 **0.06 ha (52, 47)** **0.06 ha (no property ID)** Total Area: 0.11 ha EWRs1d 1.29 ha (199) 0.20 ha (no property ID) Total Area: 1.48 ha	Representativeness – *Dominated by exotic wetland plants with few indigenous species present.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area*.	Low
		Diversity and Pattern – *Wetland dominated by exotic plant species with few indigenous species present.*	Low
		Ecological Context – *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Low	
EWRs2 - Soft rush-creeping buttercup-Yorkshire fog rushland on valley floor (Paruauku Swamp)	**0.01 ha (21)**	Representativeness – *Dominated by exotic wetland plants.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area*. *Potential habitat for wetland birds including spotless crake (At Risk –Declining) and Australasian bittern (Threatened – Nationally Critical), but not recorded during field surveys.*	Moderate
		Diversity and Pattern – *Wetland dominated by exotic plant species. Part of a larger area of wetland habitat types in an upper arm of the Paruauku Swamp. Habitat may provide foraging, breeding and roosting area for bird species*	Low

Vegetation/Habitat Type	Area (Property ID), bold areas are within or partially within the Ō2NL Project footprint	Attributes to be Considered	Assigned Value
		Ecological Context – *Provides buffering to a wetland, infiltration for water, and is part of a habitat network for common wetland fauna in the local area (e.g. pūkeko).*	Moderate
		Overall Ecological Value: Moderate	
EWRs3 - Soft rush-Yorkshire fog rushland (Paruauku Swamp)	**0.16 ha (19, 20)**	Representativeness – *Dominated by exotic wetland plants with few indigenous species present.*	Low
		Rarity/Distinctiveness – *Valley floor wetlands dominated by exotic grasses and herbs are still found throughout the local area. Potential habitat for wetland birds including spotless crake (At Risk – Declining) and Australasian bittern (Threatened – Nationally Critical), but not recorded during field surveys.*	Moderate
		Diversity and Pattern – *Wetland dominated by exotic plant species with few indigenous species present. Part of a larger area of wetland habitat types in an upper arm of the Paruauku Swamp. Habitat may provide foraging, breeding and roosting area for bird species.*	Moderate
		Ecological Context - *Provides infiltration for water and is part of a habitat network for common wetland fauna in the local area (e.g., pūkeko).*	Moderate
		Overall Ecological Value: Moderate	
OW-Open water	**0.21 (461)** **0.05 ha (21)** **0.02 ha (134)** **0.02 ha (207)** **0.02 ha (493)** **0.02 ha (493)** **0.21 ha (461)** **0.004 ha (131)** 0.14 ha (470) **0.11 ha (535, 519)** 0.05 ha (473) 0.01 ha (473) 0.05 ha (473) 0.01 ha (473) **0.10 ha (473)** 0.10 ha (39) Total Area: 0.95 ha	Representativeness – *Largely artificially created or induced and do not represent natural features.*	Low
		Rarity/Distinctiveness – *Spotless crake (At Risk – Declining) and black shag (At Risk – Naturally Uncommon) and New Zealand dabchick (At Risk – Recovering) have been recorded within or adjacent to open water habitats, and may occur elsewhere within this habitat type. Australasian bittern (Threatened – Nationally Critical), black shag (At Risk – Naturally Uncommon), and New Zealand dabchick (At Risk – Recovering) may utilise open water habitats throughout the Ō2NL Project Area, at least intermittently.*	High
		Diversity and Pattern – *Supports a low diversity of indigenous plant species, and possibly a low diversity of wetland bird species. Habitat may provide a foraging, breeding and roosting area for Threatened and At Risk bird species and act as a stepping stone for the movement of fauna between sites.*	Low
		Ecological Context – *Provides water storage and is part of a habitat network for common wetland fauna in the local area.*	Moderate
		Overall Ecological Value: Moderate	

Table J 1c: Ecological Values assessment for other habitats in the Ō2NL Project area.

Vegetation/Habitat Type	Area (Property ID)	Attributes to be Considered	Assigned Value
TG1 - Gravelfield	**0.50 ha (209)** **0.67 ha (151, 158)** Total Area: 1.17ha	Representativeness – *Representative of natural river systems, but impacted by the establishment of willow along the banks.*	Moderate
		Rarity/Distinctiveness – *No rare features known. Potential habitat for Threatened and At Risk bird species including banded dotterel (Threatened – Nationally Vulnerable) and South Island pied oystercatcher (At Risk – Declining).*	Low
		Diversity and Pattern – *Contains a low diversity of indigenous species or habitat types.*	Low
		Ecological Context – *Provides habitat and connectivity for a fauna species including birds and freshwater fish. A feature that has intrinsic value to the functioning of local ecosystems.*	High
		Overall Ecological Value: Moderate	
EHG - House, gardens and farm buildings	Not listed – throughout. Total Area: 22.72 ha	Representativeness – *Contains very few representative elements.*	Very low
		Rarity/Distinctiveness – *No rare features known. May be revised following Summer 2022 lizard surveys.*	Very low
		Diversity and Pattern – *Supports a very low diversity of indigenous species.*	Very low
		Ecological Context – *Provides limited ecological context values.*	Very low
		Overall Ecological Value: Negligible	
ETP - Cropland and pasture	Not listed – throughout. Total Area: 515.56 ha	Representativeness – *Contains no representative elements.*	Very low
		Rarity/Distinctiveness – *No rare features known.*	Very low
		Diversity and Pattern – *Supports a very low diversity of indigenous species.*	Very low
		Ecological Context – *Provides limited ecological context values, but allows for rainfall infiltration.*	Low
		Overall Ecological Value: Negligible	
RRR - River/road/rail	Not listed – throughout. Total Area: 11.89 ha	Representativeness – *Contains very few representative elements.*	Very low
		Rarity/Distinctiveness – *No rare features known.*	Very low
		Diversity and Pattern – *Supports a very low diversity of indigenous species.*	Very low
		Ecological Context – *Provides limited ecological context values.*	Low
		Overall Ecological Value: Negligible	
QRY - Quarry	**0.87 ha (209)**	Representativeness – *Contains no representative elements.*	Very low
		Rarity/distinctiveness – *Supports a Not Threatened species of indigenous skink (northern grass skink).*	Moderate
		Diversity and Pattern – *Supports a very low diversity of indigenous species.*	Very low
		Ecological Context – *Provides no ecological context values.*	Very low
		Overall Ecological Value: Negligible	

APPENDIX J.9

BIODIVERSITY OFFSET AND ACCOUNTING MODELS (BOAMS) FOR THE Ō2NL PROJECT

APPENDIX J.9: Biodiversity Offset Accounting Models (BOAMs)

[on next page]

Māhoe-dominant forest and scrub

Impact model

	This section captures which elements of biodiversity, and over what area, will be impacted by the proposal					This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated predictions			
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Area of Impact (ha)	Benchmark	Measure prior to Impact	Measure after Impact	Biodiversity Value
1.1	Canopy	1.1a	Cover	percent	2.85	90	83	0	-2.63
		1.1b	Height	metre	2.85	20	7.37	0	-1.05
		1.1c	Basal area - mahoe	m2/ha	2.85	30	10.25	0	-0.97
		1.1d	Basal area- pukatea	m2/ha	2.85	30	6.96	0	-0.66
		1.1e	Basal area- other	m2/ha	2.85	30	2.12	0	-0.20
1.2	Diversity	1.2a	Diversity indig vascular plants - canopy	Species richness	2.85	15	3	0	-0.57
		1.2b	Diversity indig vascular plants - sub-canopy	Species richness	2.85	31	6	0	-0.55
		1.2c	Diversity indig vascular - epiphytes and lianes	Species richness	2.85	39	1	0	-0.07
		1.2d	Diversity indig vascular - understorey/ground tier	Species richness	2.85	94	22	0	-0.67
1.3	Understorey and ground tier	1.3a	Absolute cover of indgneous species	Percent	2.85	70	29	0	-1.18
1.4	Fauna resources	1.4a	Canopy epiphytes	Epiphytes/ha	2.85	218.5	0	0	0.00
		1.4b	Kohekohe and mahoe fruit	Number of fruiting trees per hectare	2.85	50	10	0	-0.57
		1.4c	Leaf litter	percent cover	2.85	85	40	0	-1.34
		1.4d	CWD	percent cover	2.85	50	25	0	-1.43
		1.4e							

Offset model

	This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model					These cells provide information about the proposed Offset Actions			Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L		This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute						This is the average Net Present Biodiversity Value for the Biodiversity Component
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Benchmark	Proposed Offset Actions	Offset area (ha)	Confidence in Offset Actions			Measure prior to Offset	Measure after Offset	Time till endpoint (years)	Biodiversity Value at Offset Site	Biodiversity Value at Impact Site	Attribute Net Present Biodiversity Value	Component Net Present Biodiversity Value
1.1	Canopy	1.1a	Cover	percent	90	Revegetation planting and maintenance	4.1	Confident 75-90%	Finite end point	Continue to Column M	0	90	8	2.67	-2.63	0.04	0.01
		1.1b	Height	metre	20	Revegetation planting and maintenance	4.1	Confident 75-90%	Finite end point	Continue to Column M	0	8	20	0.75	-1.05	-0.30	
		1.1c	Basal area - mahoe	m2/ha	30	Revegetation planting and maintenance	4.1	Confident 75-90%	Finite end point	Continue to Column M	0	4	20	0.25	-0.97	-0.72	
		1.1d	Basal area- pukatea	m2/ha	30	Revegetation planting and maintenance	4.1	Confident 75-90%	Finite end point	Continue to Column M	0	0.1	20	0.01	-0.66	-0.65	
		1.1e	Basal area- other	m2/ha	30	Revegetation planting and maintenance	4.1	Confident 75-90%	Finite end point	Continue to Column M	0	35.17	20	1.87	-0.20	1.67	
1.2	Diversity	1.2a	Diversity indig vascular plants - canopy	Species richness	15	Revegetation planting and maintenance	4.1	Confident 75-90%	Finite end point	Continue to Column M	0	10	8	1.78	-0.57	1.21	0.33
		1.2b	Diversity indig vascular plants - sub-canopy	Species richness	31	Revegetation planting and maintenance	4.1	Confident 75-90%	Finite end point	Continue to Column M	0	12	10	0.97	-0.55	0.42	
		1.2c	Diversity indig vascular - epiphytes and lianes	Species richness	39	Revegetation planting and maintenance	4.1	Low confidence >50% <75%	Finite end point	Continue to Column M	0	5	25	0.16	-0.07	0.08	
		1.2d	Diversity indig vascular - understorey/ground tier	Species richness	94	Revegetation planting and maintenance	4.1	Low confidence >50% <75%	Finite end point	Continue to Column M	0	20	25	0.26	-0.67	-0.41	
1.3	Understorey and ground tier	1.3a	Absolute cover of indgneous	Percent	70	Revegetation planting and maintenance	4.1	Confident 75-90%	Finite end point	Continue to Column M	0	70	15	2.17	-1.18	0.99	0.99
1.4	Fauna resources	1.4a	Canopy epiphytes	Epiphytes/ha	218.5	Revegetation planting and maintenance	4.1	Confident 75-90%	Finite end point	Continue to Column M	0	20	35	0.11	0.00	0.11	0.17
		1.4b	Kohekohe and mahoe fruit	Number of fruiting trees per hectare	50	Revegetation planting and maintenance	4.1	Confident 75-90%	Finite end point	Continue to Column M	0	50	35	1.20	-0.57	0.63	
		1.4c	Leaf litter	percent cover	85	Revegetation planting and maintenance	4.1	Confident 75-90%	Finite end point	Continue to Column M	0	75	25	1.43	-1.34	0.08	
		1.4d	CWD	percent cover	50	Revegetation planting and maintenance	4.1	Confident 75-90%	Finite end point	Continue to Column M	0	40	25	1.29	-1.43	-0.13	

Mixed indigenous-exotic forest

Impact model

	This section captures which elements of biodiversity, and over what area, will be impacted by the proposal					This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated predictions			
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Area of Impact (ha)	Benchmark	Measure prior to Impact	Measure after Impact	Biodiversity Value
1.1	Canopy	1.1a	Cover	percent	0.8	90	51	0	-0.45
		1.1b	Height	metre	0.8	20	8.5	0	-0.34
		1.1c	Basal area - mahoe	m2/ha	0.8	30	6.7	0	-0.18
		1.1d	Basal area- totara	m2/ha	0.8	30	19.9	0	-0.53
		1.1e	Basal area- GRILit	m2/ha	0.8	10	0.61	0	-0.05
1.2	Diversity	1.2a	Diversity indig vascular plants - canopy	Species richness	0.8	15	13	0	-0.69
		1.2b	Diversity indig vascular plants - sub-canopy	Species richness	0.8	31	3	0	-0.08
		1.2c	Diversity indig vascular - epiphytes and lianes	Species richness	0.8	39	1	0	-0.02
		1.2d	Diversity indig vascular - understorey/ground tier	Species richness	0.8	94	19	0	-0.16
1.3	Understorey and ground tier	1.3a	Absolute cover of indigenous species	Percent	0.8	70	29	0	-0.33
1.4	Fauna resources	1.4a	Canopy epiphytes	Epiphytes/ha	0.8	218.5	0	0	0.00
		1.4b	Kohekohe and mahoe fruit	Number of fruiting trees per hectare	0.8	50	0	0	0.00
		1.4c	Leaf litter	percent cover	0.8	85	20	0	-0.19
		1.4d	CWD	percent cover	0.8	50	6	0	-0.10
		1.4e							

Offset model

	This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model					These cells provide information about the proposed Offset Actions			Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L		This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute						This is the average Net Present Biodiversity Value for the Biodiversity Component
	Biodiversity Component		**Biodiversity Attribute**	**Measurement Unit**	**Benchmark**	**Proposed Offset Actions**	**Offset area (ha)**	**Confidence in Offset Actions**			**Measure prior to Offset**	**Measure after Offset**	**Time till endpoint (years)**	**Biodiversity Value at Offset Site**	**Biodiversity Value at Impact Site**	**Attribute Net Present Biodiversity Value**	**Component Net Present Biodiversity Value**
1.1	Canopy	1.1a	Cover	percent	90	Revegetation planting and maintenance	1.7	Confident 75-90%	Finite end point	Continue to Column M	0	90	8	1.11	-0.45	0.65	0.02
		1.1b	Height	metre	20	Revegetation planting and maintenance	1.7	Confident 75-90%	Finite end point	Continue to Column M	0	8	20	0.31	-0.34	-0.03	
		1.1c	Basal area - mahoe	m2/ha	30	Revegetation planting and maintenance	1.7	Confident 75-90%	Finite end point	Continue to Column M	0	4	20	0.10	-0.18	-0.08	
		1.1d	Basal area-totara	m2/ha	20	Revegetation planting and maintenance	1.7	Confident 75-90%	Finite end point	Continue to Column M	0	1.02	20	0.04	-0.53	-0.49	
		1.1e	Basal area-GRILit	m2/ha	10	Revegetation planting and maintenance	1.7	Confident 75-90%	Finite end point	Continue to Column M	0	1.18	20	0.09	-0.05	0.04	
1.2	Diversity	1.2a	Diversity indig vascular plants - canopy	Species richness	15	Revegetation planting and maintenance	1.7	Confident 75-90%	Finite end point	Continue to Column M	0	10	8	0.74	-0.69	0.04	0.06
		1.2b	Diversity indig vascular plants - sub-canopy	Species richness	31	Revegetation planting and maintenance	1.7	Confident 75-90%	Finite end point	Continue to Column M	0	8	10	0.27	-0.08	0.19	
		1.2c	Diversity indig vascular - epiphytes and lianes	Species richness	39	Revegetation planting and maintenance	1.7	Low confidence >50% <75%	Finite end point	Continue to Column M	0	5	25	0.06	-0.02	0.04	
		1.2d	Diversity indig vascular - understorey/ground tier	Species richness	94	Revegetation planting and maintenance	1.7	Low confidence >50% <75%	Finite end point	Continue to Column M	0	20	25	0.11	-0.16	-0.05	
1.3	Understorey and ground tier	1.3a	Absolute cover of indigenous	Percent	70	Revegetation planting and maintenance	1.7	Very confident >90%	Finite end point	Continue to Column M	0	70	15	1.04	-0.33	0.71	0.71
1.4	Fauna resources	1.4a	Canopy epiphytes	Epiphytes/ha	218.5	Revegetation planting and maintenance	1.7	Confident 75-90%	Finite end point	Continue to Column M	0	20	35	0.05	0.00	0.05	0.35
		1.4b	Kohekohe and mahoe fruit	Number of fruiting trees per hectare	50	Revegetation planting and maintenance	1.7	Confident 75-90%	Finite end point	Continue to Column M	0	50	35	0.50	0.00	0.50	
		1.4c	Leaf litter	percent cover	85	Revegetation planting and maintenance	1.7	Confident 75-90%	Finite end point	Continue to Column M	0	75	25	0.59	-0.19	0.40	
		1.4d	CWD	percent cover	50	Revegetation planting and maintenance	1.7	Confident 75-90%	Finite end point	Continue to Column M	0	40	25	0.54	-0.10	0.44	

Exotic riparian forest, scrub and vineland

Impact model

	This section captures which elements of biodiversity, and over what area, will be impacted by the proposal					This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated predictions			
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Area of Impact (ha)	Benchmark	Measure prior to Impact	Measure after Impact	Biodiversity Value
1.1	Canopy	1.1a	Cover	percent	0.4	90	11.1	0	-0.05
		1.1b	Height	metre	0.4	20	6.91	0	-0.14
		1.1c	Basal area - mahoe	m2/ha	0.4	30	4.3	0	-0.06
		1.1d	Basal area - crack willow	m2/ha	0.4	30	9.72	0	-0.13
		1.1e	Basal area - other	m2/ha	0.4	20	0.46	0	-0.01
1.2	Diversity	1.2a	Diversity indig vascular plants - canopy	Species richness	0.4	15	3	0	-0.08
		1.2b	Diversity indig vascular plants - sub-canopy	Species richness	0.4	31	4	0	-0.05
		1.2c	Diversity indig vascular - epiphytes and lianes	Species richness	0.4	39	1	0	-0.01
		1.2d	Diversity indig vascular - understorey/ ground tier	Species richness	0.4	94	9	0	-0.04
1.3	Understorey and ground tier	1.3a	Absolute cover of indigenous species	Percent	0.4	70	7.4	0	-0.04
1.4	Fauna resources	1.4a	Canopy epiphytes	Epiphytes/ha	0.4	218.5	0	0	0.00
		1.4b	Kohekohe and mahoe fruit	Number of fruiting trees per hectare	0.4	50	0	0	0.00
		1.4c	Leaf litter	percent cover	0.4	85	6	0	-0.03
		1.4d	CWD	percent cover	0.4	50	6	0	-0.05
		1.4e							Not calculated

Offset model

	This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model					These cells provide information about the proposed Offset Actions			Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L		This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute						This is the average Net Present Biodiversity Value for the Biodiversity Component
	Biodiversity Component		**Biodiversity Attribute**	**Measurement Unit**	**Benchmark**	**Proposed Offset Actions**	**Offset area (ha)**	**Confidence in Offset Actions**			**Measure prior to Offset**	**Measure after Offset**	**Time till endpoint (years)**	**Biodiversity Value at Offset Site**	**Biodiversity Value at Impact Site**	**Attribute Net Present Biodiversity Value**	**Component Net Present Biodiversity Value**
1.1	Canopy	1.1a	Cover	percent	90	Revegetation planting and maintenance	0.42	Confident 75-90%	Finite end point	Continue to Column M	0	90	8	0.27	-0.05	0.22	0.04
		1.1b	Height	metre	20	Revegetation planting and maintenance	0.42	Confident 75-90%	Finite end point	Continue to Column M	0	8	20	0.08	-0.14	-0.06	
		1.1c	Basal area - mahoe	m2/ha	30	Revegetation planting and maintenance	0.42	Confident 75-90%	Finite end point	Continue to Column M	0	4	20	0.03	-0.06	-0.03	
		1.1d	Basal area - crack willow	m2/ha	20	Revegetation planting and maintenance	0.42	Confident 75-90%	Finite end point	Continue to Column M	0	1.02	20	0.01	-0.13	-0.12	
		1.1e	Basal area - other	m2/ha	30	Revegetation planting and maintenance	0.42	Confident 75-90%	Finite end point	Continue to Column M	0	35.17	20	0.19	-0.01	0.18	
1.2	Diversity	1.2a	Diversity indig vascular plants - canopy	Species richness	15	Revegetation planting and maintenance	0.42	Confident 75-90%	Finite end point	Continue to Column M	0	10	8	0.18	-0.08	0.10	0.03
		1.2b	Diversity indig vascular plants - sub-canopy	Species richness	31	Revegetation planting and maintenance	0.42	Confident 75-90%	Finite end point	Continue to Column M	0	8	10	0.07	-0.05	0.01	
		1.2c	Diversity indig vascular - epiphytes and lianes	Species richness	39	Revegetation planting and maintenance	0.42	Low confidence >50% <75%	Finite end point	Continue to Column M	0	5	30	0.01	-0.01	0.00	
		1.2d	Diversity indig vascular - understorey/ ground tier	Species richness	94	Revegetation planting and maintenance	0.42	Low confidence >50% <75%	Finite end point	Continue to Column M	0	20	25	0.03	-0.04	-0.01	
1.3	Understorey and ground tier	1.3a	Absolute cover of indigenous	Percent	70	Revegetation planting and maintenance	0.42	Confident 75-90%	Finite end point	Continue to Column M	0	70	15	0.22	-0.04	0.18	0.18
1.4	Fauna resources	1.4a	Canopy epiphytes	Epiphytes/ha	218.5	Revegetation planting and maintenance	0.42	Confident 75-90%	Finite end point	Continue to Column M	0	20	35	0.01	0.00	0.01	0.09
		1.4b	Kohekohe and mahoe fruit	Number of fruiting trees per hectare	50	Revegetation planting and maintenance	0.42	Confident 75-90%	Finite end point	Continue to Column M	0	50	35	0.12	0.00	0.12	
		1.4c	Leaf litter	percent cover	50	Revegetation planting and maintenance	0.42	Confident 75-90%	Finite end point	Continue to Column M	0	75	25	0.17	-0.03	0.14	
		1.4d	CWD	percent cover	50	Revegetation planting and maintenance	0.42	Confident 75-90%	Finite end point	Continue to Column M	0	40	25	0.13	-0.05	0.08	

Planted indigenous forest

Impact model

	This section captures which elements of biodiversity, and over what area, will be impacted by the proposal						This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated predictions			
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Area of Impact (ha)	Benchmark	Measure prior to Impact	Measure after Impact	Biodiversity Value
1.1	Canopy	1.1a	Cover	percent	0.4	90	46.3	0	-0.21
		1.1b	Height	metre	0.4	20	9.17	0	-0.18
		1.1c	Basal area - Pittosporum spp.	m2/ha	0.4	30	18.54	0	-0.25
		1.1d	Basal area - GRIluc	m2/ha	0.4	10	5.48	0	-0.22
		1.1e	Basal area - other	m2/ha	0.4	10	2.04	0	-0.08
1.2	Diversity	1.2a	Diversity indig vascular plants - canopy	Species richness	0.4	15	4	0	-0.11
		1.2b	Diversity indig vascular plants - sub-canopy	Species richness	0.4	31	7	0	-0.09
		1.2c	Diversity indig vascular - epiphytes and lianes	Species richness	0.4	39	0	0	0.00
		1.2d	Diversity indig vascular - understorey/ground tier	Species richness	0.4	94	21	0	-0.09
1.3	Understorey and ground tier	1.3a	Absolute cover of indigenous species	Percent	0.4	70	77	0	-0.40
1.4	Fauna resources	1.4a	Canopy epiphytes	Epiphytes/ha	0.4	218.5	0	0	0.00
		1.4b	Kohekohe and mahoe fruit	Number of fruiting trees per hectare	0.4	50	0	0	0.00
		1.4c	Leaf litter	percent cover	0.4	85	49	0	-0.23
		1.4d	CWD	percent cover	0.4	50	19	0	-0.15
		1.4e							Not calculated

Offset model

	This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model					These cells provide information about the proposed Offset Actions			Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L		This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute						This is the average Net Present Biodiversity Value for the Biodiversity Component
	Biodiversity Component		**Biodiversity Attribute**	**Measurement Unit**	**Benchmark**	**Proposed Offset Actions**	**Offset area (ha)**	**Confidence in Offset Actions**			**Measure prior to Offset**	**Measure after Offset**	**Time till endpoint (years)**	**Biodiversity Value at Offset Site**	**Biodiversity Value at Impact Site**	**Attribute Net Present Biodiversity Value**	**Component Net Present Biodiversity Value**
1.1	Canopy	1.1a	Cover	percent	90	Revegetation planting and maintenance	0.67	Confident 75-90%	Finite end point	Continue to Column M	0	90	8	0.44	-0.21	0.23	0.01
		1.1b	Height	metre	20	Revegetation planting and maintenance	0.67	Confident 75-90%	Finite end point	Continue to Column M	0	8	20	0.12	-0.18	-0.06	
		1.1c	Basal area - Pittosporum spp.	m2/ha	30	Revegetation planting and maintenance	0.67	Confident 75-90%	Finite end point	Continue to Column M	0	9.01	20	0.09	-0.25	-0.16	
		1.1d	Basal area - GRIluc	m2/ha	20	Revegetation planting and maintenance	0.67	Confident 75-90%	Finite end point	Continue to Column M	0	2.3	20	0.04	-0.22	-0.18	
		1.1e	Basal area - other	m2/ha	30	Revegetation planting and maintenance	0.67	Confident 75-90%	Finite end point	Continue to Column M	0	35.17	20	0.31	-0.08	0.22	
1.2	Diversity	1.2a	Diversity indig vascular plants - canopy	Species richness	15	Revegetation planting and maintenance	0.67	Confident 75-90%	Finite end point	Continue to Column M	0	10	8	0.29	-0.11	0.18	0.04
		1.2b	Diversity indig vascular plants - sub-canopy	Species richness	31	Revegetation planting and maintenance	0.67	Confident 75-90%	Finite end point	Continue to Column M	0	8	10	0.11	-0.09	0.02	
		1.2c	Diversity indig vascular - epiphytes and lianes	Species richness	39	Revegetation planting and maintenance	0.67	Low confidence >50% <75%	Finite end point	Continue to Column M	0	5	25	0.03	0.00	0.03	
		1.2d	Diversity indig vascular - understorey/ground tier	Species richness	94	Revegetation planting and maintenance	0.67	Low confidence >50% <75%	Finite end point	Continue to Column M	0	20	25	0.04	-0.09	-0.05	
1.3	Understorey and ground tier	1.3a	Absolute cover of indigenous	Percent	70	Revegetation planting and maintenance	0.67	Very confident >90%	Finite end point	Continue to Column M	0	70	15	0.41	-0.40	0.01	0.01
1.4	Fauna resources	1.4a	Canopy epiphytes	Epiphytes/ha	218.5	Revegetation planting and maintenance	0.67	Confident 75-90%	Finite end point	Continue to Column M	0	20	35	0.02	0.00	0.02	0.07
		1.4b	Kohekohe and mahoe fruit	Number of fruiting trees per hectare	50	Revegetation planting and maintenance	0.67	Confident 75-90%	Finite end point	Continue to Column M	0	50	35	0.20	0.00	0.20	
		1.4c	Leaf litter	percent cover	85	Revegetation planting and maintenance	0.67	Confident 75-90%	Finite end point	Continue to Column M	0	75	25	0.23	-0.23	0.00	
		1.4d	CWD	percent cover	50	Revegetation planting and maintenance	0.67	Confident 75-90%	Finite end point	Continue to Column M	0	40	25	0.21	-0.15	0.06	

Exotic forest and treeland

Impact model

	This section captures which elements of biodiversity, and over what area, will be impacted by the proposal					This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated predictions			
	Biodiversity Component		Biodiversity Attribute	Measurement Unit	Area of Impact (ha)	Benchmark	Measure prior to Impact	Measure after Impact	Biodiversity Value
1.1	Canopy	1.1a	Cover	percent	0.68	90	50	0	-0.38
		1.1b	Height	metre	0.68	20	4.2	0	-0.14
1.2	Diversity	1.2a	Diversity indig vascular plants - canopy	Species richness	0.68	15	0	0	0.00
		1.2b	Diversity indig vascular plants - sub-canopy	Species richness	0.68	31	5	0	-0.11
		1.2c	Diversity indig vascular - epiphytes and lianes	Species richness	0.68	39	1	0	-0.02
		1.2d	Diversity indig vascular - understorey/ground tier	Species richness	0.68	94	7	0	-0.05
1.3	Understorey and ground tier	1.3a	Absolute cover of indgneous species	Percent	0.68	70	41	0	-0.40
1.4	Fauna resources	1.4a	Canopy epiphytes	Epiphytes/ha	0.68	218.5	0	0	0.00
		1.4b	Kohekohe and mahoe fruit	Number of fruiting trees per hectare	0.68	50	0	0	0.00
		1.4c	Leaf litter	percent cover	0.68	85	30	0	-0.24
		1.4d	CWD	percent cover	0.68	50	7	0	-0.10
		1.4e							

Offset model

	This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model					These cells provide information about the proposed Offset Actions			Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L		This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute						This is the average Net Present Biodiversity Value for the Biodiversity Component
	Biodiversity Component		**Biodiversity Attribute**	**Measurement Unit**	**Benchmark**	**Proposed Offset Actions**	**Offset area (ha)**	**Confidence in Offset Actions**			**Measure prior to Offset**	**Measure after Offset**	**Time till endpoint (years)**	**Biodiversity Value at Offset Site**	**Biodiversity Value at Impact Site**	**Attribute Net Present Biodiversity Value**	**Component Net Present Biodiversity Value**
1.1	Canopy	1.1a	Cover	percent	90	Revegetation planting and maintenance	0.68	Very confident >90%	Finite end point	Continue to Column M	0	90	8	0.51	-0.38	0.13	0.06
		1.1b	Height	metre	20	Revegetation planting and maintenance	0.68	Confident 75-90%	Finite end point	Continue to Column M	0	8	20	0.12	-0.14	-0.02	
1.2	Diversity	1.2a	Diversity indig vascular plants - canopy	Species richness	15	Revegetation planting and maintenance	0.68	Very confident >90%	Finite end point	Continue to Column M	0	10	8	0.34	0.00	0.34	0.10
		1.2b	Diversity indig vascular plants - sub-canopy	Species richness	31	Revegetation planting and maintenance	0.68	Very confident >90%	Finite end point	Continue to Column M	0	8	10	0.12	-0.11	0.02	
		1.2c	Diversity indig vascular - epiphytes and lianes	Species richness	39	Revegetation planting and maintenance	0.68	Very confident >90%	Finite end point	Continue to Column M	0	5	25	0.04	-0.02	0.02	
		1.2d	Diversity indig vascular - understorey/ground tier	Species richness	94	Revegetation planting and maintenance	0.68	Very confident >90%	Finite end point	Continue to Column M	0	20	25	0.07	-0.05	0.02	70
1.3	Understorey and ground tier	1.3a	Absolute cover of indgneous	Percent	70	Revegetation planting and maintenance	0.68	Very confident >90%	Finite end point	Continue to Column M	0	70	15	0.42	-0.40	0.02	0.02
1.4	Fauna resources	1.4a	Canopy epiphytes	Epiphytes/ha	218.5	Revegetation planting and maintenance	0.68	Confident 75-90%	Finite end point	Continue to Column M	0	20	35	0.02	0.00	0.02	0.08
		1.4b	Kohekohe and mahoe fruit	Number of fruiting trees per hectare	50	Revegetation planting and maintenance	0.68	Confident 75-90%	Finite end point	Continue to Column M	0	50	35	0.20	0.00	0.20	
		1.4c	Leaf litter	percent cover	85	Revegetation planting and maintenance	0.68	Confident 75-90%	Finite end point	Continue to Column M	0	75	25	0.24	-0.24	0.00	
		1.4d	CWD	percent cover	50	Revegetation planting and maintenance	0.68	Confident 75-90%	Finite end point	Continue to Column M	0	40	25	0.21	-0.10	0.12	

Combined wetlands (mixed indigenous-exotic sedgeland and grassland; exotic-dominant wetlands)

Impact model

	This section captures which elements of biodiversity, and over what area, will be impacted by the proposal					This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated predictions			
	Biodiversity Component		Biodiversity Attribute	Measurement Unit	Area of Impact (ha)	Benchmark	Measure prior to Impact	Measure after Impact	Biodiversity Value
1.1	Indigenous Canopy	1.1a	Indigenous cover	percent	3.31	90	58	0	-2.13
1.2	Diversity	1.2a	Sedge and rush species	Species richness	3.31	13	10	0	-2.55
		1.2b	Fern species	Species richness	3.31	5	2	0	-1.32
		1.2c	monocot and dicot herb and liane species	Species richness	3.31	8	0	0	0.00
		1.2d	Tree species	Species richness	3.31	3	0	0	0.00
		1.2e	Shrub species	Species richness	3.31	7	0	0	0.00
1.3	Fauna habitat and food provision	1.3a	Provision of foraging habitat for wetland bird species	Percent cover	3.31	80	10	0	-0.41
1.4	Indigenous bird species	1.4a	Number of Not Threatened bird species	Count	3.31	17	5	0	-0.97
		1.4b	Number of Threatened bird species	Count	3.31	2	0	0	0.00
		1.4c	Number ofAt Risk bird species	Count	3.31	6	0	0	0.00
		1.4d			3.31				Not calculated
		1.4e							Not calculated

Offset model

	This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model					These cells provide information about the proposed Offset Actions			Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L		This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute						This is the average Net Present Biodiversity Value for the Biodiversity Component
	Biodiversity Component	**Biodiversity Attribute**		**Measurement Unit**	**Benchmark**	**Proposed Offset Actions**	**Offset area (ha)**	**Confidence in Offset Actions**			**Measure prior to Offset**	**Measure after Offset**	**Time till endpoint (years)**	**Biodiversity Value at Offset Site**	**Biodiversity Value at Impact Site**	**Attribute Net Present Biodiversity Value**	**Component Net Present Biodiversity Value**
1.1	Canopy	**1.1a**	Indigenous cover	percent	90	Restore hydrology, pest plant control, planting, monitoring, and maintenance	4.65	Low confidence >50% <75%	Finite end point	Continue to Column M	5	90	8	2.15	-2.13	0.02	0.02
1.2	Diversity	**1.2a**	Sedge and rush species	Species richness	13	Restore hydrology, pest plant control, planting, monitoring, and maintenance	4.65	Low confidence >50% <75%	Finite end point	Continue to Column M	1	4	8	0.53	-2.55	**-2.02**	0.11
		1.2b	Fern species	Species richness	5	Restore hydrology, pest plant control, planting, monitoring, and maintenance	4.65	Low confidence >50% <75%	Finite end point	Continue to Column M	0	3	15	1.11	-1.32	**-0.21**	
		1.2c	monocot and dicot herb and liane species	Species richness	8	Restore hydrology, pest plant control, planting, monitoring, and maintenance	4.65	Low confidence >50% <75%	Finite end point	Continue to Column M	1	5	15	0.93	0.00	0.93	
		1.2d	Tree species	Species richness	3	Restore hydrology, pest plant control, planting, monitoring, and maintenance	4.65	Confident 75-90%	Finite end point	Continue to Column M	2	3	8	1.01	0.00	1.01	
		1.2e	Shrub species	Species richness	7	Restore hydrology, pest plant control, planting, monitoring, and maintenance	4.65	Confident 75-90%	Finite end point	Continue to Column M	2	4	8	0.87	0.00	0.87	
1.3	Fauna habitat and food provision	**1.3a**	Provision of foraging habitat for wetland bird species	Percent cover	80	Restore hydrology, pest plant control, planting, monitoring, and maintenance	4.65	Low confidence >50% <75%	Finite end point	Continue to Column M	30	60	8	0.85	-0.41	0.44	0.44
1.4	Indigenous bird species	**1.4a**	Number of Not Threatened	Count	17	Restore hydrology, pest plant control, planting, monitoring, and maintenance	4.65	Confident 75-90%	Finite end point	Continue to Column M	12	15	8	0.53	-0.97	**-0.44**	0.29
		1.4b	Number of Threatened bird species	Count	2	Restore hydrology, pest plant control, planting, monitoring, and maintenance	4.65	Low confidence >50% <75%	Finite end point	Continue to Column M	1	1	8	0.00	0.00	0.00	
		1.4c	Number ofAt Risk bird species	Count	6	Restore hydrology, pest plant control, planting, monitoring, and maintenance	4.65	Confident 75-90%	Finite end point	Continue to Column M	1	3	8	1.01	0.00	1.01	

Raupō reedland

Impact model

	This section captures which elements of biodiversity, and over what area, will be impacted by the proposal					This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated predictions			
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Area of Impact (ha)	Benchmark	Measure prior to Impact	Measure after Impact	Biodiversity Value
1.1	Canopy	1.1a	Cover of raupo	percent	0.12	80	60	0	-0.09
		1.1b	Cover of Carex spp. sedgeland	percent	0.12	15	30	0	-0.12
		1.1c	Cover of Isolepis prolifer	percent	0.12	5	10	0	-0.12
		1.1d							Not calculated
		1.1e							Not calculated

	This section captures which elements of biodiversity, and over what area, will be impacted by the proposal					This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated predictions			
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Area of Impact (ha)	Benchmark	Measure prior to Impact	Measure after Impact	Biodiversity Value
1.2	Diversity	1.2a	Number of sedge species	Species richness	0.12	6	3	0	-0.06
		1.2b	Number of monocot herb species (excluding	Species richness	0.12	3	1	0	-0.04
		1.2c	Number of tree species	Species richness	0.12	3	0	0	0.00
		1.2d	Number of shrub and liane species	Species richness	0.12	4	0	0	0.00
		1.2e	Number of fern species	Species richness	0.12	2	0	0	0.00

	This section captures which elements of biodiversity, and over what area, will be impacted by the proposal					This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated predictions			
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Area of Impact (ha)	Benchmark	Measure prior to Impact	Measure after Impact	Biodiversity Value
1.3	Habitat complexity for wetland birds	1.3a	Provision of foraging habitat for wetland bird	Percent cover	0.12	80	80	0	-0.12
		1.3b							-0.03
		1.3c							-0.06
		1.3d							-0.06
		1.3e							Not calculated

	This section captures which elements of biodiversity, and over what area, will be impacted by the proposal					This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated predictions			
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Area of Impact (ha)	Benchmark	Measure prior to Impact	Measure after Impact	Biodiversity Value
1.4	Wetland bird species	1.4a	Diversity of wetland bird species	Count	0.12	9	2	0	Not calculated
		1.4b	Number of spotless crake	Count	0.12	4	2	0	Not calculated
		1.4c	Number of marsh crake	Count	0.12	4	2	0	Not calculated

Offset model

	This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model					These cells provide information about the proposed Offset Actions			Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L		This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute						This is the average Net Present Biodiversity Value for the Biodiversity Component
	Biodiversity Component		**Biodiversity Attribute**	**Measurement Unit**	**Benchmark**	**Proposed Offset Actions**	**Offset area (ha)**	**Confidence in Offset Actions**			**Measure prior to Offset**	**Measure after Offset**	**Time till endpoint (years)**	**Biodiversity Value at Offset Site**	**Biodiversity Value at Impact Site**	**Attribute Net Present Biodiversity Value**	**Component Net Present Biodiversity Value**
1.1	Canopy	**1.1a**	Cover of raupo	percent	80	Site preparation, direct transfer of raupo, enrichment planting	0.25	Confident 75-90%	Finite end point	Continue to Column M	0	80	8	0.16	-0.09	0.07	0.05
		1.1b	Cover of Carex spp.	percent	15	Site preparation, direct transfer of sedges enrichment planting	0.25	Confident 75-90%	Finite end point	Continue to Column M	0	15	8	0.16	-0.12	0.04	
		1.1c	Cover of Isolepis	percent	5	None required as Isolepis prolifer will naturally establish	0.25	Confident 75-90%	Finite end point	Continue to Column M	0	5	8	0.16	-0.12	0.04	
1.2	Diversity	**1.2a**	Number of sedge species	Species richness	6	Site preparation, direct transfer of raupo, enrichment planting	0.25	Confident 75-90%	Finite end point	Continue to Column M	1	4	8	0.08	-0.06	0.02	0.11
		1.2b	Number of monocot herb species (excluding sedges and rushes)	Species richness	3	Site preparation, direct transfer of raupo, enrichment planting	0.25	Confident 75-90%	Finite end point	Continue to Column M	0	3	8	0.16	-0.04	0.12	
		1.2c	Number of tree species	Species richness	3	Site preparation, planting , and maintenance	0.25	Confident 75-90%	Finite end point	Continue to Column M	0	3	8	0.16	0.00	0.16	
		1.2d	Number of shrub and liane species	Species richness	4	Site preparation, planting , and maintenance	0.25	Confident 75-90%	Finite end point	Continue to Column M	0	4	8	0.16	0.00	0.16	
		1.2e	Number of fern species	Species richness	2	Site preparation, planting , and maintenance	0.25	Confident 75-90%	Finite end point	Continue to Column M	0	1	8	0.08	0.00	0.08	
1.3	Habitat complexity for wetland birds	**1.3a**	Provision of foraging habitat for	Percent cover	80	Site preparation, direct transfer of raupo, enrichment planting	0.25	Confident 75-90%	Finite end point	Continue to Column M	10	80	8	0.14	-0.12	0.02	0.02
1.4	Wetland bird species	**1.4a**	Diversity of wetland bird species	Count	9	Site preparation, direct transfer of raupo, enrichment planting. Undertake predator control on wetland perimeter.	0.25	Confident 75-90%	Finite end point	Continue to Column M	0	6	10	0.10	Not calculated	0.10	0.11
		1.4b	Number of spotless crake	Count	4	Site preparation, direct transfer of raupo, enrichment planting. Undertake predator control on wetland perimeter.	0.25	Confident 75-90%	Finite end point	Continue to Column M	0	4	10	0.15	Not calculated	0.15	
		1.4c	Number of marsh crake	Count	4	Site preparation, direct transfer of raupo, enrichment planting. Undertake predator control on wetland perimeter.	0.25	Confident 75-90%	Finite end point	Continue to Column M	0	2	10	0.08	Not calculated	0.08	

Open water

Impact model

	This section captures which elements of biodiversity, and over what area, will be impacted by the proposal					This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated predictions			
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Area of Impact (ha)	Benchmark	Measure prior to Impact	Measure after Impact	Biodiversity Value
1.1	Habitat provision	1.1a	Open water	Percent cover	0.34	70	90	0	-0.34
		1.1b	Marginal vegetation (e.g. roads, raupo)	Percent cover	0.34	25	10	0	-0.14
		1.1c	Islands	Percent cover	0.34	5	0	0	0.00
		1.1d	Indented shoreline	Proportion of total shoreline	0.34	50	0	0	0.00
		1.1e							Not calculated

	This section captures which elements of biodiversity, and over what area, will be impacted by the proposal					This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated predictions			
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Area of Impact (ha)	Benchmark	Measure prior to Impact	Measure after Impact	Biodiversity Value
1.2	Diversity of indigenous birds	1.2a	Not Threatened species	Count	0.34	11	5	0	-0.15
		1.2b	Threatened bird species	Count	0.34	2	1	0	-0.17
		1.2c	At Risk species	Count	0.34	5	2	0	-0.14
		1.2d							Not calculated
		1.2e							Not calculated

	This section captures which elements of biodiversity, and over what area, will be impacted by the proposal					This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated predictions			
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Area of Impact (ha)	Benchmark	Measure prior to Impact	Measure after Impact	Biodiversity Value
1.3	Diversity of indigenous fish species	1.3a	Not Threatened species	Count	0.34	3	1	0	-0.11
		1.3b	Threatened species	Count	0.34	0	0	0	0.00
		1.3c	At Risk species	Count	0.34	1	0	0	0.00

Offset model

	This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model					These cells provide information about the proposed Offset Actions			Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L		This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute						This is the average Net Present Biodiversity Value for the Biodiversity Component
	Biodiversity Component	Biodiversity Attribute		Measurement Unit	Benchmark	Proposed Offset Actions	Offset area (ha)	Confidence in Offset Actions			Measure prior to Offset	Measure after Offset	Time till endpoint (years)	Biodiversity Value at Offset Site	Biodiversity Value at Impact Site	Attribute Net Present Biodiversity Value	Component Net Present Biodiversity Value
1.1	Habitat provision	1.1a	Open water	Percent cover	70	Excavation and rehabilitation of borrow site	0.48	Low confidence >50% <75%	Finite end point	Continue to Column M	0	80	8	0.23	-0.34	-0.11	0.09
		1.1b	Marginal vegetation (e.g. reeds, raupo)	Percent cover	25	Excavation and rehabilitation of borrow site	0.48	Low confidence >50% <75%	Finite end point	Continue to Column M	0	15	8	0.14	-0.14	0.00	
		1.1c	Islands	Percent cover	5	Excavation and rehabilitation of borrow site	0.48	Low confidence >50% <75%	Finite end point	Continue to Column M	0	5	8	0.23	0.00	0.23	
		1.1d	Indented shoreline	Proportion of total shoreline	50	Excavation and rehabilitation of borrow site	0.48	Low confidence >50% <75%	Finite end point	Continue to Column M	0	50	8	0.23	0.00	0.23	
1.2	Diversity of indigenous birds	1.2a	Not Threatened species	Count	11	Excavation and rehabilitation of borrow site	0.48	Confident 75-90%	Finite end point	Continue to Column M	0	4	10	0.11	-0.15	-0.05	0.02
		1.2b	Threatened bird species	Count	2	Excavation and rehabilitation of borrow site	0.48	Low confidence >50% <75%	Finite end point	Continue to Column M	0	2	10	0.22	-0.17	0.05	
		1.2c	At Risk species	Count	5	Site preparation, planting , and maintenance	0.48	Low confidence >50% <75%	Finite end point	Continue to Column M	0	4	10	0.18	-0.14	0.04	
1.3	Diversity of indigenous fish species	1.3a	Not Threatened species	Count	3	Create fish passage between Ohau River and rehabilitated materials supply site	0.48	Confident 75-90%	Finite end point	Continue to Column M	1	1	8	0.00	-0.11	-0.11	0.06
		1.3b	Threatened species	Count	0	Create fish passage between Ohau River and rehabilitated materials supply site	0.48	Low confidence >50% <75%	Finite end point	Continue to Column M	0	0	8	0.00	0.00	0.00	
		1.3c	At Risk species	Count	1	Reintroduction of brown mudfish, presence of longfin eel	0.48	Low confidence >50% <75%	Finite end point	Continue to Column M	0	2	8	0.23	0.00	0.23	

APPENDIX J.10

BENCHMARK VALUES AND ASSUMPTIONS USED FOR THE BOAMS

Table J.8: Benchmark data and offset model assumptions for māhoe-dominant forest and scrub, mixed indigenous-exotic forest and scrub, planted indigenous forest, and exotic riparian forest, scrub and vineland.

Biodiversity Attribute	Benchmark values and justification	Assumptions
Cover of indigenous canopy	90% (based on numerous surveys of intact lowland forests in Northland)	Assumes that offset planting will be undertaken in pasture with no indigenous canopy cover. Moderately confident that 90% canopy cover will be achieved after eight years from commencement of restoration works.
Canopy height	20 metres (based on numerous surveys of lowland forests in Northland and surveys of surrounding tawa and titoki-dominant forest remnants (e.g., Waiopehu Reserve and Kimberley Reserve).	Assumes with Moderate confidence that the canopy will reach eight metres after 20 years from commencement of restoration works.
Basal area - māhoe	$30m^2$ Based on professional opinion	Predicted basal area after offsetting is undertaken is based on number of each species planted per hectare. Note that <u>all pukatea trees will be offset separately by undertaking replacement planting (90 trees at Property #519 and 90 trees at Te Ripo O Hinemata).</u> Māhoe is predicted to reach 10 centimetres diameter after 20 years. Predicted basal area assumes a planting rate of 500 māhoe stems per hectare, and 4,480 stems of other indigenous species. Pukatea is predicted to have a basal area of 0.1 m^2 per hectare after 20 years, based on a conservative growth rate of five millimetres per year and planting 20 stems per hectare. Tōtara is predicted to reach 10 centimetres diameter after 20 years. The predicted basal area assumes a planting rate of 130 stems per hectare. Kāpuka/broadleaf is predicted to reach 10 centimetres diameter after 20 years. The predicted basal area assumes a planting rate of 150 māhoe stems per hectare. Diameters for tarata (*Pittosporum eugenioides*) and kōhūhū (*P. tenuifolium*) were averaged and are presented as "*Pittosporum* spp." in the BOAM for **Planted Indigenous Forest**. Both species are predicted to reach 15 centimetres diameter after 20 years. The predicted basal area assumes a planting rate of 510 stems per hectare.
Basal area – pukatea	$30m^2$ Extrapolated from growth rates from Tane's Tree Trust.	
Basal area – totara	$20m^2$ Extrapolated from Ebbett, R. L. & Ogden, J. (1998)[1].	
Basal area – kāpuka	$10m^2$ Based on professional opinion	
Pittosporum spp.	$30m^2$ Based on professional opinion and observations of *Pittosporum* spp. planted in 1980s (Auckland region).	

[1] Comparative seedling growth of five endemic New Zealand podocarp species under different light regimes. New Zealand journal of botany, 36(2), 189-201.

Biodiversity Attribute	Benchmark values and justification	Assumptions
Diversity of indigenous canopy species	15 species (based on the species list recorded from Keeble's Bush)	Moderately confident that the benchmark of 10 canopy species can be achieved after 8 years, 8 sub-canopy species can be achieved after 10 years, and 20 understorey and ground tier species can be achieved after 25 years. However, it will take much longer (100 years+) for the lower tiers to reach Benchmark diversity values given that many of the species (e.g., filmy ferns, epiphytic orchids) need the appropriate conditions present in mature forests to establish. Furthermore, very few of these species would survive if planted early on in the restoration programme. Accordingly, a low level of confidence has been used for the diversity of vascular epiphytes, lianes, and understorey/ground tier species.
Diversity of indigenous sub-canopy species	31 species (based on the species list recorded from Keeble's Bush)	
Diversity of vascular epiphytes and lianes	39 species (based on the species list recorded from Keeble's Bush)	
Diversity of indigenous understorey/ ground tier species	94 species (based on the species list recorded from Keeble's Bush)	
Cover of understorey and ground tier species	70 % (based on numerous surveys of intact lowland forests in the Northland and visit to Waiopehu Scenic Reserve)	Moderately confident that 70% cover can be achieved after 15 years as long as best practice post-planting maintenance is implemented.
No of vascular epiphytes per/ha	Lack of literature on epiphyte densities in lowland North Island forests. A benchmark value for epiphytes per hectare has therefore been estimated using data collected by Taylor and Burns (2015) from a forested reserve in Wellington. This study counted 695 vascular epiphytes on 371 host species, which is approximately 1.9 epiphytes per host tree. A conservative estimate of 115 host trees per hectare (average spacing of 10 metres) gives a benchmark value of **218.5** epiphytes per hectare (115 x 1.9 = 218.5).	Moderately confident that 20 planted canopy trees per hectare will establish epiphytes within 35 years. Early establishers are likely to be species such as leather-leaf fern (*Pyrrosia elaeagnifolia*), *Asplenium polyodon*, *Asplenium flaccidum*, and *Earina* species. Larger epiphyte species such as *Astelia hastata* are expected to take at least several decades to establish.
No of fruiting kohekohe and mahoe trees per/ha	50 trees (difficult to find a reference from the Manawatu Plains, although based on observations of kohekohe- and mahoe-dominant forests in the Wellington region, it is reasonable to expect at least 25 of each species to occur within one hectare.	Based on the restoration plant schedules and growth rates of kohekohe and mahoe, we are moderately confident that there will be at least 50 fruiting trees of each species per hectare after 35 years.
Cover of leaf litter	85% (based on numerous surveys of intact lowland forests in the Northland and observations within Waiopehu Scenic Reserve).	Moderately confident that 75% cover of leaf can be achieved after 25 years based on surveys of regenerating forests in the Wellington region.

Biodiversity Attribute	Benchmark values and justification	Assumptions
Cover of coarse woody debris	50% (based on numerous surveys of intact lowland forests in the Northland and observation within Waiopehu Scenic Reserve).	Moderately confident that 40% cover of coarse woody debris can be achieved after 25 years based on surveys of regenerating forests in the Wellington region.

Table J.9: Benchmark data and offset model assumptions for raupō reedland.

Biodiversity Attribute	Benchmark values and justification	Assumptions
Cover of raupō	80% (informed by numerous surveys of raupō-dominant wetlands throughout the North Island).	Assumed a benchmark cover of 80% for raupō, given that it often occurs with locally common species such as swamp millet and *Carex* spp. (i.e., it is rare to find 100% cover of raupō in a wetlands). Moderately confident that 80% cover of raupō can be achieved at the offset site within eight years of restoration works commencing.
Cover of *Carex* spp.	15% (informed by numerous surveys of raupō-dominant wetlands throughout the North Island).	*Carex secta* is often locally common downstream of raupō where soils are more saturated or standing water is present. Moderately confident 15% cover of *Carex* species can be achieved within eight years of restoration works commencing.
Cover of *Isolepis prolifer*	10% (based on survey of raupō reedland at Property #493 and numerous surveys of raupō-dominant wetlands throughout the North Island)	*Isolepis prolifer* is often restricted to boggy ground on the margins of raupō reedland. Moderately confident 5% cover of *Isolepis prolifer* species can be achieved within eight years of restoration works commencing.
Number of sedge species	Six species (informed by numerous surveys of raupō-dominant wetlands throughout the North Island).	A benchmark of six indigenous sedge species was used in the offsetting model: *Carex geminata*, *Carex secta*, *Carex virgata*, *Cyperus ustulatus*, *Isolepis prolifer*, and *Machaerina rubiginosa*. Moderately confident at least four of these species will have established within eight years of restoration works commencing.
Number of non-woody monocot species (excluding sedges and rushes)	Three species (raupō, harakeke, and swamp millet are considered the most likely non-woody species to occur in raupō-dominant wetlands).	A benchmark of three indigenous monocot species was used in the offsetting model. Moderately confident that all of these species will have established within eight years of restoration works commencing (noting that raupō will be established by direct transfer, harakeke will be planted, and swamp millet is expected to establish naturally).
Number of tree species	Three species (kahikatea, swamp maire, and pukatea can occur on the margins of less disturbed sites).	A benchmark of three indigenous tree species was used in the offsetting model: kahikatea, swamp maire, and pukatea. These species will be planted at the offset site. Moderately confident that all three planted tree species will have established successfully within eight years of restoration works commencing.

Biodiversity Attribute	Benchmark values and justification	Assumptions
Number of shrub and liane species	Four species (mānuka, tī kōuka, *Coprosma propinqua*, and pink bindweed are often present in raupō-dominant swamps).	A benchmark of four indigenous shrub/liane species was used in the offsetting model: mānuka, tī kōuka, *Coprosma propinqua,* and pink bindweed. Moderately confident that all of these species will have established successfully within eight years of restoration works commencing (noting that pink bindweed is expected to establish naturally).
Number of fern species	Two species (*Hiya distans* and whekī are two fern species that commonly occur in raupō-dominant swamps).	Moderately confident that at least one of these species will have established successfully within eight years of restoration works commencing.
Provision of foraging habitat for wetland bird species	80% cover, which is the estimated amount at the impact site. This is basically a measure of the density of vegetation within the wetland and is considered appropriate based on numerous surveys of raupō-dominant wetlands throughout the North Island).	80% cover is estimated for the impact site. Moderately confident that a similar level of cover can be achieved within eight years of restoration works commencing.
Diversity of wetland bird species	A benchmark of nine indigenous wetland bird species was used in the offsetting model: (pūkeko, paradise shelduck, spotless crake, marsh crake, bittern, spur winged plover, North Island fernbird, kāhu (harrier), and white-faced heron).	Assumed a low level of confidence that at least six wetland bird species will inhabit or forage at the offset site within 10 years of restoration works commencing.
Number of spotless crake	Four individuals	It is assumed that the spotless crake and marsh crake heard calling during the surveys were paired with other birds (rather than individual birds). It is difficult to set a benchmark value, as this is very much dependent on the size of the wetland. Given that the size of the proposed offset raupō reedland will be at least twice the size of the impact site, we have multiplied the current number of spotless crake and marsh crake by two to arrive at a benchmark of four for each species. Moderately confident that four spotless crake and two marsh crake will be recorded at offset sites within 10 years of restoration works commencing.
Number of marsh crake	Four individuals	

Table J.10: Benchmark data and offset model assumptions for exotic-dominant wetlands, *Isolepis prolifer*-dominant wetlands, and mixed exotic-indigenous wetlands.

Biodiversity Attribute	Benchmark values and justification	Assumptions
Cover of indigenous species	Benchmark of 90% indigenous cover (the cover expected in intact, good quality indigenous wetlands).	The relative indigenous cover was averaged across six wetland plots to determine an indigenous cover of 58% prior to impact. We have assumed with a low level of confidence that indigenous cover in the offset wetland will reach 90% within eight years of restoration works commencing.
Diversity of sedge and rush species	Benchmark value of 13 species based on wetland species lists recorded from the Manawatū Plains.	Assumed with a low level of confidence that there will be four sedge and rush species established in the restoration works area after 15 years. Lower confidence is attributed to uncertainty around restoring the natural hydrology of the offset wetland (Te Ripo O Hinemata wetland at Koputaroa).
Number of monocot and dicot herb and liane species	Benchmark number of eight species based on wetland species lists recorded from the Manawatū Plains.	We have assumed with a low level of confidence that there will be five monocot and dicot herb and liane species established in the restoration works area after 15 years. The low level of confidence is attributed to uncertainty around restoring natural hydrology of the offset wetland.
Number of tree species	Benchmark value of three species based on wetland species lists recorded from the Manawatū Plains.	Moderately confident that there will be three tree species established in the restoration works area after eight years. A higher level of confidence has been assigned to this attribute due to tree species (once planted/established) being less vulnerable to competition by weeds.
Number of shrub species	Benchmark value of seven species based on wetland species lists recorded from the Manawatū Plains.	Moderate level of confidence that there will be four shrub species established in the restoration works area after eight years. A higher level of confidence has been assigned to this attribute due to shrub species (once planted/established) being less vulnerable to competition by weeds.
Number of fern species	Benchmark value of five species based on wetland species lists recorded from the Manawatū Plains.	Assumed a low level of confidence that there will be three fern species established in the restoration works area after eight years. The low level of confidence is attributed to some fern species being less tolerant of competition.
Provision of foraging habitat for wetland bird species	Benchmark of 80%, which takes into account the presence of raupō, sedgeland, and woody species such as kahikatea and tī kōuka	Conservatively assumed at least 60% of the restored wetland will provide foraging habitat for wetland bird species over a timeframe of eight years from restoration works commencing.
Diversity of bird species	The benchmark value of 25 for diversity of indigenous wetland bird species is based on surveys undertaken by Wildland Consultants in 2006 and 2021, and observations listed in the Kereru Wetlands Conservation Covenant Management Plan (17 Not Threatened, 2 Threatened, 6 At Risk). It also includes the following species that were not observed in the	Moderately confident that at least another three 'Not Threatened' bird species and two additional 'At Risk' bird species will inhabit or forage at the offset site within eight years of restoration works commencing.

Biodiversity Attribute	Benchmark values and justification	Assumptions
	aforementioned surveys but are known from the wider area: North Island fernbird, bittern, royal spoonbill, and white-faced heron.	

Table J.11: Benchmark data and offset model assumptions for open water habitat.

Biodiversity Attribute	Benchmark data and justification	Assumptions
Habitat provision for indigenous fauna – open water	70%, based on observations of numerous lake ecosystems throughout Northland, Auckland and the Bay of Plenty.	Four key attributes for habitat provision have been included in the BOAM: open water (%), littoral vegetation (%), islands (%), and proportion of indented shoreline. All Open Water impact sites provide minimal habitat with respect to littoral vegetation (%), islands (%), and proportion of indented shoreline, and this is reflected in the BOAM. We have assumed the rehabilitated materials supply site can meet or exceed the benchmark values through careful design, construction, and planting, although we have applied a low level of confidence given the potential hydrological and geotechnical constraints with such an undertaking.
Habitat provision for indigenous fauna – littoral vegetation	25%, based on observations of numerous lake ecosystems throughout Northland, Auckland and the Bay of Plenty	
Habitat provision for indigenous fauna – islands	5%, based on observations of numerous lake ecosystems throughout Northland, Auckland and the Bay of Plenty	
Habitat provision for indigenous fauna – indented shoreline	50%, based on observations of numerous lake ecosystems throughout Northland, Auckland and the Bay of Plenty	
Diversity of indigenous bird species	A benchmark value of 11 Not 'Threatened', five 'At Risk, and two 'Threatened' indigenous bird species was used in the offsets model, based on birds recorded in Lake Horowhenua and Papaitonga. It is acknowledged that this is a conservative number (i.e., an over estimate), and it is unlikely that a similar value will be achieved within the rehabilitated materials supply site, despite its size and habitat provision values.	Moderately confident that the rehabilitated materials supply site will support at least four 'Not Threatened' indigenous bird species after eight years (moderately confident); at least four 'At Risk' indigenous bird species after eight years (low confidence); and at least two species of 'Threatened' indigenous bird species after eight years (low confidence).
Diversity of indigenous fish species	A benchmark value of three 'Not Threatened' indigenous fish species and one 'At Risk' fish species was used in the offsets model, based on fish recorded in Lake Horowhenua.	Moderately confident that the rehabilitated materials supply site will support at least one 'Not Threatened' indigenous fish species (shortfin eel) after eight years. Assumed a low level of confidence that two 'At Risk' indigenous fish species (longfin eel and brown mudfish) will be present after eight years, based on fish passage being established between the wetland and Ōhau River. Note that brown mudfish would need to be reintroduced to the site, hence the low confidence.