James Hardie New Zealand

Ecological Assessment
of
Proposed Sand Extraction Activity

KesselsEcology
SURVEY, ASSESSMENT AND RESTORATION

Table of Contents

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EXECUTIVE SUMMARY

Overview

James Hardie New Zealand (JHNZ) proposes to establish a sand extraction and washing facility on a property north-west of Kaukapakapa, located at 353 McLachlan Road. The site consists of a mosaic of pasture, exotic vegetation and indigenous scrub intersected by three ephemeral streams flowing into the Kaipara Harbour. Kessels Ecology has been contracted by JHNZ to assess the ecological values of this proposed sand extraction site, and provide an assessment of potential adverse effects of the proposed extraction activity on ecological values present. As part of the assessment, methods to avoid, remedy, mitigate or offset adverse ecological effects are outlined.

The assessment was based on:

- Aquatic surveys including assessment of riparian and aquatic habitat, water quality, macroinvertebrates and fish;
- Surveys of birds, lizards and bats;
- A vegetation assessment, mapping all vegetation on site and identifying any Significant Ecological Areas.

Description of Ecological Features

The area of proposed sand extraction lies within a mosaic of pasture, exotic scrub and indigenous scrub intersected by streams leading directly into the Kaipara Harbour. Thirteen vegetation types have been described within the wider property, of which kanuka forest, riparian margin and rushland vegetation, as well as coastal wetland are ecologically significant indigenous plant communities. While most of the vegetation where the sand extraction is proposed to take place is dominated by exotic species and pasture, about 0.12 ha of ecologically significant riparian margin and rushland would also be adversely affected. The areas of exotic scrub and a small number of exotic trees within the extraction footprint also potentially provide habitat for indigenous bats and lizards.

Three stream systems flow from east to west through the JHNZ property, two of which are ephemeral soft-bottomed natural watercourses. Near and outside the southern border of the property is a stream system consisting of four branches, one permanently flowing and the rest intermittent/ephemeral. Part of the northernmost tributary in this system (southern tributary) is within the sand extraction area, and an area of ephemeral indigenous rushland in its headwaters will be modified. No other streams will be impacted by the proposed activities, and the riparian zones of all streams within the property are proposed to be enhanced.

Long-tailed bats are present at the property, and were detected around the borders of the proposed sand extraction area. The main areas of bat activity were around stands of mature exotic trees. While bat activity was low to moderate at the site, and no active bat roosts were discovered during the bat monitoring, potential cavity bearing exotic and indigenous trees suitable for bat roosts are found in this locality.

Bird species noted during the field surveys were dominated by exotic species with no At Risk or threatened species found to be utilising the habitats on site. However, several threatened species are known to use nearby habitats, including fernbird, kaka, and Australasian bittern.

No indigenous lizards were found during any of the surveys. The site is dominated by plague (rainbow) skinks, which are an introduced pest species. Nonetheless, the habitat on site is suitable for several indigenous skink and gecko species that have been recorded in the locality.

Potential adverse effects

A number of specific avoidance, remediation and mitigation measures are required to ensure that any adverse ecological effects associated with the proposed sand extraction operation are

minimised. Key potential adverse effects that require avoidance, remediation or mitigation include:

- Removal of 0.12 ha of indigenous riparian margin and rushland vegetation and 1.5 ha of exotic riparian margin vegetation;
- Disturbance of lizards and their habitat;
- Disturbance of bat habitat;
- Disturbance of birds and their habitats; and
- Altered stream hydrology and water quality by discharges of treated stormwater.

Recommendations for avoidance, remediation, mitigation and monitoring

The mitigation package proposed for the site gives provision for improving the habitat values and ecological connectivity at the property in the long term, as well as mitigating for adverse impacts. Additional enhancement measures that will further improve the ecological function and value of the site have also been outlined in this report.

To mitigate the loss of 0.12 ha riparian margin and rushland wetland it is recommended that a wetland is re-created following sand extraction, consisting of a total area of not less than 0.36 ha. Because there will be a time lag (approximately 10 years) between removal of the rushland wetland and recreation, it is also recommended that the existing area of ephemeral riparian wetland along the northern stream is fenced and enhanced as an offset mitigation measure. Approximately 1.5 ha of exotic riparian vegetation will be removed which provides low quality habitat for a limited range of indigenous fauna species; this will be mitigated by re-planting and restoring approximately 2.6 ha of indigenous riparian vegetation in the 'middle' and 'southern' streams found on the subject property. This stream riparian planting and associated pest control will also help offset the effects of habitat loss for terrestrial fauna.

It is recommended that an ecological mitigation and restoration plan (EMRP) is prepared and implemented, which should include measures to address work staging and specific sites for wetland recreation and riparian restoration, fencing requirements, the number and type of plants to be used, and a five-year plan for the maintenance of each restored area. In addition, the EMRP should include detailed management plans to minimise harm to critical fauna species during operation (birds, lizards) and to enhance habitat opportunities post-operation. Pest control measures should also be outlined.

The EMRP will be required to include, as a minimum:

- Pre-clearance surveys and checks for bats and lizards will be required prior to felling of vegetation, even though it is exotic.
- All revegetation areas should include pest animal control for a period after the restoration has been undertaken to encourage plant growth and maximise opportunities for indigenous fauna to reoccupy the locality.
- To minimise opportunities for weeds to establish on areas of exposed earth, continual revegetation of the site will be necessary. These measures are described in the Rehabilitation Concept Plan submitted as part of the application. It is also recommended that detailed planting and ecological management requirements are to be described in an Ecological Mitigation and Restoration Plan.
- In order to secure the restoration and enhancement investment measures, some form of legal protection is required over these areas. This can be by the way of a covenant, or condition of consent.

A Wildlife Authority will be required from DOC to 1) cover incidental killing of or injury to bats during construction, in particular the removal of mature vegetation, and 2) carry out salvage and recovery of indigenous lizards.

It is considered that the residual adverse effects of the sand extraction activity will be adequately avoided and mitigated by the proposed measures. In addition, multiple enhancement actions, such as pest control and additional stream restoration planting, will improve the ecological value of the site considerably in the long term.

1 INTRODUCTION AND SCOPE

Kessels Ecology was contracted by James Hardie New Zealand (JHNZ) to assess the ecological values of a proposed sand extraction site, and provide an assessment of potential effects on ecological values including methods for avoiding, remedying and mitigating these effects where necessary.

JHNZ proposes to establish a sand extraction and washing facility on a property north-west of Kaukapakapa, located at Lot 5 DP 470614, 353 McLachlan Road (Figure 1). The proposed facility will replace JHNZ's existing extraction operation at Glorit and the ageing wash plant operations at Kumeu.

Extraction is planned to amount to 23,000 m^3 of washed sand per year giving a resource life on the site of approximately 45 years. The extraction will, however, be carried out in small stages to minimise the area of land that is worked on at one time and will include the staged rehabilitation of each area as it is closed off from extraction activity. Sand will be extracted and transported to an on-site wash plant, which separates the sand from clay particles. The resulting products are clean sand, clay and wastewater. Wastewater is then recycled to the stormwater treatment pond system. The sand will be transported from the site by truck, and the clay will be returned to the extraction area.

The proposed extraction site is located near the south-eastern shore of the Kaipara Harbour in an area where farmland is underlain by sand. The property itself falls within the Rural – Coastal Zone as designated by the Auckland Unitary Plan Operative in Part November 2016 (the "Auckland Unitary Plan" hereafter). Objective H19.2.3 of the Auckland Unitary Plan sets out that:

(1) "The character, amenity values and biodiversity values of rural areas are maintained or enhanced while accommodating the localised character of different parts of these areas and the dynamic nature of rural production activities"; and

(2) "Areas of significant indigenous biodiversity are protected and enhanced".

More specifically the Rural – Coastal Zone, as set out by the Auckland Unitary Plan, recognises the "significant relationship between land, freshwater bodies and the coastal marine area" (Auckland Unitary Plan H19.5.2).

This report describes the ecological values of the site and assesses the ecological effects of the proposed sand extraction operation. The assessment was based on:

- A literature review;
- Aquatic surveys including assessment of riparian and aquatic habitat, water quality, macroinvertebrates and fish;
- Surveys of birds, lizards and bats;
- A vegetation assessment, which maps all vegetation on site using GIS mapping software, and identifies any areas of significant indigenous biodiversity or habitat; and
- Assessment of the ecological significance of the sites against the current Significant Ecological Area assessment criteria.

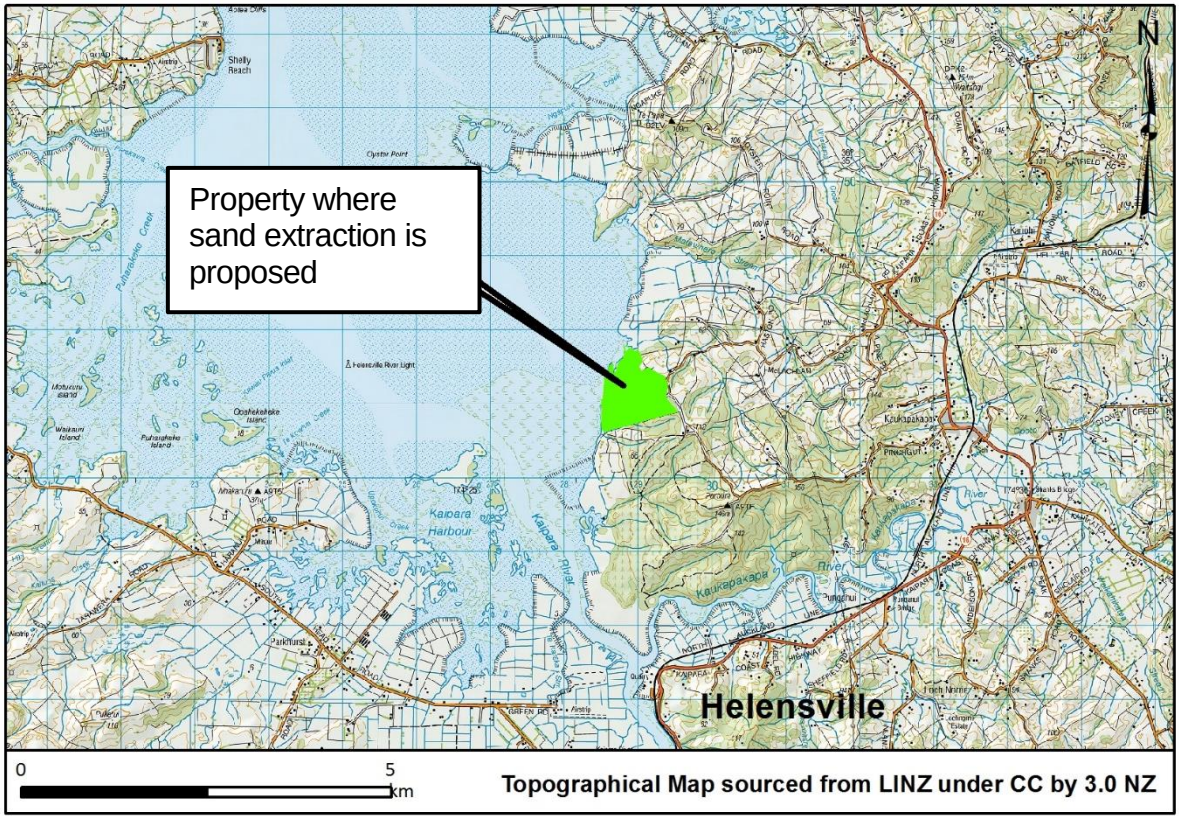

Figure 1. Location of the property where sand extraction is proposed.

2 METHODOLOGY

To assess the ecological values of the site of the proposed sand extraction, field surveys of aquatic and terrestrial environments were carried out. This information was supplemented with a thorough review of available literature.

2.1 Aquatic survey

The locations of the aquatic sampling sites are provided in Table 1 below and shown on Figure 2. Streams are unnamed waterways that flow into the Kaipara Harbour and for ease of reference have been given the names in the table below.

Table 1. Location of aquatic sampling sites. NZTM coordinates are provided for downstream end of the sampling reach, where relevant.

Site	Site location description	Northings	Eastings
Northern stream	Stream near northern extent of property	5947417	1728870
Middle stream	Stream in centre of property	5947292	1728725
Southern stream	Stream near, and partly outside southern boundary of property	5946665	1728712
Pond	Pond just beyond southern boundary of property	5946614	1728605
Southern tributary	Tributary of the southern stream (within extraction area)	5946651	1728661

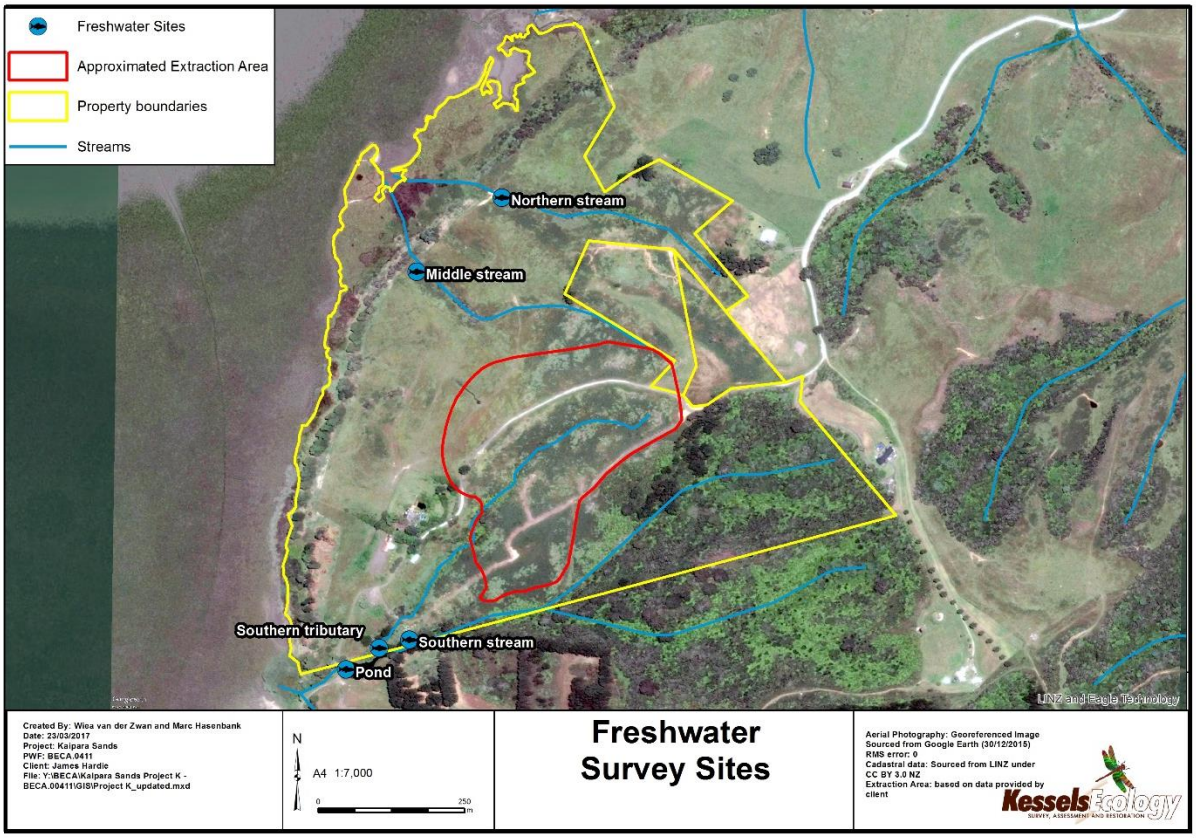

Figure 2. Location of streams and freshwater survey sites.

2.2 Stream Ecological Valuation (SEV)

Three streams at the project site (Table 1) were assessed using the Stream Ecological Valuation (SEV) methodology. The specific methodology is detailed in the Auckland Council technical report 2011/009 (Storey et al. 2011). The SEV is a method used to determine the ecological functioning or ecological value of a waterway and the results can be used to calculate the amount of environmental compensation (or offset mitigation) required to compensate for habitat loss as a result of the proposed environmental impact. While not required to assess mitigation for the sand extraction activities, SEV scores have been included for information on the wider ecological context of the property.

In addition, standard environmental habitat parameters were surveyed in accordance with Waikato Regional Council (WRC) methods (Collier and Kelly 2005) and have also been presented. While the site is not within the Waikato region, this method provides a good complement to the SEV as it has a slightly different focus, and some components are more detailed than the SEV method.

The SEV involves the measurement of the fourteen most important ecological functions identified by an expert panel of scientists (Table 2). These functions are used to determine the ecological function of a stream by scaling the values for each variable between 0 and 1. Each function is then weighted depending on its contribution to ecological function, resulting in a single score for the ecological function of the stream section.

The SEV assessment includes the sampling of periphyton, macrophytes, and macroinvertebrates, as well as morphological measurements of stream width, depth and substrate, at ten equally spaced transects at each of the sampling sites. Three stream sites (the northern, middle and southern streams) were surveyed while there was flowing water present.

Table 2. The 14 variables measured during the SEV assessment (source: Storey et al. 2011)

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

2.3 Aquatic macroinvertebrates

Aquatic macroinvertebrates were collected from the southern, middle and northern streams using a standard kick net (mesh size 500 µm and approximate aperture of 0.3 m^2) in accordance with procedures and methods detailed in 'Protocol C2- Soft-bottomed Semi-quantitative' by Collier and Kelly (2005). No macroinvertebrates were collected from the southern tributary as no water was present during sampling. Samples were processed and analysed using 'Protocol P2- 200 Fixed count and scan for rare taxa' (Stark et al. 2001) by taxonomist Brett Stansfield of EIA Ltd. Raw data is available in Appendix II. The following indices were calculated:

- Number of taxa – the number of invertebrate taxa present in each sample. Sites with more taxa are considered likely to be of higher environmental quality than sites with fewer taxa.
- Number of individuals – the number of macroinvertebrates in the sample. The number of individuals can indicate toxic pollution (if numbers are very low) or severe nutrient enrichment (if numbers of tolerant taxa are very high).
- EPT value (excluding Hydroptilidae) – the number of taxa of mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera) in the sample. These taxa are highly sensitive to environmental perturbations, and samples with higher numbers of these taxa indicate high environmental quality. The percentage of EPT taxa and the percentage of EPT individuals were also calculated. The family Hydroptilidae is not included in these indices, because this taxon is able to survive in more degraded environments than other EPT taxa.
- MCI and QMCI – The Macroinvertebrate Community Index (MCI) and Quantitative Macroinvertebrate Community Index (QMCI) indicate organic enrichment (Stark 1998). The indices are calculated by giving each taxon a score from 1 to 10, with 1 indicating highly tolerant taxa and 10 indicating highly sensitive taxa. The MCI uses

presence/absence data, and the QMCI uses abundance of each taxon. Higher MCI and QMCI scores indicate high habitat and water quality.

2.4 Water quality

Temperature, pH, dissolved oxygen, and conductivity were measured at each site using a calibrated YSI Pro-plus hand-held meter.

2.5 Fish

A fish survey was conducted in the southern stream, which is the only permanently flowing stream on the property. Fish species present at the survey sites and the wider catchments were identified using existing New Zealand Freshwater Fish Database records. Fish survey techniques were selected based on recommendations in national freshwater fish sampling protocols (Joy et al. 2014). Due to the shallow nature of the site, electric fishing was selected as the most suitable option. Fish surveys were carried out using a standardised 150 m backpack electrofishing reach as per national protocols (Joy et al. 2014). Indigenous fish captured were measured and returned to the stream alive. Habitat suitability for fish was described at all sites and potential fish passage barriers and other limitations were noted.

2.6 Terrestrial fauna

2.6.1 Bats

The focus of the bat monitoring was to investigate the potential presence of long-tailed bats (*Chalinolobus tuberculatus*) at the subject site, as well as gaining an understanding of how frequently bats visit the property.

For the field surveys, static digital recorders, alternatively known as Automated Bat Monitors (ABMs), were used in accordance with protocols developed by Dekrout & Reynolds (2009). This methodology was refined in consultation with the Department of Conservation (DoC) and was, in turn, largely based on the long-established protocols described by O'Donnell & Sedgeley (1994).

ABMs record the ultrasonic echolocation calls emitted by bats and convert them to frequencies audible by humans (Parsons and Szewczak 2009). Long-tailed bat (peak frequency 40 kHz; Parsons 2001) and lesser short-tailed bat (*Mystacina tuberculata* - peak frequency 28 kHz; Parsons 2001) echolocation calls are recorded simultaneously on two separate channels allowing straightforward identification of species present. Each echolocation pass (a series of calls separated from another series of calls by at least 1 second of silence; Thomas 1998) is time (hour/minute/second) and date (year/month/day) stamped providing timing information for activity.

Two bat surveys targeting long-tailed bats were conducted at the JHNZ site. The first survey was conducted over a period of 26 consecutive nights from 10th June to 5th of July 2016; while a second follow-up survey ran over 10 consecutive nights from 5th to 15th December 2016. Detectors were calibrated to have the same time and date settings (NZST) and were pre-set to start monitoring 30 minutes before sunset until 30 minutes after sunrise (during Jun/Jul: 16:30 to 08:30, or 15.5 hours per night; during Dec: 19:30 to 06:30, or 11 hours per night).

During the surveys in June/July and December 2016 eight and ten ABMs were set up, respectively. The locations of the ABMs during the surveys are shown in Figure 3 below (see also Appendix V). The locations were chosen based on proximity to mature exotic and indigenous tree and shrub vegetation, as well as on proximity to stream habitats. The distance between detector locations was at least 25 m apart to increase the chance of independent bat monitoring. The recorders were suspended around 2 m above the ground to reduce noise from terrestrial fauna.

All recordings were analysed visually and acoustically using Bat Search Software 1.04 or BatSearch3 (The Department of Conservation). For each night, the total number of detected bat passes was recorded.

To gain a better understanding of potential bat activity at the subject site the National Climate Database (NIWA 2016) was queried for weather conditions during each survey period. The closest station available was station 37852 in Albany, North Shore (Auckland). A summary of the weather conditions during the surveys is available in Appendix II.

Weather conditions during the June/July survey period were suboptimal for bat emergence and foraging activity (O'Donnell, 2000), due to nightly temperatures falling below 8°C on several occasions (Appendix II). Elevated precipitation towards the end of the June/July survey period may have also affected bat emergence during certain nights in June/July.

During the 5th-15th December survey, conditions were favourable for bat emergence and foraging activity (Appendix II). The lowest temperature was 11.9°C. The average daily precipitation was 1.2 mm, with no precipitation recorded on 6 of the 10 days. Wind was relatively light, with an average speed of 11.0 km/h.

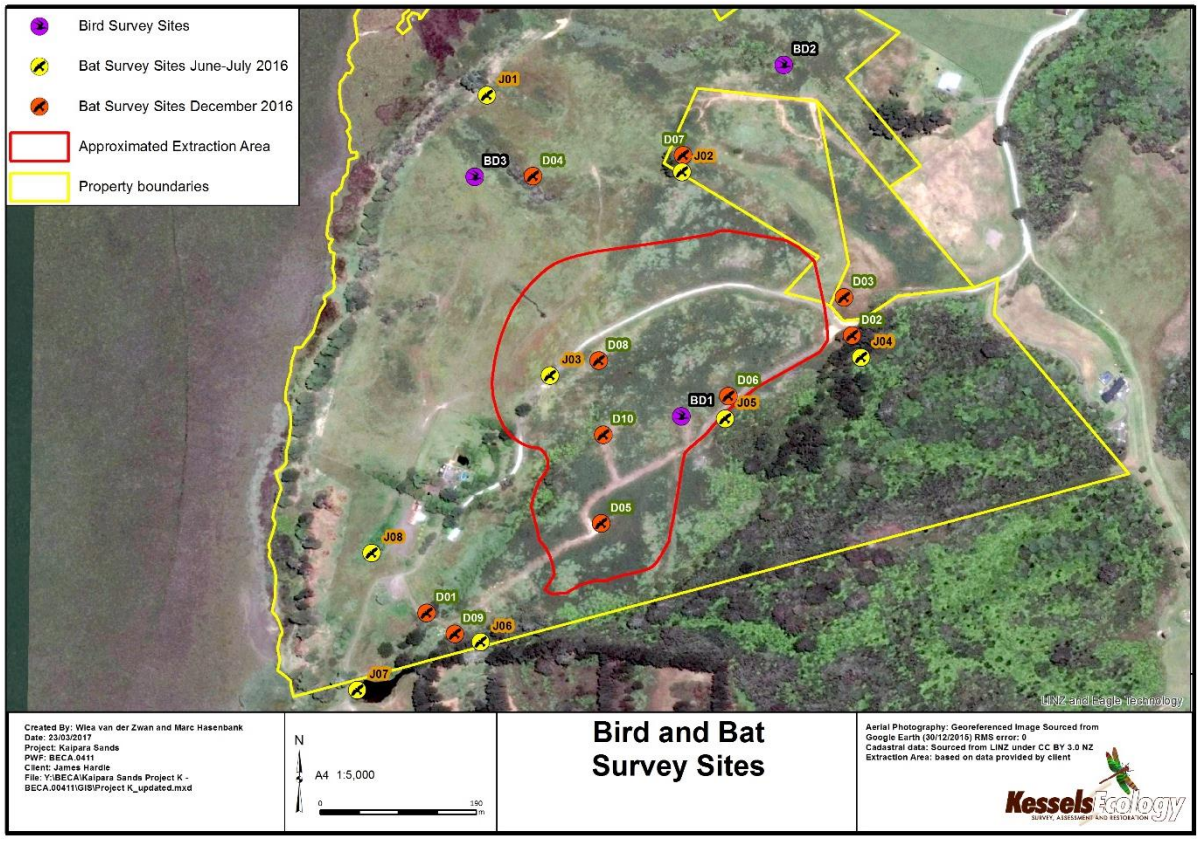

Figure 3. Locations of bat detectors during the June/July and December 2016 deployment; location of bird counts (see following section).

2.6.2 Birds

Birds were surveyed by means of 5-minute bird counts, as well as by recording of bird species observed during general ecological survey work. A summary of the search effort for birds is provided in Table 3.

In total three 5-minute bird counts were conducted on 7 May 2016. The location of the 5-minute bird counts is shown in Figure 3, and Appendix V. The three sites were chosen to reflect different habitat types, such as open pasture, as well as shrub and riparian margin. A five minute settle-in time was included with each 5-minute bird count. Any birds seen or heard during that settle-in period were recorded as general sightings, which were kept separate from the 5-minute bird count.

Table 3. Summary of all bird survey efforts at the subject site.

Survey type	Period	Hours	Minutes
5-minute bird counts	May	0	15
Walk-through survey	May, November, December	7	30

2.6.3 Lizards

A lizard survey focused on ground-dwelling skink species was conducted using artificial cover objects (ACOs) in accordance with protocols described in Lettink and Monks (2016). The survey using ACOs commenced in September 2016. Thirty-two sampling stations were established throughout the property targeting areas most likely to provide lizard habitat (e.g. suitably sheltered and damp areas alongside vegetation, log piles, edge vegetation; see Figure 4 and Appendix V). Each ACO was constructed of tri-layered Onduline® measuring 50x50 cm in size. ACOs were installed and left undisturbed for four weeks before the first inspection. This is the minimum time recommended to allow the equipment to 'weather in'. ACOs were checked a second time in December 2016.

All observations of lizards made opportunistically while conducting survey work were recorded, along with weather conditions during the observations.

In addition, destructive searches were conducted in November 2016 as part of a pre-clearance assessment of vegetation to be removed to allow access for exploratory drilling. Destructive searches involved scanning habitat for basking and/or foraging lizards, and checking all possible refuges by hand, including rocks, pampas tussocks, dead wood and crevices, during the day time (Whitaker 1994).

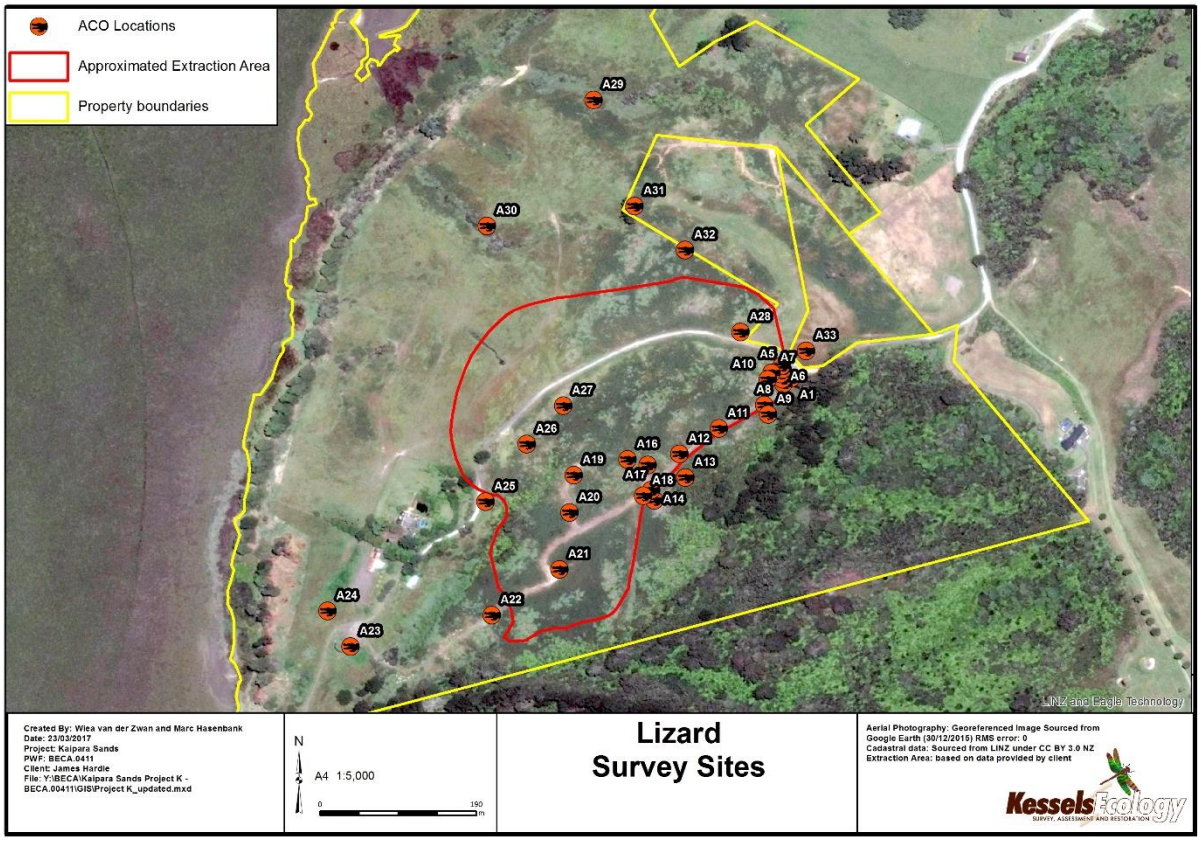

Figure 4. Locations of artificial cover objects (ACOs) for lizard survey.

2.7 Vegetation

Vegetation surveys were carried out on 6th and 7th of May 2016. Broad vegetation types at the site were recorded using an adaptation of the system developed by Atkinson (1985) (Table 4). The recording system from the original method was maintained but the boundaries of each type were determined using aerial photography and confirmed during the site visit and transferred on to a Geographic Information System (GIS). This walk-through survey methodology using aerial photography yields a vegetation map that provides a good indication of the structure and composition of the major vegetation types. In the text, common names are used, but a full botanical species list of species encountered during the walk-through survey can be found in Appendix III.

Furthermore, the vegetation survey also included searches for any rare or threatened plant species. Species records from relevant literature and biodiversity databases were utilised to focus search efforts on certain areas within the project site.

Table 4. Key to vegetation descriptions (from Atkinson 1985). Generally only species with a cover greater than 20% are included in the name but conspicuous or emergent species may also be included.

species	>50% of total vegetation cover of underlined species in a particular tier
species	20-49% of total vegetation cover of a species in a particular tier
(species)	10-19% of total vegetation cover of a bracketed species in a particular tier
[*species*]	1-10% of total vegetation cover of square bracketed species in a particular tier
Species1/*species*	Species 1 in a tier above species (e.g. species emergent above the canopy)
Species-species	Species occurring within the same tier

2.8 Literature review

Existing information on the area was reviewed to establish an understanding of the ecological values and issues associated with the site.

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

- NZ Freshwater Fish database;
- DoC BioWeb database;
- LENZ Threatened Environments database;
- Auckland Council Significant Ecological Areas database; and
- Landcare Research's NZ Lizard database.

Any threatened species found were recorded and their threat status checked against the relevant national threatened species classification lists: for bats: O'Donnell et al. (2013); for birds: Robertson et al. (2013); for fish: Goodman et al. (2014); for plants: de Lange et al. (2013); for freshwater invertebrates: Grainger et al. (2014); for spiders: Sirvid et al. (2012); and for reptiles: Hitchmough et al. (2013).

A 10 km radius around the subject property was chosen to select records of threatened freshwater fish from the NZFFD. In contrast, DoC BioWeb was queried for the wider area of the Kaipara Harbour (South Head to Parakai), as it also contains many highly mobile bird species. The NZ lizard database was queried based on potential distribution of lizard species within the upper North Island, and the Auckland region in particular.

2.9 GIS analysis

Vegetation types were mapped using ArcGIS 10.4 and the size and type of affected areas was analysed using Microsoft Excel. Databases and literature were used to calculate the extent of affected vegetation as a percentage of the remaining vegetation in the ecological district. The LENZ Threatened Environments Classification database was consulted to determine the context of the affected area from a landscape perspective.

2.10 Ecological significance analysis of vegetation cover

The Auckland Unitary Plan (AUP) lists a number of terrestrial sites of high ecological value (significant ecological areas, or SEAs) that have been identified using five main significance factors as set out in Schedule 3 Significant Ecological Areas – Terrestrial Schedule of the Auckland Unitary Plan. In short, these five significance factors are:

(1) Representativeness;

(2) Threat status and rarity;

(3) Diversity;

(4) Stepping-stones, migration pathways and buffers;

(5) Uniqueness or distinctiveness.

While the subject property does not contain any SEA as scheduled under the AUP (neither terrestrial, nor coastal), an assessment of all terrestrial and riparian vegetation areas present at the subject property was conducted against the five significance factors to formally establish the significance of any indigenous biodiversity and habitat values of these areas. The outcome of the ecological significance assessment is then used to inform any requirements under the "Natural Resources" objectives and policies of the Auckland Unitary Plan (Chapter B7). In particular, Objective B7.2.1(2) that is aimed at restoring, maintaining and enhancing indigenous biodiversity values in areas where indigenous ecological values have become degraded, or where pressures on indigenous ecological values exist through development.

A similar approach was taken for assessing any areas of coastal vegetation present within the subject property. The significance factors for assessing ecological significance for coastal environments are further outlined in Schedule 4 Significant Ecological Areas – Marine Schedule of the AUP:

(1) Recognised international or national significance;

(2) Threat status and rarity;

(3) Uniqueness or distinctiveness;

(4) Diversity;

(5) Stepping stones, buffers and migration pathways; and

(6) Representativeness.

Furthermore, those vegetation types found to be ecologically significant against the relevant significance factors of the AUP were also assessed against the nationally threatened environments classification as defined by Walker et al. (2015). This provided an assessment of the significance of those vegetation areas at a national level.

Based on the outcome of the ecological sensitivity analysis a number of recommendations for managing the indigenous vegetation and biodiversity values at the subject property were developed. These recommendations take into account the requirements under the relevant AUP's policies for vegetation management and biodiversity (Chapter E15).

3 DESCRIPTION OF ECOLOGICAL FEATURES

3.1 Aquatic ecosystems

Three stream systems flow from east to west through the JHNZ property, listed here from north to south:

- Northern stream: an ephemeral soft-bottomed natural watercourse flowing through a gully vegetated with exotic vegetation. Flows to the Kaipara Harbour;
- Middle stream: an ephemeral soft-bottomed natural watercourse flowing through a gully vegetated with exotic vegetation. Flows to the Kaipara Harbour;
- Southern stream: a system consisting of four branches, one permanently flowing and the rest consisting of intermittent and ephemeral sections. These are soft-bottomed natural watercourses that flow through areas of exotic and indigenous vegetation. These streams flow into an artificially created pond before discharging into the Kaipara Harbour. The northernmost intermittent/ephemeral tributary in this system (southern tributary) is partly within the sand extraction area, and ephemeral sections will be removed as part of the sand extraction process.

An initial site visit was conducted on 10 June 2016. During this visit, water quality was measured. The centre stream had no water flowing in it during this visit; but the southern and northern streams were flowing.

A more detailed survey was conducted on 6 July 2016. All three streams were flowing during this survey. Stream Ecological Valuation surveys were conducted on all three streams, and a fish survey was carried out in the southern stream and pond margins using backpack electrofishing.

The southern tributary was surveyed in January and March 2017; it was dry in January and flowing in March due to recent heavy rain.

3.1.1 Site description and physical habitat

3.1.1.1 Northern stream

The northern stream flows through a mostly dry gully dominated by woolly nightshade and gorse. Slightly more water was present than in the centre stream in July 2016. Near the downstream end of the stream where it leaves the property, less than 1 l/s of flow was present during the site visit on 10 June. More water was flowing during the 6 July site visit. The bottom substrate was silty and stock had access to the stream.

3.1.1.2 Middle stream

In a gully near the centre of the property was a stream channel, which was almost dry during the site visit on 10 June. No flowing water was noted, but a few pools were present at the downstream end near the western property boundary. Water was flowing on the second site visit on 6 July when the upper extent of the reach had diffuse flow over a grassy, pugged channel. The gully vegetation is dominated by dense growth of woolly nightshade and gorse. Stock have access to the stream.

3.1.1.3 Southern stream

The mainstem of the southern stream was mostly located outside the southern property boundary, with a small section of the mainstem and one tributary lying within the property. This was a small stream system consisting of four first-order gully tributaries. The main stem of the stream was a narrow, shallow channel with very low flow. The substrate was predominantly fine sediment (mainly sandy) with small amounts of small cobbles. The stream was well shaded with riparian vegetation, mostly pine trees. Habitat diversity is good, with woody debris which would provide habitat for macroinvertebrates and fish, however, the shallow depth of less than 15 cm would limit the available habitat.

3.1.1.4 Pond outside southern boundary of property

The southern stream system flows into a pond which was located outside the property boundary. The pond has been created by forming an earth bund in the location of an access track. Two culverts appear to run under the access track; one above the other. The upper culvert is clearly visible and did not contain water at the time of the site visit. The lower culvert had flowing water.

Water clarity was good, with abundant macrophytes present in the pond. Macrophytes included the introduced species curly-leaved pondweed (*Potamogeton crispus*) and bladderwort (*Utricularia gibba*). Filamentous green epiphytic algae was abundant in the margins of the pond, growing on the bladderwort.

3.1.1.5 Southern tributary

An intermittent and ephemeral tributary of the southern stream flows through the property, and an ephemeral section will be removed during sand extraction. The southern tributary is situated to the north of the southern stream and flows into the pond described above. This tributary runs in a gully that has mixed vegetation present, including indigenous rushland with indigenous riparian vegetation in the ephemeral upper reaches of the stream (vegetation type 11), eucalypt-nightshade-gorse shrubland adjacent to the ephemeral stream reaches (vegetation type 12), and nightshade, honeysuckle, and gorse-dominated shrub further downstream (vegetation type 4).

Table 5. Mean water depth and wetted width at the survey sites, 6 July 2016.

	Northern stream	Middle stream	Southern stream
Water depth (m)	0.05	0.07	0.16
Wetted width (m)	0.77	0.51	0.78

Table 6. Substrate size distribution (percentage composition) at the survey sites.

Substrate Type	Diameter (mm)	Northern stream	Middle stream	Southern stream
Bedrock				
Boulder	>256			
Cobble	64-256			4
Gravel	2-64	22		47
Silt/Sand	<2	78	100	49

Figure 5. Northern stream

Figure 6. Middle stream

Figure 7. Southern stream

Figure 8. Pond

Figure 9. Southern tributary (headwater seep)

3.1.2 Water quality

Dissolved oxygen (DO) is essential to aquatic fauna, which may become stressed or die if insufficient oxygen is present. Dissolved oxygen is depleted by microbial metabolism and respiration by plants and animals, and is typically lower in water bodies with high amounts of organic matter breakdown. Dissolved oxygen fluctuates over a 24-hour cycle in aquatic ecosystems, particularly where there are abundant macrophytes present. Concentrations are

lowest in the early hours of the morning due to respiration by plants, and are highest in the late afternoon due to photosynthesis. Dissolved oxygen varied among the survey sites and dates, with most values below 80%.

Specific conductivity is a measure of how much dissolved material is present in the water, and is a general indicator of water quality. Conductivity was very high at many of the sites, most likely due to the influence of saltwater spray from the nearby estuary. The pH was acidic, but the reason for this was unknown.

Table 7. Water quality parameters measured at the survey sites.

Site	Temperature (°C)	DO (%)	DO (mg/L)	Specific conductivity (µS/cm)	pH	Time (24hr)	Date
Pond	15.4	77.7	7.79	395.2	5.71	10.50h	10-06-16
Southern stream	14.2	70.2	7.2	402.9	5.7	11.20h	
Northern stream	14.9	52.5	5.27	1426	5.01	12.50h	
Middle stream	*Insufficient water to measure*						
Pond	10.2	62.5	7.03	343.4	5.56	12.00h	06-07-16
Southern stream	10.8	68.6	7.58	359.1	5.76	14.20h	
Northern stream	10.3	82.2	9.17	1455	4.53	10.24h	
Middle stream	10.3	66.3	7.48	940	4.41	9.00h	
Southern tributary	*Insufficient water to measure*						27-01-17

3.1.3 Macroinvertebrates

Macroinvertebrate abundance was low in the northern and centre streams, which is not surprising given their ephemeral nature (Table 8). Mites were the dominant organisms at these sites; a group that is often found in soil. MCI and QMCI indices at these sites were within the "Fair" category of habitat and water quality using the interpretation of Stark and Maxted (2007).

The southern stream had a more diverse and abundant macroinvertebrate community that was indicative of "Fair" to "Good" habitat and water quality, based on the MCI and QMCI scores. The New Zealand mudsnail *Potamopyrgus* was the most numerous macroinvertebrate here. This snail is ubiquitous in New Zealand waterways and is tolerant of a broad range of water quality and habitat conditions. Though not specifically sampled, the macroinvertebrate fauna in the southern tributary is expected to be similar to that found in the northern and middle streams, as these streams are similarly composed of ephemeral and intermittent sections.

Table 8. Aquatic macroinvertebrate community metrics (±95% confidence interval) for the survey sites. All EPT metrics exclude Hydroptilidae.

Metric	Northern stream	Middle stream	Southern stream
Taxa richness	11	10	24
EPT Taxa Richness	0	1	4
% EPT Taxa	0	10	16.7
Number of individuals	27	17	235
MCI-sb Value	85.27	96.00	101.08
QMCI-sb Value	4.56	4.66	4.76
% Dominant Taxon	26.0	29.4	28.0
Dominant Taxon*	Mites	Mites	*Potamopyrgus*

3.1.4 Fish

Three fish species were caught in the southern stream: shortfin eel (*Anguilla australis*), longfin eel (*Anguilla dieffenbachii*) and banded kokopu (*Galaxias fasciatus*) (Table 9). Of these species, the longfin eel is classified as At Risk-Declining (Goodman et al. 2014). The species present at this site indicate a reduced diversity compared to what might be expected at a site so near to the sea; moreover, the species present are all considered good climbers and are able to scale formidable obstacles during their upstream migration as juveniles. It is likely that the culvert downstream of the stream sampling point is restricting fish access upstream.

The northern stream, middle stream and southern tributary do not contain permanently flowing water and are therefore not expected to provide suitable habitat for fish.

A number of additional fish species have been found in the wider catchment within 10 km of the subject site, as recorded in the NZFFD (Table 10).

Table 9. Summary of fish caught during electrofishing survey of southern stream.

Species	Total	Density (fish/100m^2)
Shortfin eel	4	2.5
Longfin eel	1	0.6
Banded kokopu	3	1.9
Unidentified eel	3	1.9
Unidentified fish	2	1.3
Total fish incl. unidentified fish	13	8.2

Table 10. Freshwater fish species recorded within 10 km from subject site in NZFFD.

Scientific name	Common name	Threat category
Anguilla australis	Shortfin eel	Not threatened
Anguilla dieffenbachii	Longfin eel	At Risk -Declining
Galaxias fasciatus	Banded kokopu	Not threatened
Gambusia affinis	Gambusia	Introduced and naturalised
Gobiomorphus basalis	Cran's bully	Not threatened
Gobiomorphus cotidianus	Common bully	Not threatened
Gobiomorphus huttoni	Redfin bully	At Risk - Declining

3.1.5 Aquatic plants and periphyton

No periphyton was present at any of the sites. Curly-leaved pondweed *Potamogeton crispus* and bladderwort *Utricularia gibba* were observed in the pond outside the southern boundary of the property. No macrophytes were observed in the stream sites that were assessed.

3.1.6 Stream Ecological Valuation (SEV)

It is not considered appropriate to use the SEV calculations to calculate the mitigation required for removal of the ephemeral wetland within the southern tributary, as SEV is only applicable to areas with a defined channel (Storey et al. 2011). However, this method has been applied to the southern, middle and northern streams (which will not be affected by sand extraction) to provide useful information on the general condition of the streams on the property.

The SEV scores for the middle, northern and southern streams were varied and overall indicative of moderate habitat quality. The permanently flowing southern stream scored highest, in part due to the high biodiversity score which was the result of the macroinvertebrate and fish fauna present. The northern tributary scored the next highest, due to the abundance of indigenous vegetation in the riparian zone, higher flow and lesser degree of stock trampling. The middle stream was the most highly modified by invasive plant species and stock trampling. The hydraulic function score assesses how natural or modified the flow regime of the stream is, taking into account matters such as flood plain connectivity. The hydraulic function score was relatively high compared to other functions for all streams; as they have not been channelized or impacted by urban development (Table 11).

The biogeochemical functions are used to assess the quality of the water in the stream. These parameters take into account water temperature, dissolved oxygen and organic matter input and retention. The streams all scored relatively highly for the biogeochemical function, though the middle stream scored lower than the other streams due to a large amount of silty, anoxic sediment.

The habitat provision function scores a stream based on its contribution to fish habitat, including spawning habitat. Extensive trampling and lack of stable in-stream structures gave the middle stream a relatively low score, whereas the northern stream and southern stream scored fairly similarly, and slightly higher given the larger amounts of woody debris present, and smaller amount of disturbance.

The biodiversity function score was particularly low in the middle and northern streams, which had lower macroinvertebrate diversity than the southern stream. No fish are likely to be present in the middle or northern streams due to intermittent flows and very shallow water depths. Shortfin eel, longfin eel and banded kokopu were caught in the southern stream.

Table 11. SEV mean function scores for the streams surveyed

Mean scores	Northern stream	Middle stream	Southern stream
Hydraulic function	0.66	0.67	0.71
Biogeochemical function	0.75	0.58	0.82
Habitat provision function	0.48	0.31	0.45
Biodiversity function	0.15	0.22	0.67
Overall mean SEV score	**0.558**	**0.489**	**0.701**

3.2 Birds

In addition to recording any bird species seen or heard during general ecological survey work, three 5-minute bird counts were conducted at the subject site. Results from these counts, as well as the birds observed during general ecological survey work, are summarised in Table 12 (raw data in Appendix IV).

In total, 20 different bird species were recorded on site (Table 12). Of these 20 species, 12 species were native to New Zealand. No rare or threatened bird species were identified during the surveys (Robertson et al. 2012). In addition to information collected from field surveys, existing information was gathered from DOC's BioWeb database for the area surrounding the site (primarily South Head to Parakai). This background research indicated the presence of 30 indigenous or vagrant bird species within the wider Kaipara Harbour area (Table 13).

Oystercatcher calls (*Haematopus* sp.) were heard on site, indicating the nearby presence of either or both the variable oystercatcher (*Haematopus unicolor*) or the South Island pied oystercatcher (*Haematopus finschi*). The former is an At Risk - Recovering species, while the latter is an At Risk - Declining species (Robertson et al., 2012). These species are highly unlikely to ever inhabit the proposed extraction area as they are a coastal species. The South Island pied oystercatcher nests along South Island river margins.

While most of the rare or threatened bird species found as part of the background research are species associated with coastal, or marine habitats, the following three rare or threatened bird species may be associated with terrestrial and freshwater habitats found at the site. Australasian bittern (*Botaurus poiciloptilus*) and North Island fernbird (*Bowdleria punctata vealeae*) often find suitable habitat along riparian margin and coastal wetland (Goodwin 2012b) habitats. Kaka (*Nestor meridionalis septentrionalis*) are mainly associated with indigenous shrub and forest habitats. Some small areas of poor quality habitat for these species are found within the site, but it is fragmented and modified. In addition, none of these three species were encountered during any of the formal bird surveys, or during any other general ecological survey work conducted at the site.

Table 12. Birds seen and heard during site visits and 5-minute bird counts.

Species	Common name	NZ Status	NZ Conservation Status	IUCN Red List Status and Trend
Alauda arvensis	Eurasian skylark	Introduced	Introduced and Naturalised	Least concern - decreasing
Ardea cinerea	Grey heron	Native	Vagrant	Least concern - unknown
Callipepla californica	California quail	Introduced	Introduced and Naturalised	Least concern - increasing
Carduelis carduelis	Goldfinch	Introduced	Introduced and Naturalised	Least concern - stable
Circus approximans	Swamp harrier	Native	Not threatened	Least concern - stable

Egretta novaehollandiae	White-faced heron	Native	Not threatened	Least concern - unknown
Emberiza citrinella	Yellowhammer	Introduced	Introduced and Naturalised	Least concern - decreasing
Gerygone igata	Grey warbler	Endemic	Not threatened	Least concern - stable
Gymnorhina tibicen	Australasian magpie	Introduced	Introduced and Naturalised	Least concern - increasing
Haematopus sp.	Oystercatcher (only heard)	Native	Undetermined as species unknown	
Hirundo neoxena	Welcome swallow	Native	Not threatened	Least concern - increasing
Phasianus colchicus	Common pheasant	Introduced	Introduced and Naturalised	Least concern - decreasing
Platycercus eximius	Eastern rosella	Introduced	Introduced and Naturalised	Least concern - increasing
Porphyrio melanotus	Pukeko	Native	Not threatened	Not assessed
Prosthemadera novaeseelandiae	Tui	Endemic	Not threatened	Least concern - decreasing
Rhipidura fuliginosa	New Zealand fantail	Endemic	Not threatened	Least concern - unknown
Todiramphus sanctus	Kotare	Native	Not threatened	Least concern - increasing
Turdus merula	Eurasian blackbird	Introduced	Introduced and Naturalised	Least concern - stable
Vanellus miles	Spur-winged plover	Native	Not threatened	Least concern - increasing
Zosterops lateralis	Silvereye	Native	Not threatened	Least concern - stable

Table 13. Bird species recorded on DOC BioWeb to be present between South Head and Parakai, Kaipara.

Scientific name	**Common name**	**NZ Conservation Status**
Anarhynchus frontalis	Wrybill	Nationally vulnerable
Anas clypeata	Northern shoveler	Vagrant
Anas gracilis	Grey teal	Not threatened
Arenaria interpres	Turnstone	Migrant
Botaurus poiciloptilus	Australasian bittern	Nationally endangered
Bowdleria punctata vealeae	North Island fernbird	Declining
Calidris canutus	Red knot	Nationally vulnerable
Calidris ruficollis	Red-necked stint	Migrant
Charadrius obscurus aquilonius	Northern New Zealand dotterel	Nationally vulnerable
Charadrius bicinctus bicinctus	Banded dotterel	Nationally vulnerable
Chrysococcyx lucidus	Shining cuckoo	Not threatened
Haematopus finschi	New Zealand pied oystercatcher	Declining
Haematopus unicolor	Variable oystercatcher	Recovering
Himantopus himantopus leucocephalus	Pied stilt	Declining

Himantopus novaezelandiae	Black stilt	Nationally critical
Larus novaehollandiae scopulinus	Red-billed gull	Nationally vulnerable
Limosa lapponica	Bar-tailed godwit	Declining
Nestor meridionalis septentrionalis	Kaka	Nationally vulnerable
Numenius phaeopus	Whimbrel	Migrant
Phalacrocorax carbo novaehollandiae	Black shag	Naturally uncommon
Phalacrocorax melanoleucos brevirostris	Little shag	Naturally uncommon
Phalacrocorax sulcirostris	Little black shag	Naturally uncommon
Platalea regia	Royal spoonbill	Naturally uncommon
Poliocephalus rufopectus	New Zealand dabchick	Nationally vulnerable
Porzana tabuensis plumbea	Spotless crake	Relict
Pterodroma cookii	Cooks petrel	Relict
Sternula nereis davisae	New Zealand fairy tern	Nationally critical
Sterna striata striata	White-fronted tern	Declining
Tachybaptus novaehollandiae	Australasian little grebe	Coloniser
Tadorna variegata	Paradise duck	Not threatened

3.3 Bats

Background information sourced from relevant literature and biodiversity databases indicated the presence of long-tailed bats near the subject site. Based on this information two targeted bat surveys were conducted using acoustic bat monitors (ABMs).

The data collected by the ABMs confirmed the presence of long-tailed bats at the subject site. Areas where bats were detected during consecutive surveys include the margin of the pine and kanuka forest, as well as the areas surrounding free-standing pine trees to the north of the extraction area. The results of the targeted bat surveys are described below in more detail.

3.3.1 June – July 2016 bat survey

Monitoring for bat activity during June and July 2016 revealed the presence of long-tailed bats at the subject site. A summary of the results for this survey period is presented in Figure 10 below. Three ABM stations detected bat activity (ABMs J02, J04, and J06), while two of those recorded bat calls on two or more nights during the survey period (Figure 10). The number of calls recorded for each survey night is hereby shown as the relative number of calls per hour for each night. The highest number of calls per hour during one night was found for ABM station J06. None of the other ABM stations detected any bat activity during this survey period (Figure 10).

The eight ABMs deployed at the subject site during June/July 2016 recorded for a combined total of 1968.5 hours (Appendix II). However, only two of the ABMs completed recording for the full survey period (Figure 10). In some cases, livestock and other wild animals may have interfered with the ABMs.

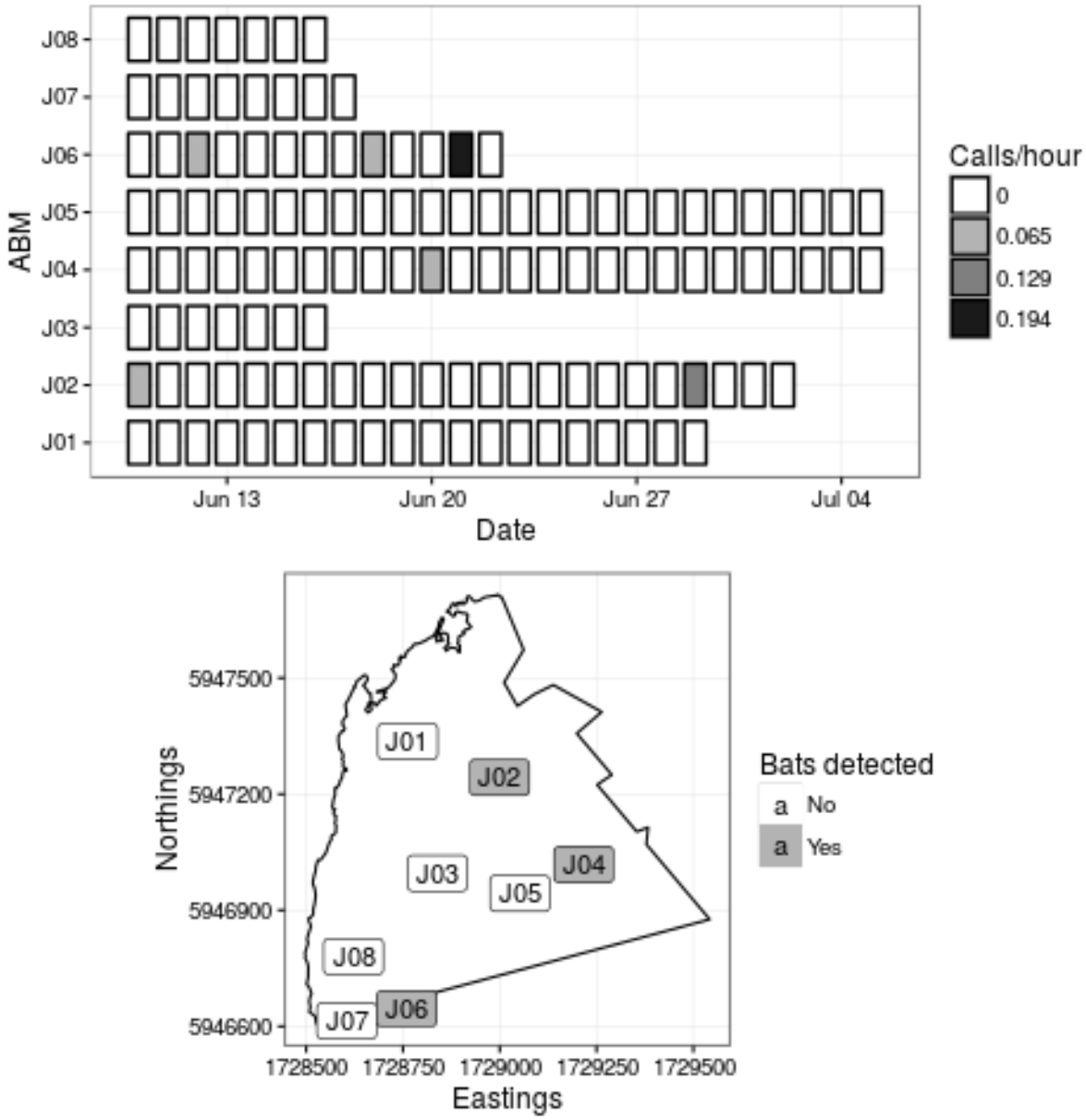

Figure 10. Top: Summary of ABM results over the June/July survey period. Each survey night is represented by one tile, while the shading of tiles indicates the number of calls per hour (based on 15.5 hours per night) for each survey night. Missing tiles indicate nights where ABMs failed to record. Bottom: Map showing subject property outline and ABM locations (in NZTM2000). Shading indicates ABM stations where bats have been detected.

The number of calls recorded in relation to ABM specific search effort (the total number of ABM recording hours for a specific ABM) are summarised in Figure 11. Overall, bat activity was highest during the first two to three hours after sunset (HAS), while an increase in activity during later HAS was detected at J02 (Figure 11). The ABM station with the highest bat activity was J06 (Figure 11).

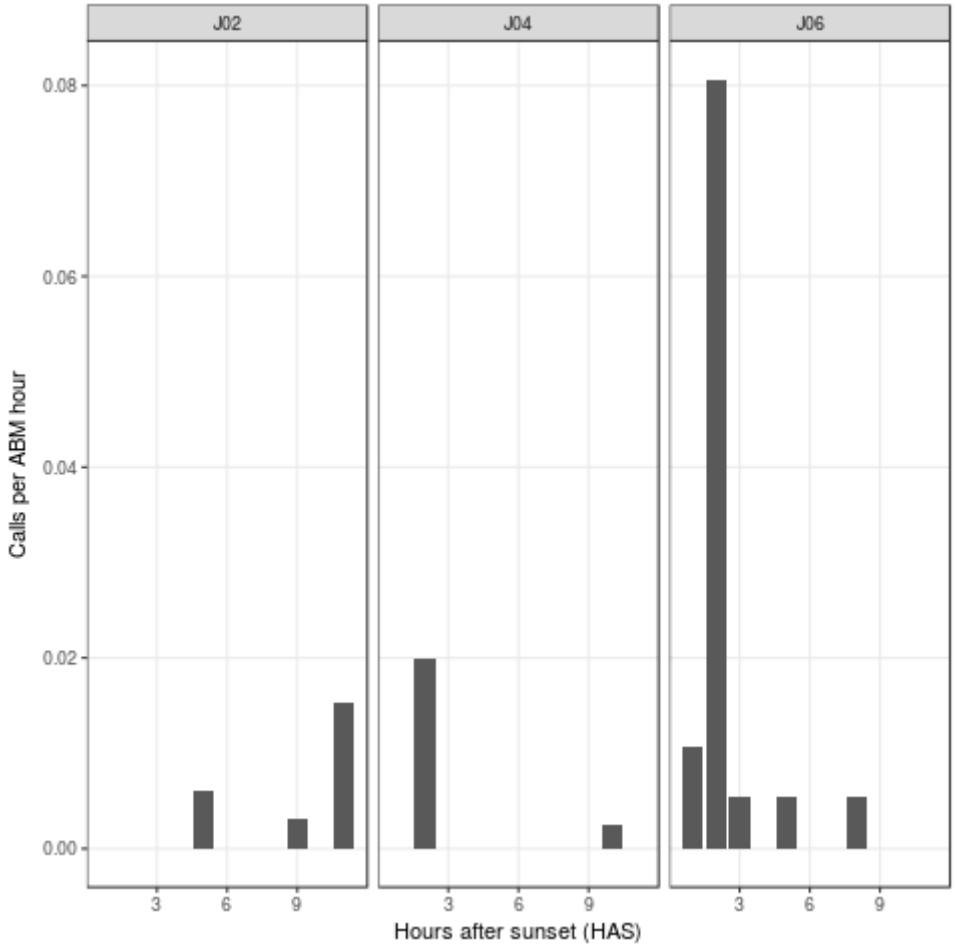

Figure 11. The number and type of call recorded per total hours of ABM recording activity (calls per ABM hour) in relation to hour after sunset (HAS) when the call was recorded.

3.3.2 December 2016 bat survey

Monitoring for bat activity during December 2016 further confirmed the presence of long-tailed bats at the subject site. A summary of the results for this survey period is presented in Figure 12 below. Five ABM stations detected bat activity (ABMs D01, D02, D05, D06, D07), while two of those recorded bat calls on two or more nights during the survey period (Figure 12). The number of calls recorded for each survey night is hereby shown as the relative number of calls per hour for each night. The highest number of calls per hour during one night was found for ABM stations D01 and D07. None of the other ABM stations detected any bat activity during this survey period.

The eight ABMs deployed at the subject site during December 2016 recorded for a combined total of 1100 hours (Appendix II), and all of the ABM completed their 10-night recording cycle.

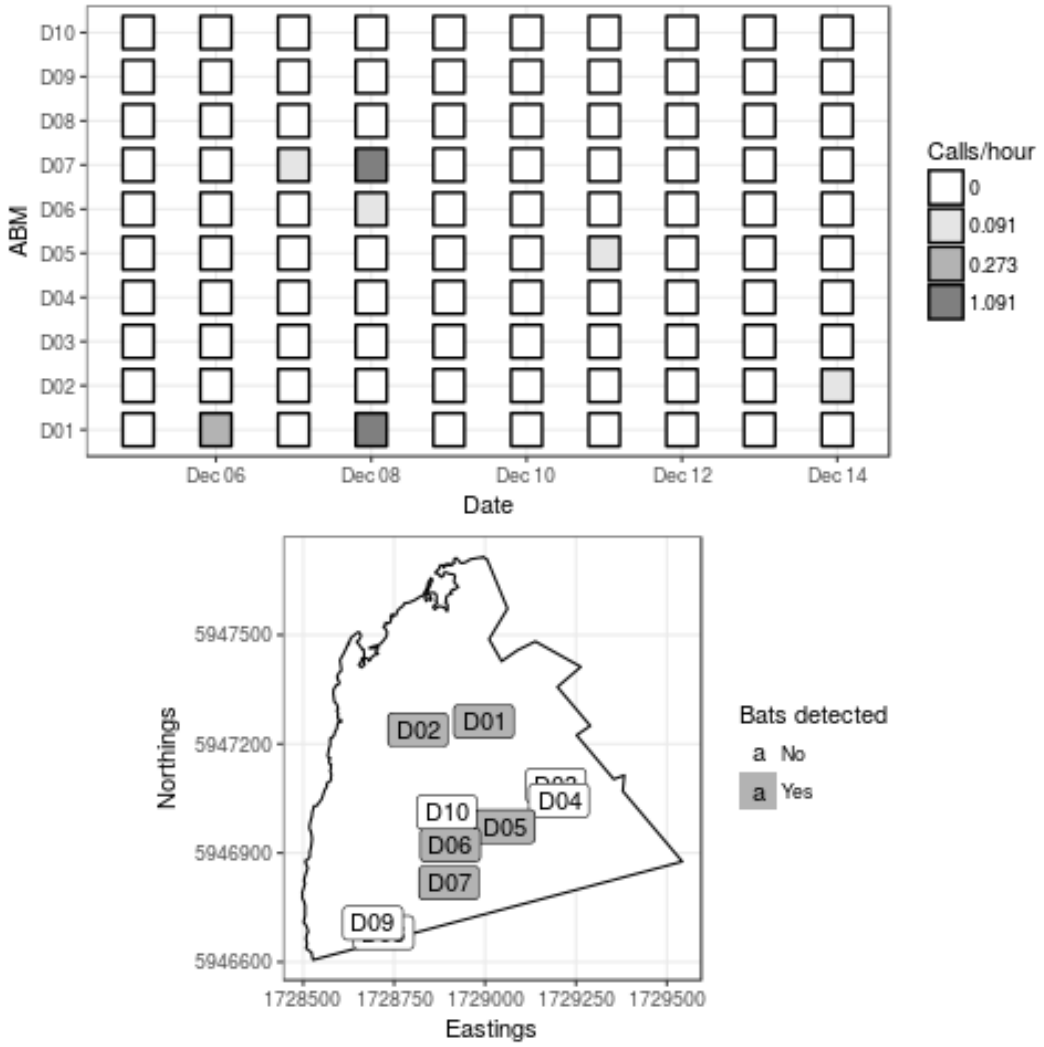

Figure 12. Top: Summary of ABM results over the June/July survey period. Each survey night is represented by one tile, while the shading of tiles indicates the number of calls per hour (based on 11 hours per night) for each survey night. Bottom: Map showing subject property outline and ABM locations (in NZTM2000). Shading indicates ABM stations where bats have been detected.

The number of calls recorded in relation to ABM specific search effort (the total number of ABM recording hours for a specific ABM) are summarised in Figure 13. Overall, bat activity was highest during the first two to three hours after sunset (HAS), while an increase in activity during later HAS was also detected at (Figure 13). The ABM stations with the highest bat activity were D01 and D07 (Figure 13).

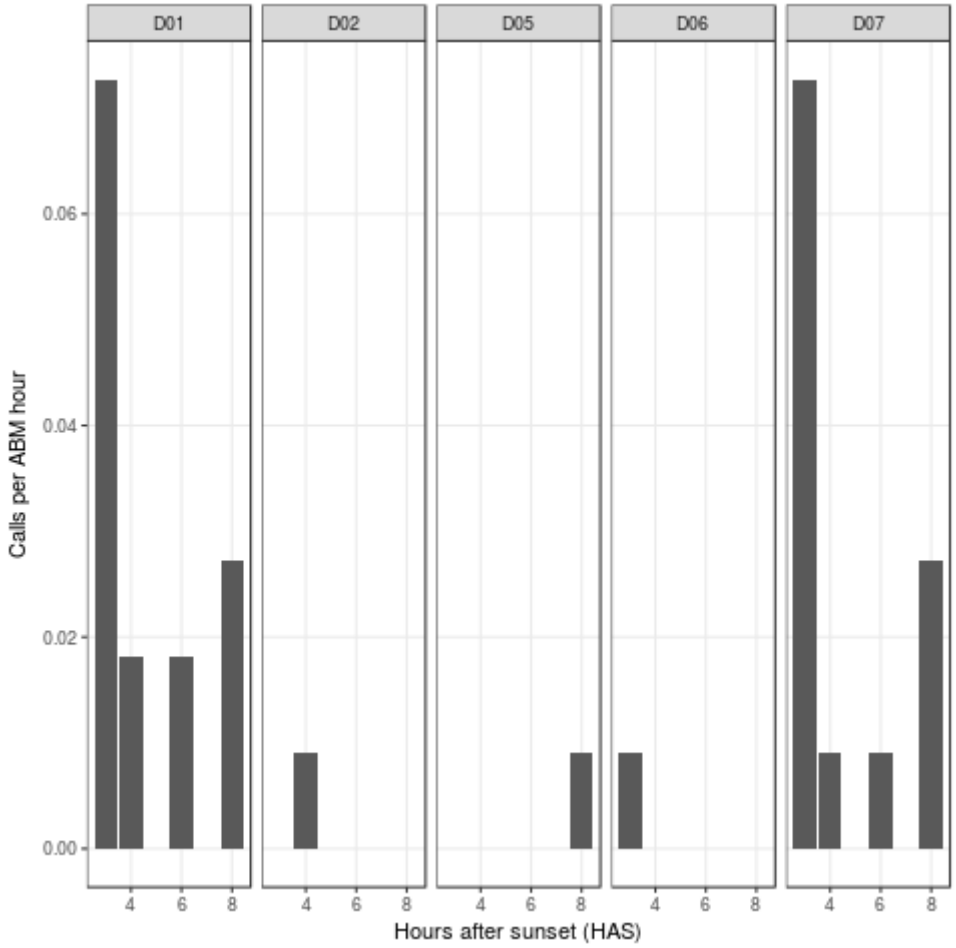

Figure 13. The number and type of call recorded per total hours of ABM recording activity (calls per ABM hour) in relation to hour after sunset (HAS) when the call was recorded.

3.3.3 Conclusions of bat surveys

The bat monitoring during both survey periods indicated the presence of long-tailed bats at the subject site. The main areas of bat activity were around stands of mature trees, indicating the valuable ecological function of large trees for bats. Bat activity was low to moderate at the site and the data suggests that no bat roosts were active on site during the survey periods. While this does not exclude the possibility of such roosts existing in mature trees found in and around the property, the information gathered from the bat monitoring so far indicates that bats use areas at the subject property mainly for foraging.

3.4 Lizards

3.4.1 Database records

Any relevant databases were queried for the potential presence of skink and gecko species at the subject site, as well as for presence within the wider area (DOC's BioWeb database, and Landcare Research's NZ Lizard database). Information was gathered based on records from the wider Auckland region, and filtered further by taking into account the known life history of any lizard species and potential (current an historic) habitats available at, or near the subject site. The results of the database queries revealed 11 lizard species to be potentially present within or near the subject site (Table 14).

Table 14. Skink and gecko species potentially present at the site based on review of relevant databases.

Scientific name	Common name	NZ Conservation Status	Potential habitats
Dactylocnemius pacificus	Pacific gecko	Relict	Coastal to inland, forest shrub, rock outcrops, clay banks
Hoplodactylus duvaucelii	Duvaucel's gecko, or giant gecko	Relict	Arboreal and terrestrial, often under stones, logs and rocks
Lampropholis delicata	Rainbow skink	Introduced and naturalised	Open country, clearings and pasture
Mokopiriakau granulatus	Forest gecko	Not threatened	Forest, shrubland, including manuka scrub
Nautilnus elegans elegans	Auckland green gecko	Declining	Forest, scrub, including manuka/kanuka
Oligosoma aeneum	Copper skink	Not threatened	Forest and open shaded areas with adequate ground cover, also coastal above high-tide line
Oligosoma moco	Moko skink	Relict	Coastal, including open forest, scrub and grassland
Oligosoma ornatum	Ornate skink	Declining	Low scrub
Oligosoma smithi	Shore skink	Not threatened	Coastal, under rocks, logs, also on sand dunes, and pastoral to shrubland
Oligosoma striatum	Striped skink	Declining	Pastoral farmland under rocks, logs, often in areas of former forest habitat
Woodworthia maculatus	Common gecko	Not threatened	Coastal to inland forest, also pasture areas

3.4.2 Opportunistic observations

A large number of plague (or rainbow) skink (*Lampropholis delicata* – Introduced and naturalised, Hitchmough et al. 2013) were observed throughout the site, basking in the sun around logs and branches, as well as in sheltered sandy areas and low growing vegetation. No other lizard species were observed opportunistically.

3.4.3 ACO Surveys

Results of the ACO surveys to date have shown only records of plague skink in a small number of the ACOs, either found between the Onduline® layers or basking on top of the sheets. On one occasion, one lizard was observed when checking the ACO at Station A31 (see Methods section for location). Only a fleeting observation was possible of the animal, but there was a small chance that it may have been a copper skink (*Oligosoma aeneum* – not threatened).

3.4.4 Destructive searches for drilling vegetation clearance

Clearance of sand resource and groundwater bores and the access tracks leading to them was monitored by an ecologist. Monitored clearance operations took place from 11am to 5.30pm on October 25th, 8am to 4pm on October 26th, and 11am to 4pm on October 27th. Some additional grading of access tracks and levelling of unvegetated sites took place outside these hours. Where possible, the ecologist walked ahead of the digger, inspecting any loose cover items such as short sections of pine log, but for the most part cover objects were not readily moveable by hand. A close watch was therefore kept on material as it was removed by the digger, and when lizards or other significant fauna were observed the digger operator was notified and the fauna captured and relocated to a position outside of the works footprint. In areas of dense gorse it was not possible to work ahead of the digger, but clearance operations were monitored from close behind, and cleared material watched for indications of disturbed

or injured wildlife. This method was considered to give the best chance of recovering indigenous lizards in the conditions present at the site.

Exotic plague skinks were the only lizard species observed. In open areas with woody cover, such as margins of existing access tracks or woodpiles among kikuyu grass, these skinks could be very abundant, though numbers were much lower where there was a dense vegetation cover.

In conclusion, site surveys found exotic plague skinks and one potential sighting of the indigenous copper skink. While search efforts and survey techniques were appropriate to survey the various habitat types, the site's location and habitat types present mean that other indigenous lizard species are potentially present.

3.5 Terrestrial invertebrates

Opportunistic surveys were undertaken for terrestrial invertebrates while other surveys were conducted. Among the invertebrates, the most notable were giant centipedes (*Cormocephalus rubriceps*), which were common under cover in a range of vegetated habitats including kikuyu grassland and gorse. Other invertebrate species included cicada nymphs (*Amphipsalta* sp. and a smaller species), which were often exposed when the surface soil was scraped away by the digger, ground beetles (*Ctenognathus novaezelandiae*), rhaphidophorid weta (*Neonetus variegatus* and at least one other species), huhu grubs (*Prionoplus reticularis*) in decaying pine logs, vagrant spiders (*Uliodon* sp.) and geoplanid flatworms (possibly *Arthurdendyus* sp.). All of these species are ubiquitous and found throughout the Auckland region.

3.6 Terrestrial vegetation

The project site extends over a total area of approximately 65 ha of terrestrial, freshwater and coastal vegetation (e.g. pasture, exotic shrub, and indigenous forest), as well as residential areas and farming infrastructure (e.g. houses, farm tracks and roads). The vegetation found at the coastal margin to the west of the property, as well as the vegetation found within a conservation covenant along the eastern boundary of the site, have previously been assessed by Goodwin (2012a,b), as well as Lowe (2013). The proposed extraction plan falls outside of those two areas. Therefore, this ecological assessment focused on surveying the different vegetation types present within areas affected by the proposed sand extraction activities. However, references are made to the assessments of Goodwin (2012a,b) and Lowe (2013).

The property lies within the Rodney Ecological District (ED) between approximately sea level and 80 m elevation. The following list provides a brief summary of the 13 vegetation types and two non-vegetation cover types occurring at the subject site, as well as their approximate spatial extents:

- Type 1: Kanuka forest (9.8 ha)
- Type 2: Pine forest (0.6 ha)
- Type 3: Macrocarpa - [kanuka] treeland (1.4 ha)
- Type 4: Nightshade - (honeysuckle) - (gorse) shrub (1.3 ha)
- Type 5: Nightshade - gorse shrub (17.2 ha)
- Type 6: Gorse shrubland (4.2 ha)
- Type 7: Unsealed road/track (1 ha)
- Type 8: Pasture grassland (16.6 ha)
- Type 9: Residential/farm yard (2 ha)
- Type 10: [Kanuka] - nightshade - gorse shrubland (0.9 ha)
- Type 11: Riparian margin and rushland (0.5 ha)

- Type 12: Eucalypt – nightshade – gorse shrub (0.04 ha)
- Type 13: Coastal wetland (8.8 ha)
- Type 14: Pond (0.1 ha)
- Type 15: [Totara] - nightshade - gorse shrubland (0.07 ha)

The areas covered by kanuka forest (type 1), the riparian margin and rushland (type 11), as well as the coastal wetland (Type 13) are especially noteworthy, as these three vegetation types contain the bulk of the indigenous vegetation cover found at the subject site.

No rare or threatened plant species were encountered during ecological survey work conducted at the subject site as part of this report.

A more detailed description for each of the vegetation types is provided below, and a map showing the spatial extent of each vegetation type is provided in Figure 15. Where feasible, vegetation types were classified using the naming convention introduced by Atkinson (1985). Further information on the threatened plant survey work undertaken is also provided in the relevant section below.

3.6.1 Description of vegetation types

Type 1: Kanuka forest (9.8 ha)

Mature kanuka forest was found in the south-western corner of the subject property (Figure 14). The indigenous coastal forest is part of a covenanted bush area, which has previously been assessed by Goodwin (2012a) and was found to be of significant ecological value. Along its northern margin a number of radiata pine and macrocarpas emerge above the indigenous canopy. The understorey is composed of a variety of native shrubs and treeferns, including karamu, twiggy coprosma, mingimingi, manuka, mapou, hangehange, wheki, and ponga. Along the margin of the forest remnant, a number of exotic species have become established. These species include woolly nightshade, gorse, and inkweed, all three of which are also present in abundance in the adjacent shrubland.

Figure 14. Kanuka forest with mixed exotic/native vegetation along margins, and some emergent pine trees.

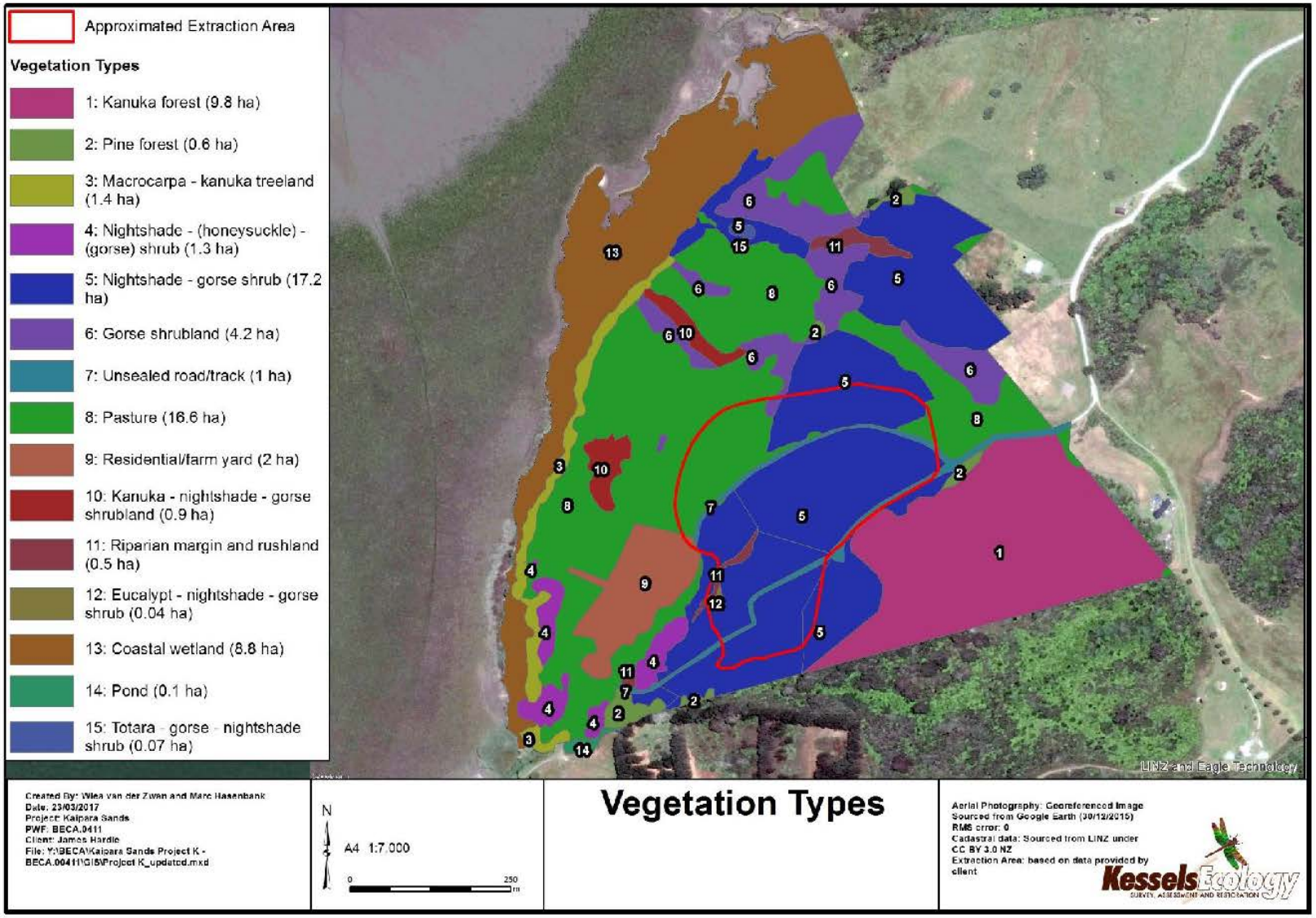

Figure 15. Vegetation types present at the subject site.

Type 2: Pine forest (0.6 ha)

Aerial imagery suggests that a considerable portion of the site was previously covered by pine forest. Small areas of pine forest continue to grow along the southern property boundary (Figure 16). A number of exotic and indigenous species were found in the understorey where a less dense canopy allowed more light to penetrate. These include gorse, kanuka, mahoe, hangehange, ponga. Overall, the mixed understorey was light compared to other vegetation areas within the property.

Figure 16. Pine forest can be seen in the background, where it grows along one of the streams found within the site.

Type 3: Macrocarpa - [kanuka] treeland (1.4 ha)

A shelterbelt comprised of macrocarpa as well as small amounts of kanuka runs along the western boundary of the subject site (Figure 17). Beyond the shelterbelt the land drops steeply towards a coastal margin comprised of a mosaic of saline grass and herb vegetation, as well as mangrove forest. Shrubs growing under the mostly pine canopy include gorse, woolly nightshade, mapou, and karamu. Several cabbage trees were also found near to the stream that flows through the belt towards the estuary.

Figure 17. Area characterised by its abundance of soft rushes growing over pasture grasses and herbs.

Type 4: Nightshade - (honeysuckle) - (gorse) shrub (1.3 ha)

The vegetation type is a variation of the nightshade and gorse shrub/shrubland found within the site. While nightshade and gorse make up a considerable amount of the exotic shrub species, large patches of Japanese honeysuckle were found as part of this vegetation type. In addition, to the south of the property creeping pohuehue has begun to encapsulate some of the shrubs, as well as dominate the ground cover within a small area (Figure 18).

Figure 18. Woolly nightshade can be seen in left foreground, while a patch of honeysuckle lies to the right. The area on the photograph lies towards the south of the property and is characterized by dense patches of pohuehue.

Type 5: Nightshade - gorse shrub (17.2 ha)

This vegetation type is one of the most abundant types that was found within the site. Woolly nightshade and gorse make up the majority of canopy species (Figure 19). Some areas are less dense than others and resemble more of a shrubland vegetation type with mainly pasture species as groundcover. Inkweed was also found to be abundant in areas where the gorse and nightshade canopy had recently been disturbed. Indigenous species encountered within the vegetation types include mapou, twiggy coprosma, cabbage tree, and kanuka. Native plants were small in number and growth, and only represented in the low understorey. Pampas grass and small pine trees were also found.

Figure 19. View across a gully covered in woolly nightshade and gorse. Extensive stands of woolly nightshade can be seen on the opposite side of the gully.

Type 6: Gorse shrubland (4.2 ha)

Not as abundant as the nightshade and gorse vegetation type above, this vegetation type is mainly found in the northern part of the site. While in most areas pasture grasses and herbs gain enough light to grow, the gorse canopy can reach high closures in some areas (Figure 20). Here the vegetation resembles more of a gorse shrub vegetation type. Indigenous components within this vegetation type were minor, and confined to border areas where two different types of shrub vegetation met.

Figure 20. Pasture area (left) adjacent to dense gorse shrub (right).

Type 8: Pasture grassland (16.6 ha)

Pasture makes up a large portion of the vegetation found within this site. Cattle are continuing to actively graze the pasture areas. A diversity of pasture grasses and herbaceous pasture species make up this vegetation type. In addition, small gorse specimens in some areas indicate ongoing colonisation of the pasture areas by exotic shrub species.

Type 10: [Kanuka] - nightshade - gorse shrubland (0.9 ha)

This vegetation type is a variation of the nightshade and gorse vegetation that dominates many of the areas within this site. Besides woolly nightshade and gorse this vegetation type also contains a sparse canopy of kanuka (Figure 21). The amount of nightshade varies however, and the southern area is primarily gorse with small amounts of kanuka that make up the remnant indigenous canopy.

Figure 21. Sparse kanuka canopy over woolly nightshade, gorse and pasture.

Type 11: Riparian margin and rushland (0.5 ha)

This vegetation type resembles a remnant riparian margin and indigenous wetland. Most of the vegetation is "shrubby" with considerable areas of rushes and sedges growing within and along the stream where the canopy is sparse (Figure 22). Where canopy closure by indigenous and exotic species is higher, the vegetation resembles more of an indigenous riparian shrub. Indigenous species found within this vegetation type include: karamu, mahoe, ponga, wheki, mapou, kanuka, manuka, kiokio, cabbage tree, mingimingi, and sedges such as pukio. Gorse and woolly nightshade, as well as moisture seeking exotic grasses, also invade the fringes of this vegetation type. This vegetation type is only found in two small areas within the site. The number and abundance of indigenous vegetation within these areas is higher than in any of the other vegetation types.

Figure 22. Rushland with wheki treeferns in background.

Type 12: [Eucalypt] - nightshade - gorse shrubland (0.04 ha)

This vegetation type is a variation of the nightshade and gorse vegetation that dominates many of the areas within this site. Besides woolly nightshade and gorse, this vegetation type also contains a sparse canopy of eucalypt. The vegetation type is only found in the central gully near the southern tributary and the residential and farm yard areas.

Type 13: Coastal wetland (8.8 ha)

A narrow strip of coastal land lies along the western boundary of the property that borders onto the coastal marine area of the Kaipara Harbour. This area of land is generally low-lying, and while not intertidal in nature, seepages and stream run-offs have created conditions that allowed indigenous and exotic wetland vegetation to become established (Goodwin, 2012b). The area of coastal wetland has previously been assessed by Goodwin (2012b) and Lowe (2013) who found that the wetland contained indigenous-dominated vegetation components, which were connected via a mosaic of mixed indigenous-exotic flora. Plant species found within the area included (Goodwin, 2012b): *Machaerina articulate, M. juncea, M rubiginosa, M. teretifolia, Juncus gregiflorus, J. pallidus, J. maritimus, Ficinia nodosa, Eleocharis acuta, Cyperus ustulatus, Carex lessoniana, C. secta, Isachne globosa*. Woody plant species included (Goodwin, 2012b): manuka, cabbage trees, kahikatea, as well as *Meuhlembickia complexa*. *Convolvulus* sp., woolly nightshade, arum lily, gorse, kikuyu and alligator weed were also present (Goodwin, 2012b).

Type 14: Pond (0.1 ha)

Just outside the southern boundary of the site lies a small pond area, which is fed by a stream from a neighbouring property. Vegetation along the pond margin comprises mainly pasture grasses and herbs, as well as *Isolepis prolifera* (Figure 23). Along its northern boundary a number of exotic shrubs, including Japanese honeysuckle, was present.

Figure 23. Pond just outside the southern boundary of the site.

Type 15: [Totara] - nightshade - gorse shrubland (0.07 ha)

This vegetation type is another variation of the nightshade and gorse vegetation that dominates many of the areas within this site. This vegetation type only exists within a small area along a stream depression to the north of the property. Two small to medium sized totara trees were found here emergent over gorse and woolly nightshade.

3.6.2 Threatened plant survey

The vegetation survey included a walk-through survey for threatened plant species that may be present at the subject site. The survey for rare and threatened plant species utilised database records of DoC's BioWeb to focus search effort. The database records indicated the potential presence of several rare or threatened plant species within the wider area surrounding the subject site (Table 15).

Table 15. Threatened and At Risk vascular plant species recorded within Woodhill and Kaipara harbour area

Scientific name	Common name	Conservation Status
Cyclosorus interruptus		Declining
Hebe speciosa	Titirangi	Nationally vulnerable
Lobelia aff. *angulata*	Pratia	Nationally critical
Mazus novaezeelandiae subsp. *impolitus*	Dwarf musk	Nationally critical
Pimelea tomentosa		Nationally vulnerable
Pseudopanax ferox	Fierce lancewood	Naturally uncommon
Thelypteris confluens	Swamp fern	Declining
Danhatchia australis	Danhatchia (orchid)	Declining

While the initial vegetation survey took place in May 2016, a follow-up survey was conducted on the 5th of December 2016. Highest search effort was put into areas that contained a significant amount of remnant indigenous vegetation along either of the two main stream gullies, as well as any adjoining shrub or shrubland: type 5: Nightshade - gorse shrub; type 10: [Kanuka] - nightshade - gorse shrubland; as well as type 11: Riparian margin and rushland. No survey for rare or threatened plant species was conducted within the kanuka forest (type1), or within the coastal wetland (type 13).

After a total of seven hours of targeted survey, no rare or threatened flora species were detected at the subject site within the areas surveyed.

3.7 Threatened species

The investigation into the potential presence of rare or at risk/threatened indigenous flora or fauna species was split into reviewing relevant literature and biodiversity databases (DOC Bioweb, NZ Lizard Database, and NZ freshwater fish database), as well as targeted field surveys. Detailed findings for each of these groups are provided in the relevant sections of this report. Appendix VI provides a summary of any rare or threatened flora and fauna species found within the locality of the property based on available information from relevant databases and field survey work conducted as part of this report.

Seven hours of targeted searching yielded no evidence of rare or threatened flora species being present. Given this survey effort and that the extraction site is entirely situated within highly modified exotic dominated vegetation communities, it is considered highly unlikely any at risk or threatened plants species are present.

Fauna surveys for rare or threatened species detected the presence of threatened long-tailed bats in the areas around the proposed extraction area, as well as one At Risk freshwater fish species, longfin eel, in the permanent stream to the south of the extraction area. The habitat to be removed during sand extraction is not considered likely to provide habitat for threatened or any other fish species.

While a number of rare and threatened seabirds are found at the Kaipara Harbour, any field observations made were flyovers of the site, rather than seabirds utilising any areas at the subject site for nesting or foraging. Seabirds would be more likely to be present along the intertidal area, and associated mangrove forest. Coastal seabirds may also be encountered within the coastal wetland vegetation (type 13).

In conclusion, long-tailed bats are the only threatened species potentially impacted by the proposed sand extraction activity. Because the area to be removed contains no longfin eel habitat, this species is not expected to be adversely affected by the extraction activities.

3.7.1 Threats

This section details the existing and potential threats to the long-term sustainability of the site.

3.7.2 Pest animals

During the site visits, a number of red deer were observed within the eastern section of the property within the gorse and woolly nightshade scrub. A rat was observed during the lizard survey before vegetation clearance, and a stoat was observed during the initial site visit. Droppings of possums were observed in several locations throughout the site. It is likely that rabbits are also present.

Present pest animal species are likely to have an adverse effect on the indigenous vegetation and fauna present within the site. As no targeted pest animal survey was undertaken, little can be said about the degree to which these animals affect native flora and fauna. However, possums, rabbits, and deer browse native vegetation including small seedlings, thereby hindering any native plant recruitment and regeneration, as well as site revegetation. Rats eat seeds and fruit as well as predating on small birds, their eggs and young, along with invertebrates and lizards. Mustelids (stoats, ferrets, and weasels) and may also hunt in this area. These predators can be particularly harmful to ground-nesting birds. Rats, possums and mustelids pose a major threat to the survival of bats and lizard species.

3.7.3 Pest plants

The vegetation at the site has been highly modified by past and present land use. As such, a large number of exotic species are present within the subject site. For the purpose of assessing ecological significance, this report focuses on those exotic plant species that were observed during the visit (Table 16), and which are also listed within the Auckland Regional Pest Management Strategy 2007 - 2012 (RPMS). The RPMS is currently being reviewed and the updated version will be notified in 2017.

The RPMS outlines the former Auckland Regional Council's priorities and strategies in managing invasive, exotic plant species. Those plant species listed in the RPMS have been classified based on their actual or potential adverse impacts on the environment. The classification process also took into account the biology of the species in question, as well as the species' distribution within the region at the time. By triaging invasive plant species based on these criteria, the RPMS aims to minimise adverse environmental impacts while making good use of the available resources. As a result, pest plant species classifications range from low-grade management, such as advising landowners on the potential impacts of certain invasive plant species, to actively eradicating certain pest plant species where they occur. The RPMS pest plant species designations are as follows:

(a) Total Control: "*The ARC itself carries out, or otherwise arranges all control work for Total Control Pest Plants at no expense to the landowner/occupier.*";

(b) Containment: "*Landowners/occupiers are required to carry out the control work for Containment Pest Plants on their property. Landowners/occupiers may be required to control the Containment Pest Plant on their whole property (removal) or within a specified distance from any property boundary (boundary control).";*

(c) Surveillance: "*Surveillance Pest Plants are banned from sale, propagation, distribution and exhibition. There are no requirements for control of existing specimens.* "; and

(d) Community Initiatives Programme: "*Community groups may nominate any pest plant in the Strategy on which to carry out control work collaboratively. The ARC may provide regulatory backup for those species listed as Community Initiative Pest Plants.* ".

In general, any pest plant species listed are also banned from sale, propagation, distribution and exhibition within the Auckland region.

Table 16. Pest plant information. The Regional Pest Management Strategy (RPMS) designation indicates any legal requirements for pest plant control as described in the current policy document. Environmental impacts are shaded as follows: minor: yellow, moderate: orange, and major: red.

Common name	Botanical name	RPMS Designation	Environmental impact	Perceived Environmental Impact within Subject Site
Blackberry	*Rubus fruticosus* agg.	Surveillance	This plant species grows rapidly and can create a dense canopy in a short time. Therefore, it is able to outcompete small and slower growing native vegetation. It can become a particular problem in swamp areas. The patches formed by this species can also provide safe haven for a variety of pest animal species.	Minor
Pampas grass	*Cortaderia selloana* & *Cortaderia jubata*	Surveillance Community Initiatives Programme	The species is able to out-compete other plants by overgrowing and smothering them. It also provides a safe haven for pest animals, and can pose a fire risk.	Minor
Gorse	*Ulex europaeus*	Containment (boundary control) in rural zones	This species forms dense, impenetrable shrub patches that compete strongly with any indigenous vegetation. It also reduces pasture productivity, and stands of this species often harbour a number of pest animal species. Furthermore, it presents a fire hazard. This species recovers quickly from burning. As a more positive effect for restoration this plant species may act as nursery crop for native seedlings. However, due to the nitrogen fixing it changes soil composition and affects the type of indigenous regeneration that can take place.	Moderate
Woolly nightshade	*Solanum mauritianum*	Containment (boundary control)	The berries are toxic, and dust from plants is highly irritating to mucus membranes. This plant forms pure colonies, crowding out other plants.	Major
Japanese honeysuckle	*Lonicera japonica*	Surveillance Community Initiatives Programme	This plant is able to invade margins and interiors of indigenous shrub and forest habitats. The species is able to out-compete other plants by overgrowing and smothering them.	Moderate

3.8 Ecological significance

The ecological significance assessment based on the relevant AUP significance factors indicated that the following vegetation types were of ecological significance:

- Type 1: Kanuka forest (9.8 ha), and
- Type 11: Riparian margin and rushland (0.5 ha), and

- Type 13: Coastal wetland (2 ha).

In terms of their national significance, the national threatened environments classification indicated that the areas of kanuka forest, and riparian margin and rushland are found to belong to an environment classification for which 20 to 30 percent of indigenous vegetation cover remains nationally. The approximately 2 ha of ecological significant coastal wetland are found on land described as unclassified (non-terrestrial) by the national threatened environments classification. The 9.8 ha of kanuka forest, and 0.5 ha of riparian margin and rushland, as well as the 2 ha of coastal wetland contained within the subject site therefore provide valuable habitat to indigenous flora and fauna, as well as providing ecological stepping stones and refugia. These ecological values and functions will not be adversely affected by the extraction activities, and in fact, are likely to be enhanced if suitable mitigation is undertaken as recommended in Section 5.2 of this report.

The areas of vegetation within the subject site that were found to be of ecological significance are shown in Figure 24. Further detailed descriptions of these ecological significance assessments are provided in the relevant sections below.

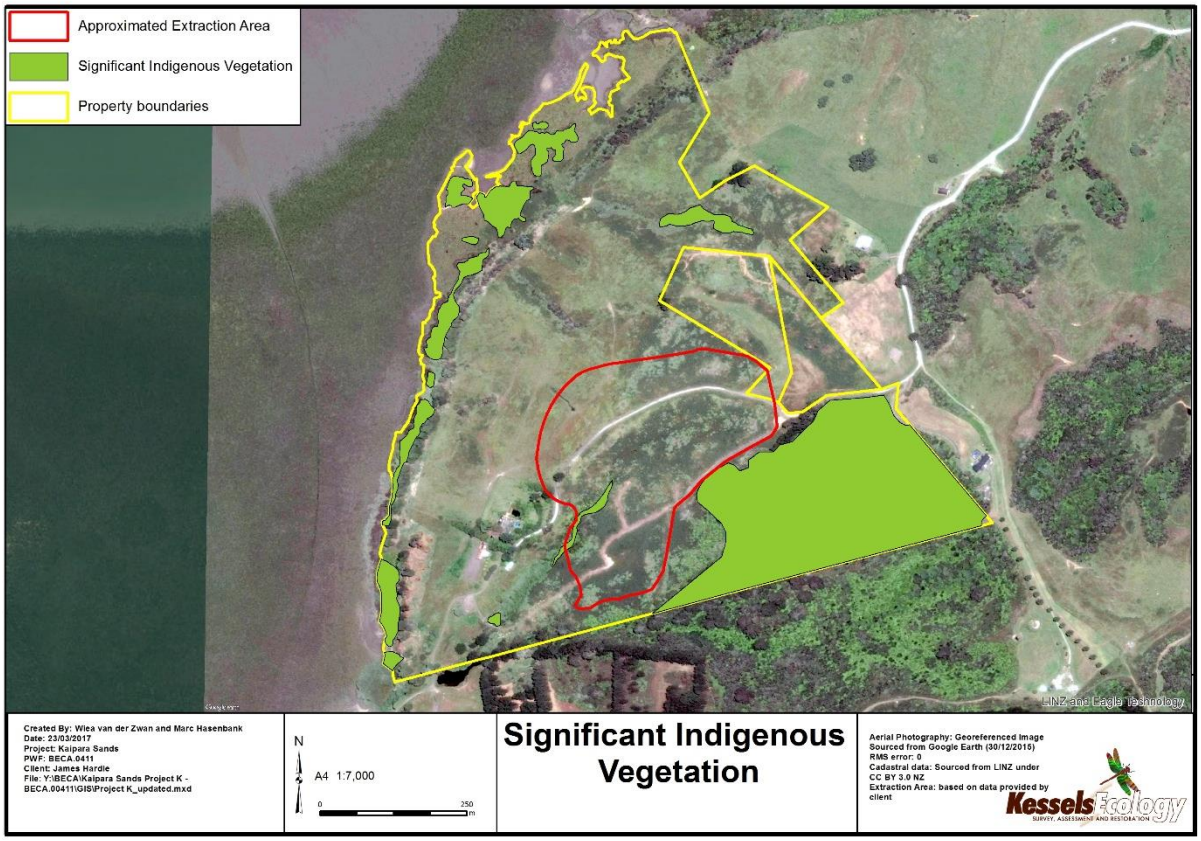

Figure 24. Areas of significant indigenous vegetation within subject site.

3.8.1 Auckland Unitary Plan ecological significance assessment

3.8.1.1 Terrestrial vegetation

Apart from the kanuka forest vegetation type, none of the other terrestrial vegetation types were found to have an intact canopy that is dominated by indigenous plant species, or to have an intact regenerating indigenous understorey. Furthermore, most other areas of terrestrial vegetation are dominated by a range of pest plant species that had and continue to have a major environmental impact.

(1) *Representativeness*: Within the Rodney ED indigenous bush habitats have become increasingly rare, with less than 15% of indigenous bush remaining within the ED. (**Yes, meets factor**)

(2) *Threat status and rarity*: No confirmed records of rare species within kanuka forest, however, long tailed bats are likely to utilise the kanuka forest for foraging. (**Yes, meets factor**)

(3) *Diversity*: The kanuka forest resembles secondary indigenous vegetation at a mid-stage of forest regeneration. (**No, does not meet factor**)

(4) *Stepping-stones, migration pathways and buffers*: Looking at the wider landscape context, the subject site lies within close proximity to several areas of indigenous riparian margin and estuarine marine habitats, which have been identified to be SEAs under the Auckland Unitary Plan. The 9.8 ha of kanuka forest contained within the subject site therefore provide valuable habitat to indigenous flora and fauna, as well as extend the ecological corridor present within the Rodney Ecological District. (**Yes, meets factor**)

(5) *Uniqueness or distinctiveness*: No records have been found for indigenous flora or fauna species endemic to the Auckland region to occur within the kanuka forest. (**No, does not meet factor**)

The kanuka forest was found to meet three of these significance factors and is therefore considered to be ecologically significant habitat for indigenous flora and fauna.

3.8.1.2 Riparian vegetation

The riparian margin and rushland vegetation found at three locations within the subject site was assessed as follows:

(1) *Representativeness*: Within the Rodney ED indigenous wetland habitats have become increasingly rare, with less than one percent of native wetlands remaining within the ED. (**Yes, meets factor**)

(2) *Threat status and rarity*: No confirmed records of rare species within riparian margin or rushland. However, the indigenous vegetation forms part of a remnant indigenous wetland ecosystem along the respective streams found at the subject property. (**Yes, meets factor**)

(3) *Diversity*: The riparian margin and rushland vegetation contains a range of indigenous species commonly found within this ecosystem type. However, the riparian and rushland vegetation is only found a long a confined environmental gradient and lacks a consistently indigenous canopy that would be expected for such a vegetation type. (**No, does not meet factor**)

(4) *Stepping-stones, migration pathways and buffers*: The three riparian and rushland areas provide indigenous cover for the two streams running through them. However, their spatial extent is small and therefore it is unlikely that these areas provide a significant buffer or linkage for native species. (**No, does not meet factor**)

(5) *Uniqueness or distinctiveness*: No records have been found for indigenous flora or fauna species endemic to the Auckland region to occur within the areas of riparian margin and rushland vegetation. (**No, does not meet factor**)

The riparian margin and rushland was found to meet two of these significance factors and is therefore considered to be ecologically significant habitat for indigenous flora and fauna.

3.8.1.3 Coastal wetland

The area of coastal wetland along the western boundary of the property has previously been assessed by Goodwin (2012b) and Lowe (2013) against ecological significance criteria

outlined in Appendix 7B of the Auckland Council District Plan (Rodney Section) 2011. Both Goodwin (2012b) and Lowe (2013) agreed that approximately 2 ha of the coastal wetland met at least one of these ecological significance criteria, and could therefore be deemed to be of significant ecological value. Table 17 provides a summary of the assessment by Goodwin (2012b) and Lowe (2013).

Table 17. Assessment of coastal wetland area against ecological significance criteria outlined in Appendix 7B of the Auckland Council District Plan (Rodney Section) 2011.

Auckland Council criteria	Goodwin (2012b)	Lowe (2013)
(a) Diversity	Partial compliance	Compliance
(b) Naturalness	Compliance	Compliance
(c) Rarity	Non-compliance	Non-compliance
(d) Wildlife habitat	Compliance	Partial compliance
(e) Linkages	Compliance	Compliance
(f) Potential for improvement	Does not rely upon	Does not rely upon

The coastal vegetation was re-assessed against the significance factors for coastal environments outlined in Schedule 4 Significant Ecological Areas – Marine Schedule of the Auckland Unitary Plan:

(1) *Recognised international or national significance*: While the Kaipara harbour is recognised on a regional and national level as a significant marine area, the coastal margin does not have national significance as such. (**No, does not meet factor**)

(2) *Threat status and rarity*: The coastal wetland provides habitat for rare indigenous shorebird species (e.g. pied stilt, and pied oystercatcher). (**Yes, meets factor**)

(3) *Uniqueness or distinctiveness*: No records of indigenous species endemic to the Auckland region were found for the coastal wetland areas. (**No, does not meet factor**)

(4) *Diversity*: The coastal wetland supports a range of indigenous coastal plant and animal species across a number of different environmental gradients from coastal margin to intertidal. (**Yes, meets factor**)

(5) *Stepping stones, buffers and migration pathways*: The coastal wetland provides an ecological important zone of coastal vegetation, and provides a buffer for the adjoining marine area of the Kaipara harbour. (**Yes, meets factor**)

(6) *Representativeness*: The coastal wetland provides habitat within the Auckland region that is important to rare indigenous migrating shorebirds. (**Yes, meets factor**)

The coastal wetland was found to meet four of these significance factors and is therefore considered to be ecologically significant habitat for indigenous flora and fauna.

3.8.2 National Threatened Environments Classification

The national Threatened Environments Classification (TEC) indicated that the subject site contained two main land environment classifications: 12.2 ha of land environments of which less than 10 percent of indigenous vegetation cover is remaining nationally; and 51.7 ha of land environments of which 20 to 30 percent of indigenous vegetation cover are remaining nationally (Figure 25).

As shown in Figure 25, 9.8 ha of kanuka forest, and 0.5 ha of indigenous riparian margin and rushland vegetation fall within the TEC classification of 20 to 30 percent of indigenous vegetation cover remaining nationally (At Risk). Of the ecologically significant coastal wetland approximately 2 ha fall within the TEC classification of less than 10 percent of indigenous vegetation cover remaining nationally (Acutely Threatened). Only a negligible portion of the

coastal wetland falls within an unclassified (non-terrestrial) area (approximately 0.2 ha) (Figure 25). No threatened vegetation types will be affected by the proposed sand extraction.

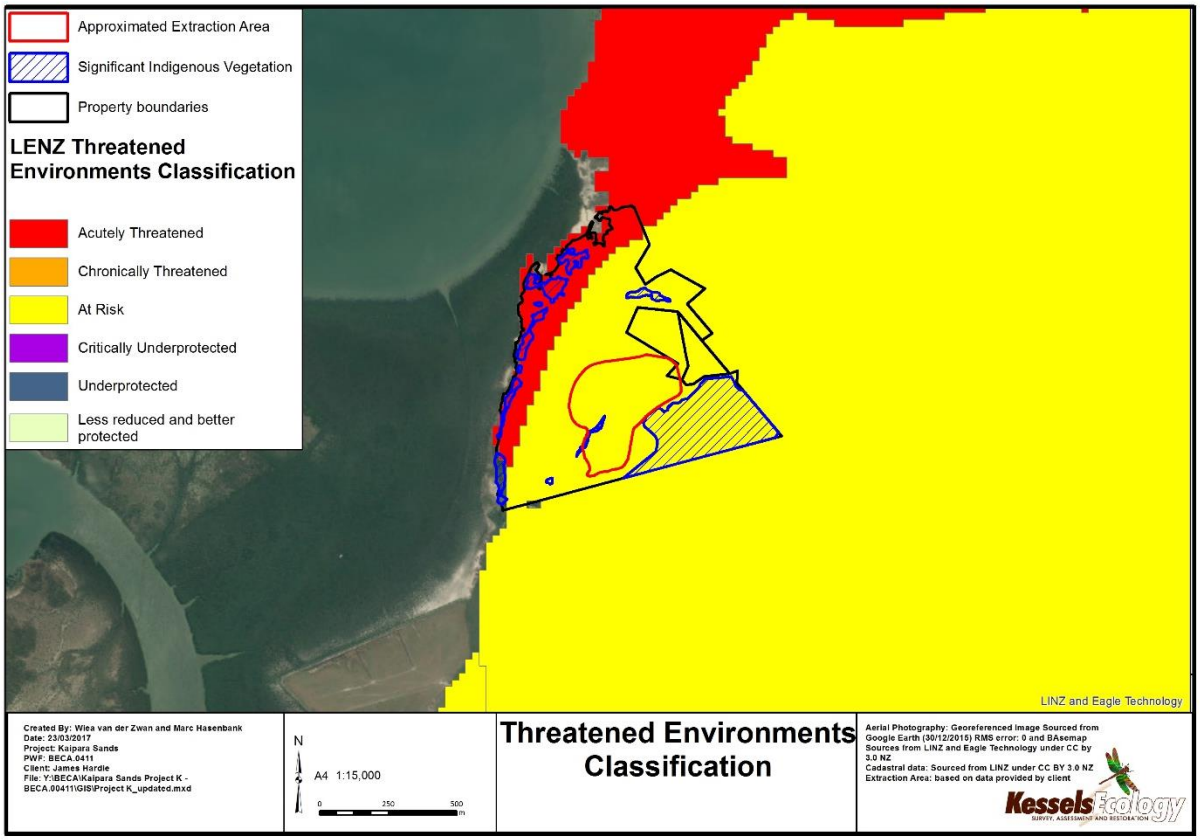

Figure 25. Overview of Threatened Environments Classification for assessment of indigenous vegetation values.

4 ASSESSMENT OF ECOLOGICAL EFFECTS

This section addresses the actual and potential environmental effects associated with the proposed sand extraction activity. The assessment of ecological effects is structured as follows:

- A brief description of the proposed activities;
- Identification of any potential adverse effects;
- Assessment of these effects, including consideration of any measures proposed to minimise or remove the impact of these effects; and
- Identification of further amelioration required to compensate for any adverse impacts that cannot be avoided.

4.1 Description of proposed activities

The assessed area is proposed to be utilised for a sand extraction activity, based on the presence of significant deposits of silica sand, which is located mostly within two ridges to the east and north of the dwelling on the property. Extraction of raw sand is to be undertaken using standard earthmoving equipment including excavators, dump trucks and front-end loaders.

Approximately 23,000 m^3 of sand will be extracted each year, proceeding in stages. Sand will be extracted and transported to an on-site wash plant, which separates the sand from clay particles. The resulting products are clean sand, clay and wastewater which is then recycled

to the stormwater treatment pond system. The sand will be transported from the site by truck, and the clay will be returned to the extraction area.

Stormwater on site will be collected, attenuated and treated in ponds designed to accommodate a 10-year storm event. The treated stormwater will be used in the wash plant and to wet sand for transport. No discharges of water will occur from the site except on rare occasions when the stormwater ponds overflow.

4.2 Identification of potential adverse effects

Potential adverse ecological effects that require assessment in relation to the sand extraction activities at the JHNZ site are:

- Removal of 0.12 ha of indigenous vegetation, including riparian margin and rushland vegetation;
- Removal of 1.5 ha of exotic vegetation within 20 m of an ephemeral stream;
- Positive effects of riparian retirement, enhancement and wetland restoration;
- Positive effects of pest control,
- Adverse effects of edge creation, dust and noise on indigenous vegetation;
- Disturbance of lizards and their habitat;
- Disturbance of invertebrates and their habitat;
- Disturbance of bat habitat;
- Disturbance of birds and their habitat;
- Altered stream hydrology and water quality by discharges of treated stormwater;
- Altered stream hydrology by changes to catchment topography; and
- Modification of aquatic and riparian habitats as a result of culvert installation.

4.3 Assessment of effects

4.3.1 Terrestrial vegetation

4.3.1.1 Vegetation clearance

Vegetation clearance is required in the area to be utilised for sand extraction. The majority of this area is covered in exotic, weedy vegetation, but a small amount of indigenous vegetation including riparian margin and rushland vegetation (0.12 ha) would be affected (Table 18). Under the Auckland Unitary Plan policies for vegetation management and biodiversity (Chapter E15) the removal of the riparian and rushland vegetation would trigger Rule A18 (“Vegetation alteration or removal within 20 m of a natural wetland, in the bed of a river or stream (permanent or intermittent), or lake”) as shown in Table E15.4.1 of the AUP. The vegetation clearance would therefore be a restricted discretionary (RD) activity under the AUP.

Because the Threatened Environments Classification data is mapped at a broad scale, all of these types are classified under At Risk (20 to 30% remaining nationally; see Section 3.9.2). Examining the individual vegetation types, the riparian margin and rushland vegetation was determined to be of significant ecological value, and as such, the indigenous vegetation provides valuable habitat to indigenous fauna and flora. The total extent of the riparian margin and rushland vegetation type found within the property is 0.5 ha. The vegetation clearance of 0.12 ha would equate to a loss of approximately a quarter of that particular vegetation type from the property. From a regional perspective, the loss of 0.12 ha of riparian margin and rushland would further the decline of wetland habitats within the Rodney ED, of which less

than 1 percent of their original extent remain to date (Auckland Council District Plan (Rodney Section) 2011).

Table 18. Approximate areas of vegetation clearance based on proposed extent of extraction area.

Type	Description	Area (ha)
5	Nightshade - gorse shrub	8.12
6	Gorse shrubland	0.05
8	Pasture	1.88
11	Riparian margin and rushland	0.12
12	Eucalypt - nightshade - gorse shrub	0.05

This effect will be mitigated and offset by wetland re-creation, restoration and riparian planting, which is described in Section 5.2. This proposal will re-create the wetland and improve the connectivity of it to other streams and native vegetation on the site in the long term, and improve the existing native vegetation corridors on the site. Because the wetland area comprises rushland with no defined channel, the mitigation required has been calculated on an area basis, rather than using SEV analysis.

General guidance on the use of biodiversity offsetting in New Zealand is provided by the Department of Conservation (2014) in the document "Guidance on biodiversity offsetting in New Zealand". This approach aims for 'no net loss' in overall ecological function and is comparable to an offset mitigation approach (DOC 2014). The preference for environmental compensation is 'like-for-like' habitat, to help guard against the cumulative loss of habitat. Therefore, mitigation is recommended to include restoration of the headwater seep wetlands in the northern stream, as well as re-instatement of the wetland within the sand extraction area. Offset multipliers are the most rudimentary approach to determine a suitable compensation quantum to offset residual biodiversity losses. Alternatives to using multipliers include employing more rigorous methods for calculating biodiversity losses and gains, using multiple and complementary field-tested biodiversity currencies and 'biodiversity accounting models' which are relatively widely adopted approaches overseas (e.g. Gibbons et al. 2009), but which require a very large amount of data and high level of analysis in order to provide robust outputs. However, in this case, given the residual ecological impacts which cannot be directly avoided, remedied or mitigated are relatively small and simply assessed, a multiplier approach is considered to be entirely appropriate.

Because 0.12 ha of rushland will be lost, it is recommended that provision is made to replace a minimum of 0.36 ha of wetland habitat once sand extraction is complete, and restore approximately 0.32 ha of existing indigenous wetland in the northern stream through fencing and weed control. Both of these actions have been recommended in this case to account for the ecological value of the habitat and the time lag between sand extraction and creation of the replacement habitat.

4.3.1.2 Edge effects

When indigenous vegetation is cleared, it is not only necessary to examine the effects of the habitat loss, but also the creation of new "edges" which can change the microclimate and allow invasive plant species to encroach on any remaining vegetation. The area of indigenous rushland and riparian vegetation that will be cleared is surrounded by exotic nightshade-gorse scrub; therefore, edge effects will not be created by the proposed extraction activities.

Because of the maturity of the kanuka forest adjacent to the extraction area, it is unlikely that the forest edge would be adversely affected by the adjacent vegetation clearance.

4.3.1.3 Dust and noise

Dust has the potential to negatively affect a plant's ability to photosynthesize by covering leaves. There will be small amounts of particulate matter expelled through disturbance caused

by extraction activities and vehicle traffic at the site. The effects of the sand extraction on air quality have been assessed by Beca Ltd. as part of the application for consent (Simpson 2017). The Air Quality Report concludes that the dust produced by the activities would be avoided and mitigated using proven techniques, and that the overall effect would be less than minor. It is therefore considered that the overall effects of dust on ecological values will be less than minor, provided the site is managed as proposed.

Noise generated by the sand extraction and washing activities has been modelled and assessed by Marshall Day Acoustics Ltd. (Lawrence 2017). The author of this assessment concludes that the greatest level of effects of noise will be in the areas adjacent to the access road due to truck movements. There are predicted to be a maximum of 8-10 truck movements per day (6 days per week). Overall, the extraction and washing activities are predicted to comply with the relevant noise rule in the Rural-Mixed zone under the Auckland Unitary Plan. Effects of noise on specific fauna are considered in the following sections.

4.3.2 Terrestrial fauna

4.3.2.1 Bats

Bats have been detected around the edges of the proposed extraction area, indicating that they are utilising the area around the subject site as feeding and commuting habitat. It is possible that they are roosting in the mature trees in the area. Because long-tailed bats have extensive home ranges (up to 19 km), the local bat population could be negatively affected by the loss of a single macrocarpa tree and a stand of eucalypts within the extraction area. It is recommended that immediately prior to felling, an assessment of these trees is conducted by a suitably qualified bat ecologist.

It is recommended that due to the possibility of impacts on bat feeding and flight paths, this potential effect can be mitigated by the planting of cavity bearing trees, such as puriri, but also indigenous forest tree and shrub species such as rimu, totara and kanuka in areas adjacent to or within the covenanted areas at the edge. This planting would further improve the bat habitat in the area for the long term. It is considered that this planting will more than offset any potential adverse effects created. Such planting has been incorporated into the Rehabilitation Concept Plan for the site.

4.3.2.2 Birds

Over the recent past, anthropogenic noise pollution has been increasing (Ortega 2012). While some bird species, mostly those in urban areas (Ortega 2012), appear to cope well with anthropogenic noise, e.g. by being able to shift vocal frequencies, other boreal species, for example, appear to be adversely affected by anthropogenic noise (Bayne et al. 2008). Songbirds are often the worst affected by anthropogenic noise pollution, particularly those species that have a low-frequency component within their song (Proppe et al. 2013).

Habitat exists throughout the whole site, but especially in the wetland area and more mature vegetation (exotic and indigenous). In addition, many indigenous species of shorebirds, wetland birds and forest birds dwell near the site of the proposed sand extraction activities. The sensitivity of the species to such disturbance varies. To place this in context however, the Kaipara Harbour area provides a magnitude of varying habitats for many of New Zealand's rarer avian species. There are many other habitats nearby that will remain available to sensitive bird species. In addition, many indigenous bird species adapt relatively well to localised increases in human-created noise (G Kessels, pers obs). Thus, the possible deterrence of some species from the small coastal area, which will be mostly further than 500 m from the noise source, is likely to have a less than minor effect.

Mitigation and enhancement measures outlined in Table 20 (see Section 5.2) are expected to have a positive effect on birds in the long term.

4.3.2.3 Invertebrates

The proposed extraction activities and associated clearance of exotic scrub, pasture, and 0.12 ha of native rushland vegetation will potentially cause disturbance and temporary loss of habitat for indigenous invertebrate species. However, all of the species found on site are ubiquitous and found through the Auckland region. Removal of habitat for these terrestrial invertebrates will therefore result in less than minor ecological effects. Therefore, no further management of indigenous invertebrates will be required.

Nonetheless, protection and restoration of nearby riparian and wetland habitats, as well as control of weeds and animal pest species, will benefit indigenous invertebrate populations on the property.

4.3.2.4 Lizards

Although only plague skinks were found on site, there remains a possibility that indigenous species are present. Indigenous lizard species that may potentially be present at the property include: Pacific gecko, Auckland green gecko, moko skink, ornate skink and striped skink. The proposed sand extraction activity and associated vegetation clearance will destroy some of the available lizard habitat at the site.

Given the significance of the site in a wider ecological and landscape context and the habitat types present that offer suitable refuges for both terrestrial and arboreal lizard species, we recommend preparation and implementation of a Lizard Management Plan to ensure any adverse effects on indigenous lizard species that may be present are minimised during clearance of vegetation (exotic or indigenous) associated with the sand extraction operation. It is recommended that the Lizard Management Plan is supplied as part of the EMRP for the site.

Control of introduced mammalian predators within the property would be of significant benefit for the remaining indigenous lizard population, and is proposed as an enhancement measure.

4.3.3 Aquatic habitat

4.3.3.1 Effects of process and stormwater

Adverse ecological effects associated with stormwater runoff are well documented in stream and wetland ecosystems, and are primarily due to high hydraulic efficiency of stormwater transport systems. Also of concern are contaminants such as suspended solids, and a range of traffic borne heavy metals and polynuclear hydrocarbons. Though extraction trucks and heavy machinery have the potential to contribute contaminants, it is likely that suspended sediments will be more of a concern for the proposed sand extraction activities.

Sand extraction will result in altered hydrology of stormwater. Particularly during peak rainfall events, surface flows may reach large volumes, and if discharged directly to water courses, can create an increase in flood flows, with potential for increased scouring and channelization. The detrimental effects of peak rainfall events and potential contaminants within the sand extraction area will be avoided using stormwater management devices which are designed in detail in the included sediment control plan, and will accommodate a 10-year flood event.

Water used to wash the sand will be collected in a sediment control pond (as detailed in the sediment control report) and reused again in the wash process. Flocculant will be used to assist settling the sediment and to reduce the potential it will flow out of the pond in the unlikely event it overtops in flood events. Ponds will also be designed with sufficient capacity to minimise this risk. Therefore, it is unlikely that there will be adverse effects on the streams in relation to increased sediment discharge or altered hydrology, particularly when considering the improved riparian margin planting that will occur as a result of the proposal.

4.3.3.2 Effects of culvert installation

To allow for vehicle movements to the wash plant and related areas, an existing vehicle crossing point over the southern tributary will be utilised and a new culvert installed.

An existing farm culvert over the middle stream will remain in place to serve agricultural and restoration activities until approximately year 11, when a new primary access through the site would be established. That route has been aligned to utilise the existing crossing point, which would be upgraded as necessary with new pipes.

A new crossing of the northern stream is indicated to provide access to proposed Lot 3. That crossing point has been selected to avoid an established wetland associated with the upper section of this ephemeral watercourse, and to coincide with a point where the stream is narrow and tightly constrained within steep banks.

These culverts and crossing points have been planned and will be installed in accordance with the permitted activity standards of the AUP. Though assessment of effects of permitted activities is not formally required, it is considered that the restoration recommendations for the site will mitigate the small loss of stream habitat caused by these culvert replacements and installations.

Although the aforementioned streams are not perennial and are unlikely to provide fish habitat, adherence to current best practice at the time of installation will ensure that the culverts have minimal effects on stream habitat and allow for movement of invertebrates. All culverts should be sufficiently large and installed below the natural streambed so that natural bed-load movement forms a stable bed inside the culvert (Stevenson and Baker 2009, Boubée et al. 1999). The design of the outlet of the culvert is critical to prevent scouring and over-hanging lips.

The key design features for culverts need to include:

1. The culverts should be installed so that the invert is about 300 mm below the existing channel invert;
2. The culverts should be set at the same or lesser grade than the existing stream bed and at a gradient of no more than 1 in 300;
3. Average water velocities in the culvert should be 0.3 m/s or lower;
4. Culvert width should be sufficient to contain the existing natural channel width plus 0.5 m as a minimum on each side;
5. Channel beds at upstream and downstream ends of the culvert should be protected against erosion and/or aggradation/degradation;
6. Overhanging vegetation should be planted at both ends of the culvert; and
7. Boulders should be fixed to culvert abutments and along edges of the channel outlet structure where grades are steeper than 1 in 300.

4.3.3.3 Effects of altered stream hydrology

Following sand extraction, the catchment of the southern tributary will be slightly enlarged. These changes will reduce the catchment area that drains directly to the Kaipara Harbour through overland flow paths. The overall effect of these changes is predicted to be neutral, and the habitat recreation and riparian planting along the southern tributary will result in a net positive effect on stream hydrology in the long term.

5 KEY FINDINGS AND RECOMMENDATIONS

5.1 Key findings

The area of proposed sand extraction lies within a mosaic of pasture, exotic scrub and indigenous scrub intersected by streams leading directly into the Kaipara Harbour. Thirteen vegetation types have been described, of which kanuka forest, riparian margin and rushland, as well as the coastal wetland vegetation type are the only significant indigenous communities present within the wider property. While there is 0.12 ha of indigenous riparian margin and rushland present within the sand extraction area, the bulk of the vegetation where the sand extraction is proposed to take place is dominated by exotic species and pasture. The areas of exotic scrub and a small number of exotic trees within the extraction footprint may nevertheless provide habitat for indigenous bats and potentially lizards. Removal of the ecologically significant riparian margin and rushland vegetation within the proposed sand extraction area is considered a restricted discretionary activity under the AUP.

Three stream systems flow from east to west through the JHNZ property, two of which are ephemeral soft-bottomed natural watercourses. Near and outside the southern border of the property is a stream system consisting of four branches, one permanently flowing and the rest intermittent/ephemeral. Part of the northernmost tributary in this system (southern tributary) is within the sand extraction area, and an area of ephemeral indigenous rushland in its headwaters will be removed. No other streams will be impacted by the proposed activities, and the riparian zones of two other streams within the property are proposed to be enhanced.

Bat monitoring detected long-tailed bats around the property. The main areas of bat activity were around stands of mature exotic trees located adjacent to the extraction area. However, bat activity was low to moderate at the site, and no active bat roosts were discovered during the bat monitoring.

Bird species noted during the field surveys were dominated by exotic species, with no At Risk or Threatened species found to be utilising the habitats on site.

No indigenous lizards were found during any of the surveys. However, Pacific gecko, Auckland green gecko, moko skink, ornate skink and striped skink may potentially be present at the site. The site is dominated by plague (rainbow) skinks, which are an introduced pest species and will not require further management.

5.2 Recommendations for avoidance, remediation, mitigation and monitoring

5.2.1 Overview

A number of specific avoidance, remediation, mitigation and monitoring measures will be required to ensure that any adverse ecological effects associated with the proposed sand extraction activities are minimised as far as practicable. The following sections set out our recommended avoidance, remediation, mitigation and monitoring requirements that will need to be incorporated into consent conditions.

Offset mitigation is required to compensate for the loss of 0.12 ha of ecologically significant indigenous vegetation. This will be provided in the form of a minimum of 0.36 ha of habitat replacement and restoration as broadly described in Section 5.2.3. Replacement of approximately 1.5 ha of exotic riparian vegetation will also be required.

As part of the resource consent application, it is recommended that conditions require an EMRP and Operational Management Plan to be developed and implemented. As a minimum, the EMRP should include:

- Pre-clearance surveys and checks for bats and lizards will be required prior to felling of vegetation, even though it is exotic.
- All revegetation areas should include pest animal control for a period after the restoration has been undertaken to encourage plant growth and maximise opportunities for indigenous fauna to reoccupy the locality.
- To minimise opportunities for weeds to establish on areas of exposed earth, continual revegetation of the site will be necessary. These measures are described in the Rehabilitation Concept Plan submitted as part of the application. It is also recommended that detailed planting and ecological management requirements are to be described in the EMRP to provide detailed staging and planting information.
- In order to secure the restoration and enhancement investment measures, some form of legal protection is required over these areas. This can be by the way of a covenant, or condition of consent.

Table 20 summarises the effects, mitigation and enhancement measures recommended.

Table 20. Summary of ecological effects, extent or severity, and mitigation measures proposed.

Potential ecological effect	**Threatened species/ecosystems affected**	**Extent or severity <u>without</u> avoidance, remediation, mitigation or offsetting**	**Avoidance, remediation, mitigation or offsetting requirements (detailed in Section 5.2)**	**Residual effect <u>after</u> avoidance, remediation, mitigation or offsetting**	**Enhancement**
Native vegetation clearance, increased edge, noise and dust effects on vegetation Non-indigenous vegetation clearance within 20m of a stream and wetland	Ephemeral stream/wetland Stream and wetland ecology	Removal of **0.12 ha** of indigenous wetland vegetation Removal of approximately **1.5 ha** of non-indigenous vegetation within 20 m of an ephemeral stream and wetland (comprising nightshade, gorse and eucalyptus scrub). Though not indigenous, this vegetation provides valuable filtering and buffering services improving downstream habitat and water quality.	**3.3 ha** restoration/habitat recreation in total. 1) Wetland habitat restoration/recreation: at least **0.6 ha**, incorporating: a) Wetland habitat recreation within extraction area (post extraction); **at least 0.36 ha;** b) Restoration of existing wetland vegetation (northern stream): approximately **0.32 ha** 2) Stream riparian habitat: **2.63 ha**, incorporating: a) Restoration on riparian margins of southern stream: **0.78 ha** (includes 10 m buffer around wetland); b) Restoration of riparian margins of middle stream: **1.85 ha** Wetland vegetation: The multiplier ratio for offset mitigation can range from 1:1 to as high as 20 in some cases. However, in the absence of any offset modelling, we consider that an offset ratio of 1:5 is appropriate, and consistent with approaches used elsewhere, including case law. Assuming a 1:5 ratio for the loss of indigenous wetland vegetation, a minimum of 0.6 ha would be required. This will be more than achieved through replacement of the wetland within the extraction zone (0.36 ha) combined with restoration of existing wetland vegetation in the northern stream. Stream riparian vegetation: An additional 1.5 ha is proposed to replace non-native vegetation within 20 m of the ephemeral stream within the extraction area (assuming a 1:1 replacement ratio). The southern and Middle streams are the best location for this given their proximity to the extraction area. Approximately 2.63 ha of stream restoration is planned for these areas. This total exceeds the 1.5 ha required; however, loss of terrestrial fauna habitat should be accounted for in the final figure. We consider the residual effect on bats and lizards is less than minor if the 3.3 ha of restoration is carried out. Restoration and enhancement should be detailed in the EMRP for the site.	Less than minor	Animal pest control as described in Section 5.2.6 (rat and possum control for duration of extraction activity over approximately 20 ha of the property) Restoration of stream riparian vegetation, northern stream: **1.6 ha.** This area is separated from the main impact area by a ridge, but will provide useful buffering, biodiversity values and ecological linkages for the existing wetland area, if restored. Landscape/enhancement planting as described in Rehabilitation Concept Plan.
Loss of bat habitat	Long-tailed bat	Minor; removal of few exotic trees that could provide bat habitat. Removal of potential foraging habitat around ephemeral wetland.	To be detailed in a Bat Management Plan. Pre-felling assessment of trees by bat ecologist. Recreation and restoration of wetland and stream riparian habitat, with planting of 15 cavity-bearing trees. (included in 3.3 ha detailed above)	Less than minor	
Loss of bird habitat	Loss of habitat, increased dust and noise effects for indigenous (non-threatened) birds. No threatened species likely to be adversely affected	Minor effect on habitat for existing indigenous birds.	Habitat recreation and restoration (included in 3.3 ha detailed above)	Less than minor	

Table 20. (continued). Summary of ecological effects, extent or severity, and mitigation measures proposed.

Potential ecological effect	**Species/ecosystems affected**	**Extent or severity <u>without</u> avoidance, remediation, mitigation or offsetting**	**Avoidance, remediation, mitigation or offsetting requirements (detailed in Section 5.2)**	**Residual effect <u>after</u> avoidance, remediation, mitigation or offsetting**	**Enhancement**
Removal of invertebrates / loss of invertebrate habitat	Loss of habitat for indigenous (non-threatened) invertebrates. No threatened species likely to be adversely affected	Minor effect on habitat for existing indigenous invertebrates on site	Habitat recreation and restoration (included in 3.3 ha detailed above)	Less than minor	Animal pest control as described in Section 5.2.6 (rat and possum control for duration of extraction activity over approximately 20 ha of the property) Restoration of stream riparian vegetation, northern stream: **1.6 ha.** This area is separated from the main impact area by a ridge, but will provide useful buffering, biodiversity values and ecological linkages for the existing wetland area, if restored. Landscape/enhancement planting as described in Rehabilitation Concept Plan.
Removal of lizards / loss of lizard habitat	Removal of potential habitat for indigenous lizards	Potentially more than minor effects if indigenous lizards present within extraction area.	Pre-clearance spotlighting and destructive searches to be detailed in a Lizard Management Plan. A Wildlife Permit will be required. Recreation and restoration of wetland and stream riparian habitat. (included in 3.3 ha detailed above)	Less than minor	
Effects on stream and coastal water quality, quantity and stream habitat	Downstream aquatic and estuarine systems Ephemeral and intermittent southern tributary downstream of extraction area	Potentially more than minor effect on water quality and habitat from sediment, culverts and loss of stream margin vegetation Neutral effects on stream flow and volume Culverts will be installed under permitted activity rules in PAUP; do not formally require assessment. However, effects are expected to be minor	Avoided by installation of stormwater management system. Most water is recycled on site and discharge from stormwater ponds will be rare. Changes to hydrology will be mitigated through habitat re-creation and planting post extraction. Culvert effects will be mitigated and offset by riparian retirement and restoration, included in the 3.3 ha detailed above.	Less than minor Neutral/positive Neutral/positive	

5.2.2 Pre- felling and clearance protocols for lizards and bats

Given the significance of the site in a wider ecological and landscape context and the habitat types present that offer suitable refuges for both terrestrial and arboreal lizard species, we recommend a Lizard Management Plan to ensure any adverse effects on indigenous lizard species that may be present are minimised. We recommend a survey using a combination of destructive searches and spotlighting for lizards within a 48-hour period before vegetation removal, in order to ensure no lizards are present in the area of vegetation to be removed and to meet the requirements of the Wildlife Act to protect indigenous fauna. If necessary, any lizards present should be salvaged and relocated to an appropriate alternative habitat. The Lizard Management Plan will form of the EMRP for the site.

Because long-tailed bats are also legally protected under the Wildlife Act (1953), a tree removal protocol will be required to outline timing and type of surveys conducted before the removal of individual mature trees. No mature vegetation should be removed without prior inspection by qualified and approved bat ecologists, and, where necessary, a three-night ABM survey targeting individual trees identified as 'high risk' for bat roosts should be undertaken to investigate whether or not bats are present before felling. A detailed Bat Management Plan and site-specific tree removal protocols should be included as part of the EMRP for the site.

A Wildlife Authority will be required from DOC to 1) cover incidental killing of or injury to bats during construction, in particular the removal of mature vegetation, and 2) carry out salvage and recovery of indigenous lizards.

5.2.3 Rehabilitation of existing culvert below pond

There is a pond located outside the property on a paper road. Rehabilitation of fish passage past the culvert at the downstream end of the pond was considered as part of the development of a suitable mitigation package to address effects on aquatic biota. However, reinstating fish passage would provide only marginal net benefits. The small size of the stream and habitat types present upstream of the culvert limit the benefits possible. Installation of spat ropes would potentially allow redfin bullies to access the stream and pond; an additional species to those already present. However, the stream and pond do not provide suitable habitat for redfin bullies. Rehabilitation of passage for non-climbing species, such as inanga would likely require major earthworks or installation of heavily engineered structures, and is considered outside the scope and requirements for this project.

5.2.4 Animal pest control

The purpose of the animal pest control is to provide additional benefit to native fauna while habitat is being lost and in the interim period that the restoration sites achieve their full biodiversity benefits. Pest control is a requirement of the existing covenant conditions, but the pest control programme should be extended for all of the property and be undertaken to current industry best practice standards for greater overall benefit. Therefore, in addition to control of animal pests in the covenant area, annual control of pest animals over the life of the sand extraction site would reduce damage to indigenous vegetation, as well as allow populations of indigenous fauna species to increase as pressure from predation is reduced. The pest control operation should ideally target possums and rats to achieve the greatest benefits and be conducted at least during the extraction process, covering approximately 20 ha. Priority areas are the restored vegetation, stream riparian areas, and the coastal margin.

It is recommended that details for pest management are included in the EMRP for the site.

Animal pest control outside the covenant areas is considered to contribute toward the enhancement of the site, rather than as mitigation for the sand extraction.

5.2.5 Habitat recreation and enhancement

Habitat restoration will be required in order to offset the loss of of 0.12 ha of ecologically significant riparian and rushland habitat, and 1.5 ha of exotic riparian vegetation (Table 20; Figure 26). To mitigate the loss of 0.12 ha riparian margin and rushland wetland it is recommended that a wetland is re-created following sand extraction, consisting of a total area of not less than 0.36 ha. Because there will be a time lag (approximately 10 years) between removal of the rushland wetland and recreation, it is also recommended that the existing area of ephemeral riparian wetland along the northern stream is fenced and enhanced as an offset mitigation measure.

Approximately 1.5 ha of exotic riparian vegetation will be removed; this will be mitigated by re-planting and restoring approximately 2.6 ha of indigenous riparian vegetation in the middle and southern streams. This stream riparian planting and associated pest control will also help offset the effects of habitat loss for terrestrial fauna.

Detailed requirements for restoration planting should be included in the EMRP for the site, incorporating the type and number of plants needed and an ongoing annual work plan which will detail the activities that need to be undertaken to achieve a self-sustaining planted area. The area of habitat recreation within the extraction area is proposed to be at least 0.36 ha; this will be confirmed in the detailed management plans for the site, as this will depend on final land contours post sand extraction.

5.2.5.1 Benefits of stream riparian vegetation

Fencing and planting of waterways is a key action to reduce sediment and nutrient inputs from the catchment and is considered the most suitable method for mitigating the residual adverse effects of the power station. Weed control and providing a wider buffer zone would allow the treatment and slowing of runoff to the streams and provide additional benefits to the streams, including:

- increasing shading and limiting light available for aquatic plant and periphyton growth;
- decreasing stream temperature, which will improve habitat conditions for macroinvertebrates and fish;
- attenuating sediment inputs from the catchment by preventing erosion;
- in the long term, inputs of plant material and wood from the riparian margins will provide food and habitat for fish and invertebrates; and
- improving connectivity between the streams/drains and nearby terrestrial areas, benefiting biodiversity and providing corridors for movements of animals.

5.2.5.2 Plant selection and eco-sourcing

Plants which naturally grow in the local Ecological District should be selected and sourced locally. The locality from which the seeds of plants were gathered is important because local populations are adapted to local soil and climatic conditions and are part of the distinctive character of that area. Exotic plant species that are likely to become weeds should be avoided. Care will need to be taken not to spread disease into the restoration sites and hence the inclusion of kauri in any planting plans needs careful thought and specific disease minimisation strategies before brining seedlings to site.

5.2.5.3 Fencing

To ensure that the restoration work is protected, the restored riparian buffer zones should be fenced with a good quality 7- or 8- wire post and batten fence or at least a 3-wire electric fence to ensure that stock do not go through them.

5.2.5.4 Permanent legal protection of restoration areas

In order to secure the restoration and enhancement investment measures, some form of legal protection is required over these areas. This can be by the way of a covenant, or condition of consent.

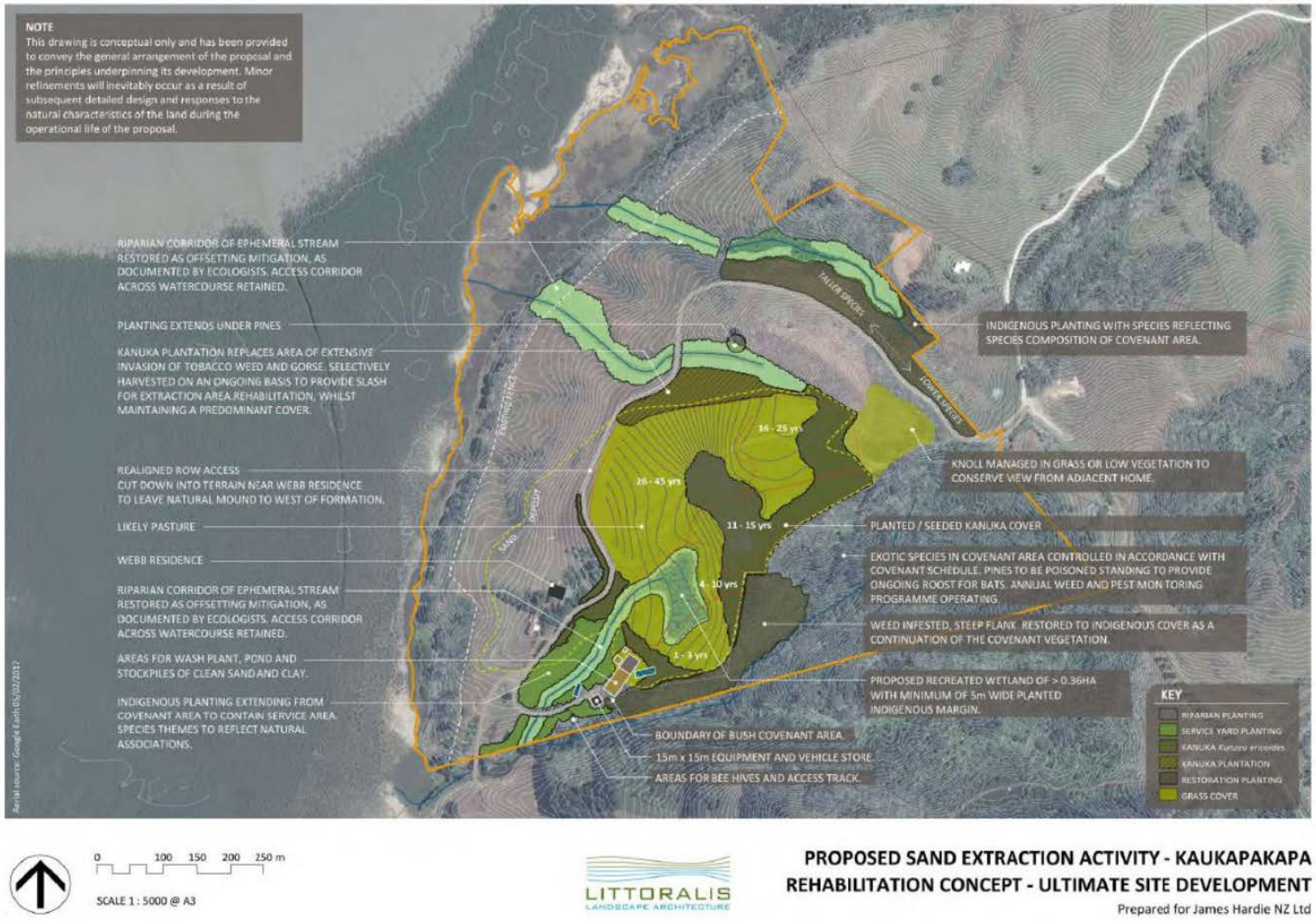

Figure 26. Proposed restoration zones, as part of site rehabilitation concept. Source: Littoralis Landscape Architecture 2017.

6 GLOSSARY OF TERMS

EPT or **Ephemeroptera, Plecoptera and Trichoptera:** Refers to scientific names for mayflies, stoneflies and caddisflies, three orders of stream macroinvertebrates that are considered to be generally sensitive to poor habitat conditions.

Macroinvertebrate: Animals without a backbone that can be seen with the naked eye.

Macrophyte: Aquatic plants. Can be emergent (with parts growing above and below the water's surface), submerged (growing completely under water) or floating.

MCI or **Macroinvertebrate Community Index:** An indicator of aquatic habitat quality based on the presence/absence of species which have a predefined tolerance score. Different scores are used in soft and hard-bottomed streams. MCI-sb indicates that the soft-bottom index was used.

Mesohabitat: Literal translation is "middle' habitat. Used in stream ecology to describe stream sections with similar depth and velocity characteristics (e.g. pools, riffles, runs).

Periphyton: Algae and bacteria growing on the surface of rocks or other surfaces.

QMCI or **Quantitative Macroinvertebrate Community Index:** An indicator of aquatic habitat quality based on the relative abundances of macroinvertebrate taxa that have a predefined tolerance score. Different scores are used in soft and hard-bottomed streams. QMCI-sb indicates that the soft-bottom index was used.

Riparian zone: The zone along the edge of stream and river beds.

Stream morphology: Shape and composition of stream channels.

Taxon or **taxa:** A group of organisms judged to be similar by a taxonomist. The smallest taxonomic grouping used is typically a 'species'.

Thalweg: Continuous line running along the deepest part of a channel.

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Appendix I
Macroinvertebrate Data

Taxa	MCI	MCI-sb	Northern Tributary	Middle Tributary	Southern Stream
Mayfly Tepakia	8	7.6			1
Mayfly Zephlebia	7	8.8			28
Stonefly Acroperla	5	5.1			6
Caddisfly Oxyethira	2	1.2			1
Caddisfly Polyplectropus	8	8.1		1	1
Damselfly Xanthocnemis	5	1.2			5
Beetle Dytiscidae	5	0.4	1	2	
True Fly Austrosimulium	3	3.9			1
True Fly Ceratopogonidae	3	6.2			1
True Fly Culicidae	3	1.2	2	1	
True Fly Hexatomini	5	6.7	1		4
True Fly Lobodiamesa	5	7.7		1	
True Fly Molophilus	5	6.3	2		
True Fly Muscidae	3	1.6			1
True Fly Paradixa	4	8.5			2
True Fly Paralimnophila	6	7.4	3		1
True Fly Sciomyzidae	3	3			1
True Fly Tanypodinae	5	6.5		2	26
True Fly Tanytarsini	3	4.5	1		2
True Fly Zelandotipula	6	3.6		2	
Collembola	6	5.3		1	2
Crustacea Isopoda	5	4.5	2		1
Crustacea Ostracoda	3	1.9	2		
Crustacea Paracalliope	5	5.5			43
Crustacea Paraleptampho	5	5.5			11
Crustacea Phreatogamma	5	5	2		
Mites	5	5.2	7	5	4
Spiders Dolomedes	5	6.2		1	1
Mollusc Potamopyrgus	4	2.1			66
Mollusc Sphaeriidae	3	2.9			1
Oligochaetes	1	3.8	4	1	25
Number of Taxa			11	10	24
EPT Value			0	1	5
Number of Individuals			27	17	235
% EPT (taxa number)			0.00	10.00	20.83
SBMCI Value			85.27	96.00	101.08
QMCI-sb Value			4.56	4.66	4.76

Appendix II
Bat Survey Supplementary Data

Table 1. Summary of weather conditions during the June/July survey period. Daily maximum/minimum temperatures in °C, wind speed in km/h and precipitation in mm/24hrs. Data obtained from NIWA CliFlo database, station number 37852.

Date	Precipitation	Wind	Temperature (min)	Temperature (max)
10-Jun	7.4	37.1	16	18
11-Jun	0.6	25.9	11.3	19.4
12-Jun	0	38.9	10.4	17.6
13-Jun	2	40.8	10.4	17.8
14-Jun	0	24.1	5.1	14.4
15-Jun	0.6	29.7	9.9	15.4
16-Jun	1.8	24.1	7.2	15.9
17-Jun	0	22.2	4.8	16.4
18-Jun	0	25.9	5.5	16.4
19-Jun	0	33.4	9.4	14
20-Jun	0	25.9	6.3	17.1
21-Jun	0	46.3	9.6	16.5
22-Jun	4.4	48.2	15.3	17.4
23-Jun	46	50	14.9	17.7
24-Jun	9.6	37.1	12.2	17.4
25-Jun	4.2	40.8	9.3	17.4
26-Jun	9.2	44.5	12.2	16.2
27-Jun	6.4	70.4	9	17.2
28-Jun	7.6	31.5	11.2	16.8
29-Jun	8.2	46.3	11.8	16.5
30-Jun	23.6	35.2	10.3	16
1-Jul	2.8	33.4	5.7	15
2-Jul	0.2	20.4	-0.3	12.3
3-Jul	0	14.8	-0.8	13.7
4-Jul	0	9.3	2.1	13
5-Jul	0	22.2	3.8	16.6

Table 2. Summary of weather conditions during the November/December survey period. Daily maximum/minimum temperatures in °C, wind speed in km/h and precipitation in mm/24hrs. Data obtained from NIWA CliFlo database, station number 37852.

Date	Precipitation	Wind	Temperature (min)	Temperature (max)
05-Dec	0	5.8	13.7	22
06-Dec	0	8.6	13.2	23.9
07-Dec	0	16.9	14.9	22.7
08-Dec	6.4	12.6	15.7	21.5
09-Dec	0.8	5.8	15.3	19.4
10-Dec	0.2	11.9	18.2	22.4
11-Dec	4	15.8	13	21.2

Date	Precipitation	Wind	Temperature (min)	Temperature (max)
12-Dec	1.6	9.7	12.6	19.2
13-Dec	0	11.2	13	19.7
14-Dec	0	10.4	11.9	19.7
15-Dec	0	12.2	15.2	19.9

Table 3. Summary of recording nights and hours for June/July and November/December survey periods.

ABM	Total nights recorded	ABM hour
June/July		
J01	20	310
J02	21	325.5
J03	7	108.5
J04	26	403
J05	26	403
J06	12	186
J07	8	124
J08	7	108.5
December		
KB3	10	110
KB4	10	110
KB5	10	110
KB6	10	110
KB7	10	110
KB8	10	110
KB9	10	110
KB10	10	110
KB11	10	110
KB12	10	110

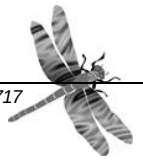
Appendix III
Botanical Species List

This list was compiled during the visit on 11/05/2016.
* denotes a non-native species

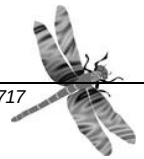
Gymnosperm Trees & Shrubs	
**Cupressus macrocarpa*	macrocarpa
**Pinus radiata*	radiata pine
Dicotyledonous trees and shrubs	
Coprosma robusta	karamu
Coprosma rhamnoides	twiggy coprosma
Cordyline australis	cabbage tree
Cortaderia selloana	pampas grass
Cortaderia jubata	pampas grass
**Eucalypptus sp.*	eucalypt
Geniostoma ligustrifolium var. ligustrifolium	hangehange
Kunzea ericoides	kanuka
Myrsine australis	mapou
Leucopogon fasciculatus	mingimingi
Leptospermum scoparium	manuka
**Phytolacca octandra*	inkweed
Pittosporum eugenoides	lemonwood
Podocarpus totara	totara
**Solanum mauritianum*	woolly nightshade
**Ulex europaeus*	gorse
Dicotyledonous lianes	
**Lonicera japonica*	Japanese honeysuckle
Muehlenbeckia sp.	pohuehue
**Rubus fruticosus* agg.	blackberry
Ferns	
Blechnum novae-zelandiae	kiokio
Cyathea dealbata	ponga
Dicksonia squarrosa	wheki
Pteridium esculentum	bracken, rarauhe
Sedges	
Carex virgata	pukio
**Isolepis prolifera*	
Rushes and allied plants	
**Juncus* sp.	
Dicotyledonous herbs - including composites	
**Jacobaea vulgaris*	ragwort
**Lotus pedunculatus*	lotus
**Persicaria hydropiper*	water pepper
**Plantago lanceolata*	narrow-leaved plantain
**Ranunculus repens*	creeping buttercup
**Rumex acetosa*	sorrel

Appendix IV
5-Minute Bird Count Data

Observer	Date	Station	Settle-in Time	Start Time	End Time	Species	Common name	NZ Status	NZ Conservation Status	IUCN Red List Status	Heard Count	Seen Count	Weather	Wind Direction	Wind Strength	Precipitation Type	Precipitation Value	Temperature	Noise
MH	7/07/16	1	5	10:30	10:35	*Zosterops lateralis*	Silvereye	Native	Not threatened	Least concern - stable	1		Overcast	NW	1	None	None	Cool	Low
MH	7/07/16	1	5	10:30	10:35	*Turdus merula*	Eurasian blackbird	Introduced	Introduced and Naturalised	Least concern - stable	2		Overcast	NW	1	None	None	Cool	Low
MH	7/07/16	1	5	10:30	10:35	*Alauda arvensis*	Eurasian skylark	Introduced	Introduced and Naturalised	Least concern - decreasing		1	Overcast	NW	1	None	None	Cool	Low
MH	7/07/16	1	5	10:30	10:35	*Carduelis carduelis*	Goldfinch	Introduced	Introduced and Naturalised	Least concern - stable	1		Overcast	NW	1	None	None	Cool	Low
MH	7/07/16	1	5	10:30	10:35	*Gymnorhina tibicen*	Australasian magpie	Introduced	Introduced and Naturalised	Least concern - increasing	1		Overcast	NW	1	None	None	Cool	Low
MH	7/07/16	1	5	10:30	10:35	*Gerygone igata*	Grey warbler	Endemic	Not threatened	Least concern - stable	1		Overcast	NW	1	None	None	Cool	Low
MH	7/07/16	2	5	11:00	11:05	*Gerygone igata*	Grey warbler	Endemic	Not threatened	Least concern - stable	1		Overcast	NW	2	None	None	Cool	Moderate
MH	7/07/16	2	5	11:00	11:05	*Carduelis carduelis*	Goldfinch	Introduced	Introduced and Naturalised	Least concern - stable	2		Overcast	NW	2	None	None	Cool	Moderate
MH	7/07/16	2	5	11:00	11:05	*Zosterops lateralis*	Silvereye	Native	Not threatened	Least concern - stable	1		Overcast	NW	2	None	None	Cool	Moderate
MH	7/07/16	3	5	11:45	11:50	*Alauda arvensis*	Eurasian skylark	Introduced	Introduced and Naturalised	Least concern - decreasing	1		Overcast	NW	2	None	None	Cool	Moderate
MH	7/07/16	3	5	11:45	11:50	*Gymnorhina tibicen*	Australasian magpie	Introduced	Introduced and Naturalised	Least concern - increasing		1	Overcast	NW	2	None	None	Cool	Moderate



MH	7/07/16	3	5	11:45	11:50	*Rhipidura fuliginosa*	New Zealand fantail	Endemic	Not threatened	Least concern - unknown	1		Overcast	NW	2	None	None	Cool	Moderate
MH	7/07/16	3	5	11:45	11:50	*Callipepla californica*	California quail	Introduced	Introduced and Naturalised	Least concern - increasing		2	Overcast	NW	2	None	None	Cool	Moderate



Appendix V
Bat, bird and lizard survey locations

Locations shown in Figure 3: ABMs for the June and December bat surveys (J, D), as well as of the three 5-minute bird count stations (BD). Locations given as NZTM coordinates.

Bat monitor/bird count station	Northings	Eastings
J01	5947335	1728762
J02	5947242	1728999
J03	5946995	1728839
J04	5947017	1729217
J05	5946943	1729051
J06	5946645	1728759
J07	5946613	1728604
J08	5946780	1728622
D01	5947261	1728996
D02	5947238	1728815
D03	5947085	1729194
D04	5947043	1729203
D05	5946972	1729054
D06	5946921	1728904
D07	5946817	1728900
D08	5946680	1728721
D09	5946706	1728691
D10	5947012	1728895
BD1	5946946	1728998
BD2	5947372	1729123
BD3	5947236	1728747

Location of lizard ACOs. All locations are NZTM.

ACO	Northings	Eastings
A1	5947049	1729181
A2	5947043	1729172
A3	5947048	1729171
A4	5947055	1729169
A5	5947060	1729171
A6	5947065	1729170
A7	5947056	1729157
A8	5947017	1729149
A9	5947006	1729153
A10	5947048	1729153
A11	5946989	1729094
A12	5946958	1729046
A13	5946929	1729053
A14	5946901	1729015
A15	5946944	1729007
A16	5946951	1728983
A17	5946914	1729012
A18	5946907	1729002
A19	5946932	1728917
A20	5946887	1728913
A21	5946818	1728900
A22	5946762	1728818
A23	5946724	1728647

ACO	Northings	Eastings
A24	5946767	1728619
A25	5946900	1728810
A26	5946970	1728860
A27	5947016	1728905
A28	5947106	1729120
A29	5947387	1728942
A30	5947234	1728812
A31	5947258	1728991
A32	5947205	1729053
A33	5947083	1729200

Appendix VI

At risk or threatened species previously recorded in the vicinity of the property

Flora – fauna classification	**Scientific name**	**Common name**	**DOC conservation status**	**Notes**
Bat	*Chalinolobus tuberculatus*	North Island long-tailed bat	Nationally vulnerable	Present around border of extraction area
Plant	*Cyclosorus interruptus*		Declining	Potentially present in kanuka forest block
Plant	*Lobelia* aff. *angulata*	Pratia	Nationally critical	Potentially present in kanuka forest block
Plant	*Mazus novaezeelandiae* subsp. *impolitus*	Dwarf musk	Nationally critical	Potentially present in kanuka forest block
Plant	*Pimelea tomentosa*		Nationally vulnerable	Potentially present in kanuka forest block
Plant	*Pseudopanax ferox*	Fierce lancewood	Naturally uncommon	Potentially present in kanuka forest block
Plant	*Thelypteris confluens*	Swamp fern	Declining	Potentially present in kanuka forest block
Plant	*Danhatchia australis*	Danhatchia (orchid)	Declining	Potentially present in kanuka forest block
Bird	*Botaurus poiciloptilus*	Australasian bittern	Nationally endangered	Potentially present in rushland, and coastal wetland
Bird	*Bowdleria punctata vealeae*	North Island fernbird	Declining	Previously sighted in coastal wetland, and potentially present in rushland, or shrub
Bird	*Nestor meridionalis septentrionalis*	Kaka	Nationally vulnerable	Potentially present in kanuka forest block
Bird	*Porzana tabuensis plumbea*	Spotless crake	Relict	Potentially present in rushland, or nearby scrub
Lizard	*Dactylocnemis pacificus*	Pacific gecko	Relict	Potentially present in kanuka forest and adjacent shrub vegetation.
Lizard	*Naultinus elegans elegans*	Auckland green gecko	Declining	Potentially present in kanuka forest.
Lizard	*Oligosoma moco*	Moko skink	Relict	Potentially present in kanuka forest and nearby scrub.
Lizard	*Oligosoma ornatum*	Ornate skink	Declining	Potentially present in low shrub vegetation, and along fringes of kanuka forest.
Lizard	*Oligosoma striatum*	Striped skink	Declining	Potentially present in farmland. Likely present in kanuka forest or riparian margin.
Fish	*Anguilla dieffenbachii*	Longfin eel	Declining	Present in the permanently flowing southern stream
Fish	*Gobiomorphus huttoni*	Redfin bully	Declining	Potentially present in permanently flowing lower reaches of southern stream.