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Kings Quarry Stage Two Expansion

Ecological Impact Assessment

for: Kings Quarry Limited

Consulting Biologists – Established 1972
P.O. Box 2027, Auckland 1140. New Zealand
www.Bioresearches.co.nz

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Author(s)	Kate Feickert, B.Sc., PG.Dip.Sc Senior Ecologist	
	Laura Drummond, M.Sc (Hons) Freshwater Ecologist	
	Michael Anderson, PhD Senior Ecologist, Ornithologist	
	Treffery Barnett, M.Sc (Hons) Technical Director, Freshwater and Coastal Ecology	
Reviewer(s)	Chris Wedding, M.Sc (Hons) Technical Director, Ecology Manager	

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EXECUTIVE SUMMARY

Kings Quarry Limited is proposing Stage 2 of Kings Quarry at Wainui, North Auckland (Project), and Bioresearches has been engaged to provide an Ecological Impact Assessment (EcIA) to inform the application for resource consents.

The Project will involve excavation of over 8,650,000 BCM of aggregate; over a lifespan of 45 years. Throughout years 1 to 5, the 'A-Pit' will be quarried, totalling 6.11 ha, along with an access road leading to the pit. Over the following 40 years, the quarry will gradually be expanded to eventually cover the entire proposed 33.125 ha extent, encompassing both the fill area (A-pit), associated settling ponds, and the quarried extent (B-pit). Fill material from the Stage 2 quarry will be placed back into the A Pit. Within this 33.125 ha, a total of 28.97 ha of indigenous vegetation and habitat would be removed.

The proposed Stage 2 pit and associated fill areas are located within the wider Kings Quarry Landholdings (Figure 1). Collectively, the Stage 2 pit and fill areas and associated infrastructure are hereafter referred to as the 'Project area.' Collectively, the landholdings, and also the Project Area, comprise approximately 167 ha of land, which is predominantly vegetated with regenerating native forest.

This assessment generally follows the EcIA Guidelines for use in New Zealand published by the Environmental Institute of Australia and New Zealand. Both a desktop assessment (which included a review of existing literature and fauna databases) and multiple site assessments (including vegetation, habitat and fauna surveys) were completed to inform this assessment.

Ecological values

Vegetation within the Project area is a mixture of regenerating broadleaved species scrub/forest (VS5) and kānuka scrub/forest (VS2). Both of these habitats were assigned a high ecological value; and were identified as supporting a range of Threatened or At Risk plant species, as well as the assemblage of native fauna, including:

- A wide range of Not Threatened invertebrate species (low ecological value);
- The confirmed presence of two At Risk lizard species (copper skink, forest gecko) within the Project Area, and the potential for presence of an additional three TAR species (high ecological value);
- Seventeen Not Threatened bird species were identified within the site, and the potential for additional TAR species to be present was also identified (moderate ecological value); and
- Threatened - Nationally Critical long-tailed bats (very high ecological value).
- No native frogs were identified within the site, and these are considered unlikely to be present.

Thirteen streams were identified within the Project Area (this included 12 intermittent streams and one permanent stream) ranging from low to high ecological value. These streams were found to provide habitat for a range of freshwater fish species, including At Risk species. No wetlands were identified within the Project area.

Adverse effects on ecological values

The Project will involve completion of bulk earthworks and quarrying activities across the entirety of the Project area, which will result in the permanent, complete loss of all existing freshwater and terrestrial habitat within the Project area boundaries. This includes the loss of approximately 28.97 ha of indigenous

vegetation and associated fauna habitats; and loss of 2,439 linear meters of stream habitat, corresponding to 1,119 m^2 of aquatic habitat when multiplied by the stream widths.

The levels of effect of various aspects of the Project upon the ecological features, prior to ecological mitigation, range from low to high.

Mitigation of adverse effects and further recommendations

Actual and potential adverse effects on terrestrial and freshwater fauna and flora as a result of this proposal will be managed through a range of actions to avoid, minimise and remedy adverse effects. These include:

- Avoid higher value mature kauri, podocarp & broadleaved forest that occurs to the north of Stage 2.
- Avoid potential injury or mortality to threatened bats and nesting native birds, as far as practicable, through pre-works surveys and implementation of precautionary bat roost tree removal protocols
- Minimise edge effects and fragmentation of the forest through edge buffer planting around all newly created edges, and restoration planting of 3.5 ha at the south western edge of the forest fragment, at 306 Pebble Brook Road.
- Minimise injury and mortality to native skinks and geckos through capture and relocation of lizards prior to and during vegetation removal, and enhancement of receiving habitats
- Minimise loss of threatened and at risk plants and their populations through propagation and restoration onsite in edge, remediation and buffer planting schedules.
- Minimise injury and mortality to freshwater fish through capture and relocation of fish prior to works.
- Minimise erosion and sedimentation into adjacent freshwater habitats through implementation of standard control measures.
- Minimise potential effects of catchment reduction through monitoring of Waitoki Stream and adaptive management
- Sequential remediation of the Project area, such that remediation planting will commence from year 1 and be back-filled as fill and pit areas become available throughout the quarry life. This approach will ensure that edge effects are further minimised, and habitats for fauna and flora will become available to fauna after 2-20 years of vegetation maturation.

The implementation of management plans, which have been compiled into one Ecological Management Plan and accompanied with a remediation plan, will ensure that effects on fauna and flora are reduced to low. However, temporary but moderate level residual effects are expected as a result of the losses of high value regenerating ecosystems and freshwater habitats, and these effects should be offset or compensated as appropriate, and as determined through residual effects analysis and implementation.

TABLE OF CONTENTS

List of Tables

List of Photos

List of Figures

List of Appendices

LIST OF ABBREVIATIONS AND GLOSSARY

Abbreviation/Acronym	Explanation
ABM	Automatic Bat Monitor
AR	Artificial Retreat
AUP	Auckland Unitary Plan (Operative in Part)
ARDS	Amphibian and Reptile Distribution Scheme
asl	Above sea level
AVS1	Anthropogenic Totara Forest
bcm	Billion cubic meters
CliFlo	New Zealand's National Climate Database, administered by NIWA
CPUE	Catch Per Unit Effort
dbh	Diameter at breast height
DOC	Department of Conservation
eDNA	Environmental DNA (Deoxyribonucleic Acid)
EcIA	Ecological Impact Assessment
ECR	Environmental Compensation Ratio
ED	Ecological District
EIANZ	Environmental Institute of Australia and New Zealand
EPT	Ephemeroptera (mayflies); Plecoptera (stoneflies) and Trichoptera (caddisflies)
ESU	Evolutionarily Significant Unit
FAC	Facultative
FACU	Facultative Upland
FACW	Facultative Wetland
FTAA	Fast-track Approvals Act
GPS	Global Positioning System
ha	hectare
IBI	Index of Biotic Integrity
IUCN	International Union for Conservation of Nature
KQL	Kings Quarry Limited
LTB	Long-tailed bat, *Chalinolobus tuberculatus*
MCI	Macroinvertebrate Community Index
MfE	Ministry for the Environment
NES-F	National Environmental Standards for Freshwater
NIWA	National Institute of Water and Atmospheric Research
NPS-IB	National Policy Statement for Indigenous Biodiversity
NPS-FM	National Policy Statement for Freshwater Management 2020
OBL	Obligate
PRT	Potential Roost Tree
REMP	Residual Effects Management Plan
RMA	Resource Management Act 1991
SEA	Significant Ecological Area
SEV	Stream Ecological Valuation
SNA	Significant Natural Area

Sp.	One species
Spp.	More than one species
SPQZ	Special Purpose Quarry Zone
SQMCI	Semi-Quantitative Macroinvertebrate Community Index
STB	Short-tailed bat, *Mystacina tuberculata*
Subsp.	Subspecies
TAR	Threatened and/or At Risk
UPL	Upland
VES	Visual Encounter Survey
VS2	Regenerating kānuka scrub/forest
VS5	Regenerating broadleaved species scrub/forest
WA	Wildlife Act 1953
WF11	Kauri, podocarp, broadleaved forest (Warm Forest type 11)
WWLA	Williamson Water and Land Advisory
ZOI	Zone if Influence
5MBC	Five-minute bird count

Term	Definition
Biodiversity Compensation	Actions (excluding biodiversity offsets) to compensate for residual adverse biodiversity effects arising from activities after all appropriate avoidance, minimisation, remediation, and biodiversity offset measures have been applied. Gains generated by compensation actions must be additional to those that would have occurred anyway in the absence of those actions (Baber *et al.*, 2025).
Biodiversity Offsetting	A measurable outcome resulting from actions designed to compensate for residual adverse biodiversity effects arising from activities after appropriate avoidance, minimisation, and remediation measures have been subsequently applied and that achieves No Net Loss or preferably a Net Gain (Baber *et al.*, 2025).
EIANZ Guidelines	The Environmental Institute of Australia and New Zealand Ecological Impact Assessment Guidelines provide a structured, science-based framework for assessing and managing the ecological effects of proposed activities in New Zealand.
Environmental Compensation Ratio (ECR)	The ECR considers the SEV values of both the affected or impacted stream/s and the proposed restoration site stream/s and determines any differential between the scores to provide a ratio for compensation which will result in “no net loss of area weighted stream function” (Storey *et al.,* 2011).
EPT index	Ephemeroptera (mayflies); Plecoptera (stoneflies) and Trichoptera (caddisflies); three orders of insects that are generally sensitive to organic or nutrient enrichment. Diversity and percentages of these species collected in macroinvertebrate samples are used as an index for interpreting the ecological condition of water bodies.
Index of Biotic Integrity (IBI)	A measure of stream ecological health based on freshwater fish community data, assessing factors like species richness, the presence of native versus introduced species, and tolerance to habitat degradation.
Macroinvertebrate Community Index (MCI)	Biotic index calculated using abundance of macroinvertebrates and their tolerance to pollution to aid in interpreting the ecological condition of water bodies.
Management	Management includes all action under the RMA Management Hierarchy, including avoidance, minimisation, remediation, offsetting and compensation.
Mitigation	Mitigation refers only to avoidance, minimisation and remediation actions.

Natural Inland Wetland	A subtype of wetland as defined by the National Policy Statement for Freshwater Management 2020
Project Area	Collectively, the Stage 2 pit and fill areas and associated infrastructure
Semi-Quantitative Macroinvertebrate Community Index (MCI)	Biotic index calculated using coded abundance of macroinvertebrates to aid in interpreting the ecological condition of water bodies.
Zone of Influence (ZOI)	The areas/resources that may be affected by the biophysical changes caused by the proposed project and associated activities (EIANZ, 2018)

1 INTRODUCTION

Kings Quarry Limited is proposing Stage 2 of Kings Quarry at Wainui, North Auckland. Bioresearches has been engaged to provide an Ecological Impact Assessment (EcIA) to inform the application for resource consents.

The proposed stage 2 pit and associated fill areas are located within the wider Kings Quarry Landholdings (Figure 1). Collectively, the Stage 2 pit and fill areas and associated infrastructure are hereafter referred to as the 'Project area.'

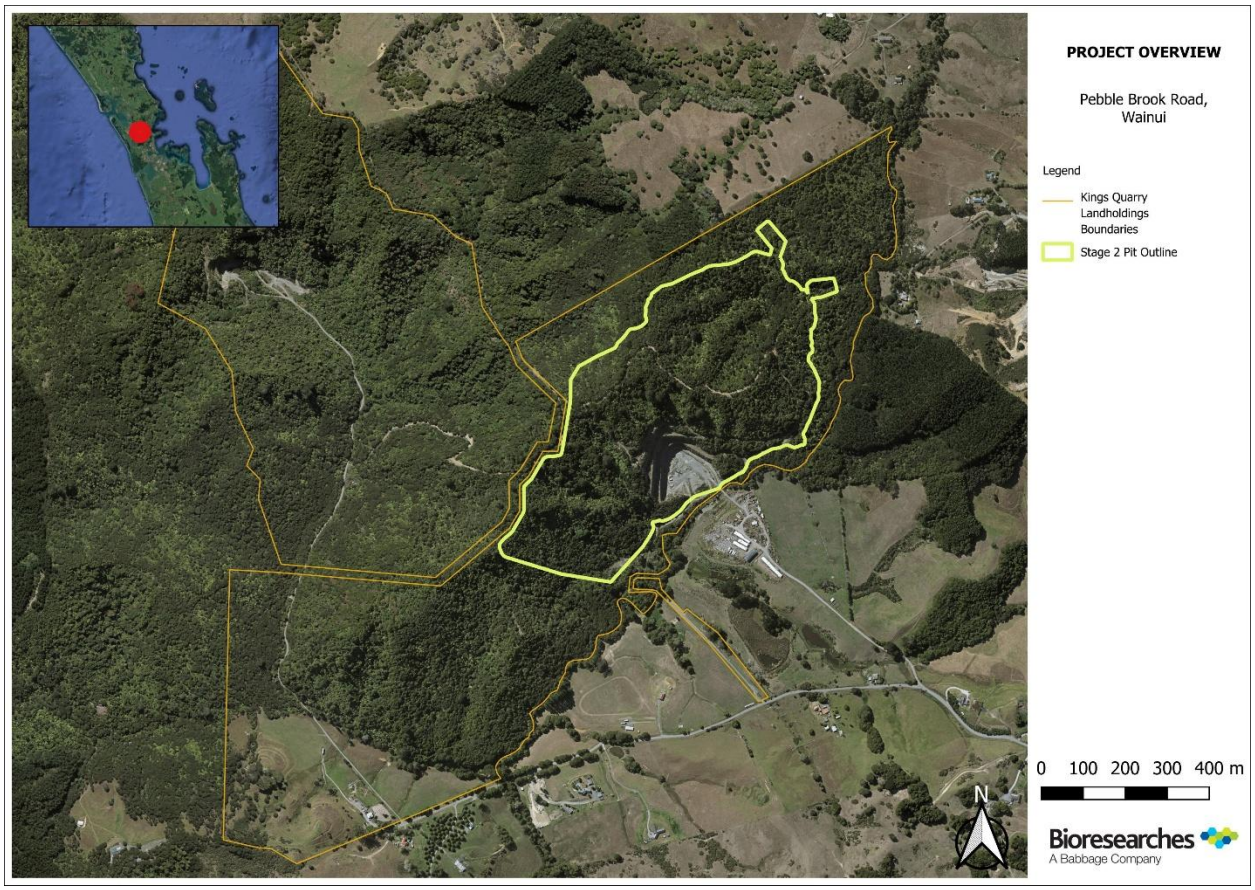

Figure 1. Proposed Stage 2 pit and fill areas within the Kings Quarry landholdings at Pebble Brook Road, Wainui.

1.1 Background

Bioresearches has previously undertaken ecological investigations at Kings Quarry (Bioresearches 1998, 2008, 2009 and 2021). In 2021, Bioresearches prepared an EcIA in support of the proposed recommissioning of Kings Quarry, after the quarry was inactive for approximately 30 years (Bioresearches, 2021). Thereafter, 'Stage 1' of the quarry was consented, which provided for recommissioning of the quarry and removal of 6,945 m^2 of indigenous vegetation (Figure 2). To date, a portion of these works have been completed, including construction of the access road and the widening of Pebble Brook Road and commencing of some quarrying and filling activities to facilitate access road construction and Pebble Brook Road widening.

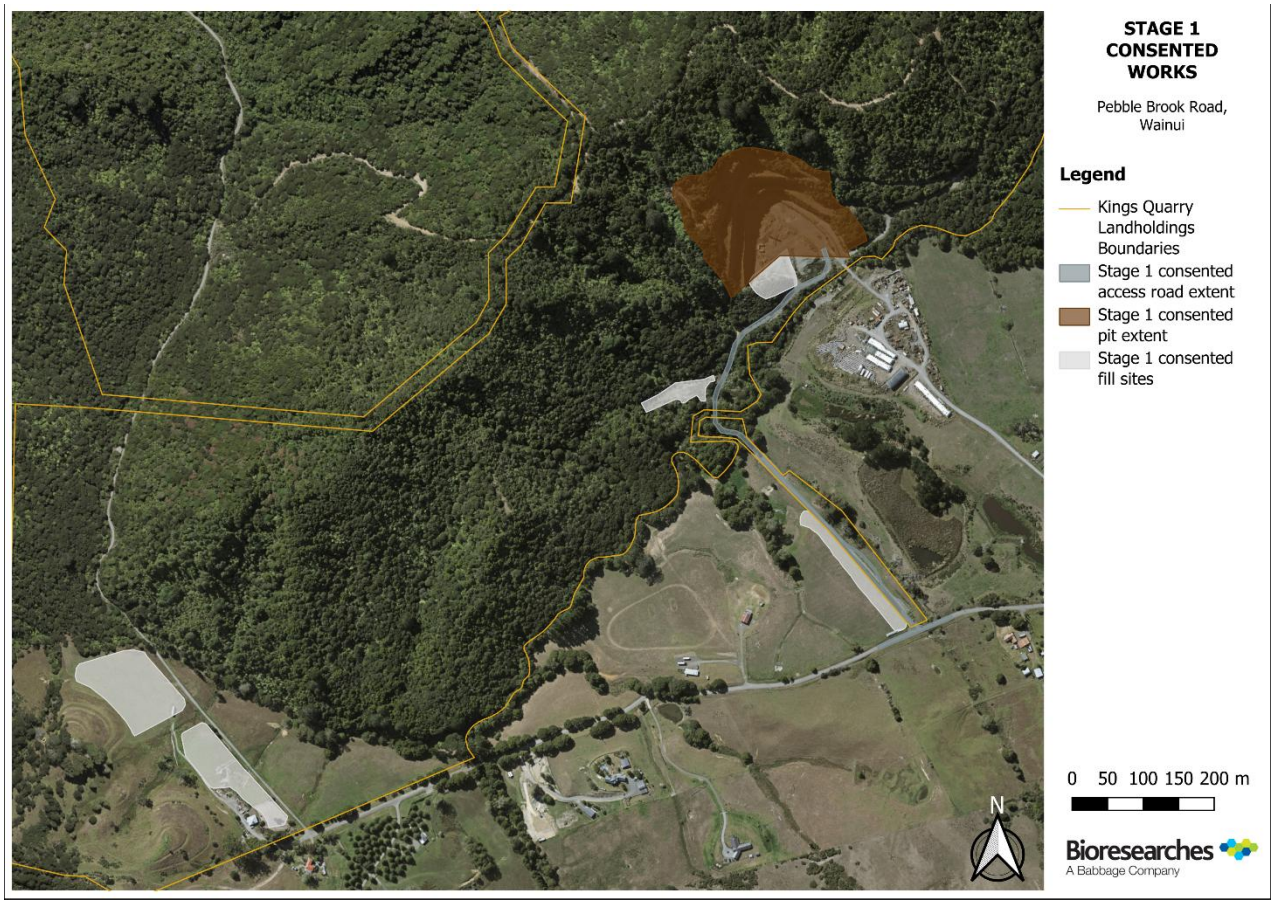

Figure 2. Consented Stage 1 pit and fill areas and access road within the Kings Quarry landholdings at Pebble Brook Road, Wainui.

1.2 Site description

The Kings Quarry Landholdings are located within the Wainui area, approximately 32 km north-west of Auckland City. Collectively, the landholdings comprise approximately 167 ha of land, which is predominantly vegetated with regenerating native forest. They are situated on hilly terrain, which ranges from 251 m asl[1] in the northern-most corner, at the peak of Te Rite-a-Kawhauru Hill, to approximately 35 m asl in the southern portion of the landholdings (Figure 3).

The landholdings are bordered on their south-eastern edge by the Waitoki Stream, flows in a south-western direction along the site boundary, eventually discharging into the Kaukapakapa River, which itself discharges into the southern arm of the Kaipara Harbour. Within the landholdings are two quarries, Kings Quarry, and a second, disused quarry located within the northern portion of the landholdings. The second quarry is accessed via Pebble Brook Road, which crosses the landholdings. In addition, the landholdings are bisected by a paper road, splitting them into northern and southern portions.

The proposed Project area is located within this southern portion of the landholdings, on a south-eastern facing slope.

[1] Above Sea Level

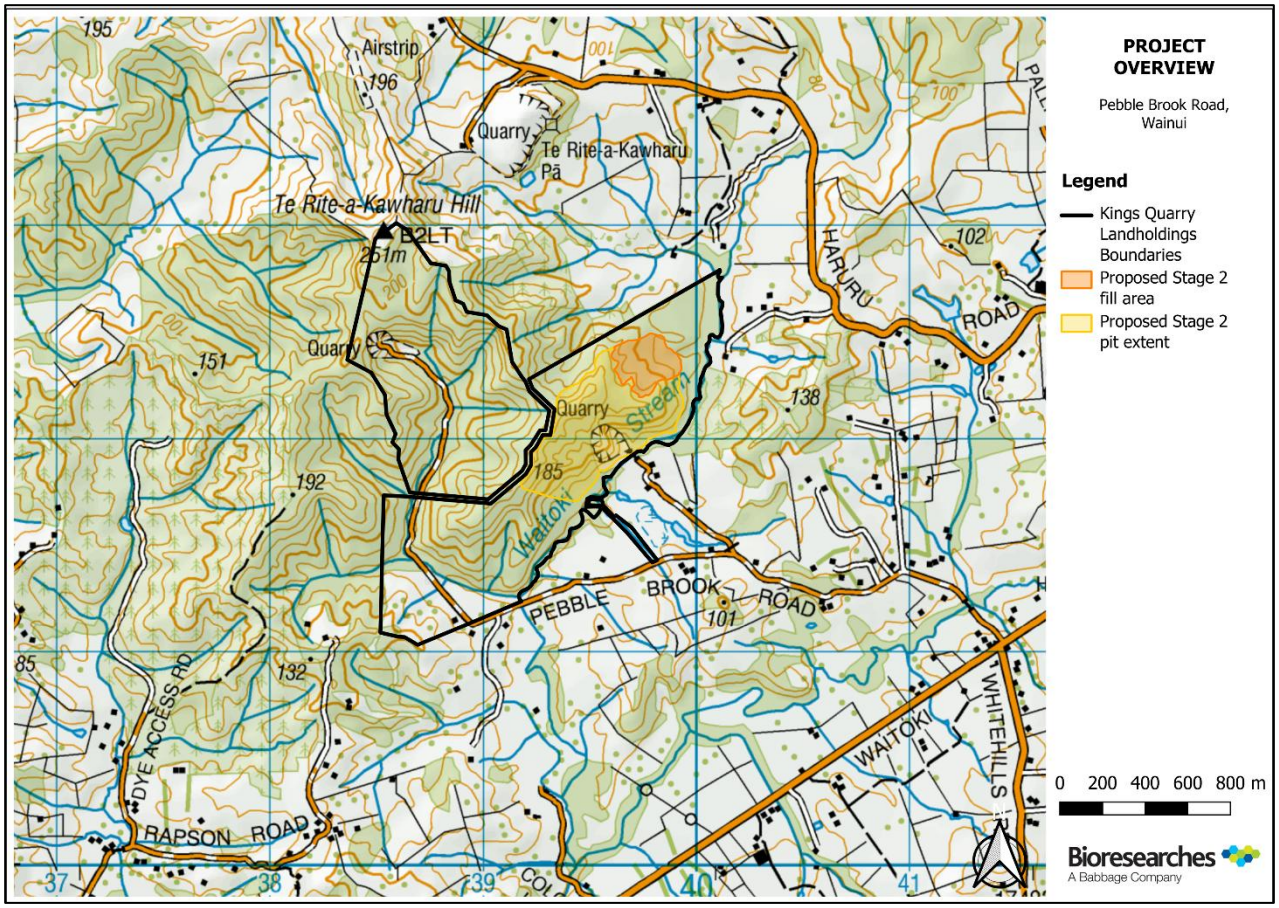

Figure 3. The proposed stage 2 works and the Kings Quarry Landholdings overlaid on a 1:50,000 scale topographic map (Basemap sourced from LINZ[2])

1.3 Summary of proposed works

The proposed works will involve excavation of over 10,100,000 BCM of material (aggregate and overburden); over a lifespan of 45 years. Throughout years 1 to 5, the 'A-Pit' will be quarried, totalling 6.11 ha, along with an access road leading to the pit (Figure 4). Over the following 40 years, the quarry will gradually be expanded to eventually cover the entire proposed 26.46 ha extent, with fill material from the remainder of the Stage 2 quarry placed back into the A Pit.

[2] https://www.linz.govt.nz/

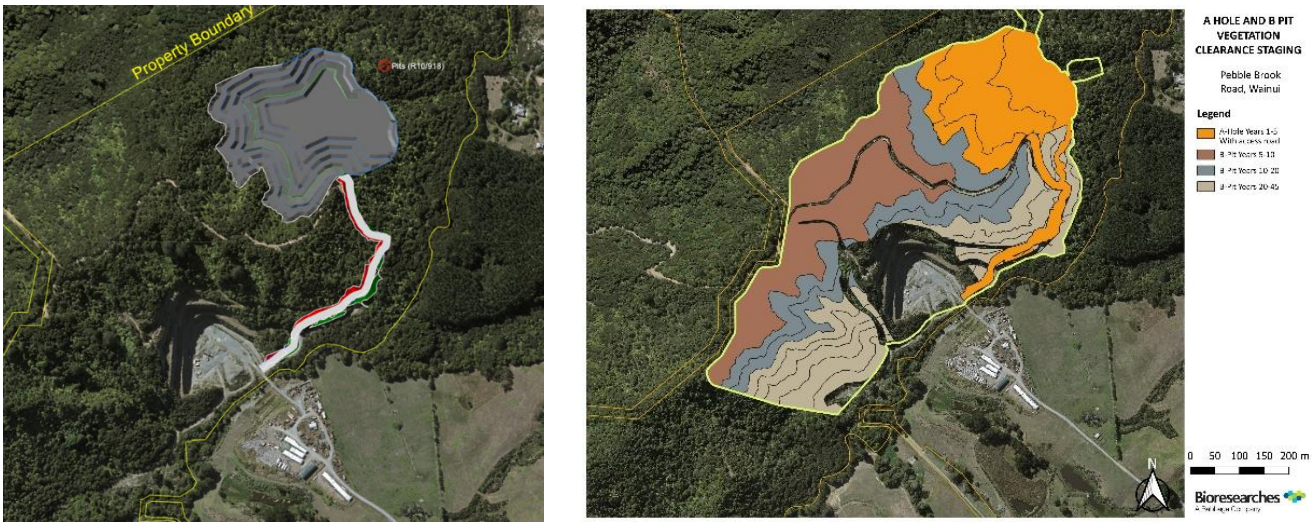

Figure 4. The proposed A-Pit and haul road (left) and the proposed final Stage 2 extent (right)

2 STATUTORY CONTEXT

This section summarises the legislation, policy, plans and strategies relevant to the protection, conservation and enhancement of nature conservation interests associated with the site. The ecological values described in this report allow significant ecological issues and adverse effects to be identified as they relate the Resource Management Act 1991 (RMA). The identification of significant values and subsequent management recommendations to mitigate adverse effects are consistent with standards and objectives of the following legislative, policy statement and regional plan documents.

2.1 Legislation

2.1.1 Fast-track Approvals Act 2024 (FTAA)

The purpose of the FTAA is to facilitate the delivery of infrastructure and development projects with significant regional or national benefits. The system is intended to be a 'one-stop-shop' for resource consents under the Resource Management Act 1991, and will include approvals required (for the purposes of this Project) under the Wildlife Act (1953).

2.1.2 Resource Management Act 1991 (RMA)

The purpose of the RMA is to achieve sustainable management. Important elements of this are the maintenance of indigenous biodiversity and protection of significant indigenous vegetation and habitats. The RMA requires that any adverse effects of development be avoided in the first instance, and where avoidance is not reasonably practicable, impacts should be minimised, remedied, or mitigated. These elements are given effect in Sections 5, 6 and 7, and Schedule 4 sets out the requirements for effects assessments.

2.1.3 Wildlife Act 1953

The Wildlife Act provides legal protection to listed species classed as wildlife. It controls how people interact with wildlife, including all native birds, bats, frogs and lizards and some invertebrates. Note it does not cover plants or freshwater fish. Approvals under the Wildlife Act are included under the Fast-track Approvals Act (2024).

2.1.4 National Environmental Standards for Freshwater (NES-F, 2020)

The National Environmental Standards for Freshwater 2020 (NES-F) set requirements for carrying out certain activities that pose risks to freshwater and freshwater ecosystems.

Reclamation of rivers is a Discretionary Activity, provided that a functional need for the reclamation in that location; and the effects management hierarchy is applied. Quarrying activities have a specific status under the NES-F regulations relating to natural inland wetlands, and any works proposed within, or within 100 m of a natural inland wetland are required to be assessed as to whether they trigger the requirements to obtain resource consent to ensure that potential impacts to the wetlands are managed.

2.2 National policy statements

2.2.1 Freshwater Management

The National Policy Statement for Freshwater Management 2020 (NPS-FM) provides direction under the RMA, to local authorities on managing activities that affect the health of freshwater, and provides protections to freshwater bodies, including natural inland wetlands, includes provisions for monitoring and reporting on freshwater quality and quantity, and for addressing the impacts of land use activities on freshwater resources.

2.2.2 Indigenous Biodiversity

The National Policy Statement for Indigenous Biodiversity (NPS-IB) provides direction to councils to protect, maintain and restore indigenous biodiversity in the terrestrial environment, requiring at least no overall loss in indigenous biodiversity. It is relevant to the proposal because the Project area is within the terrestrial environment, and it contains indigenous biodiversity as defined in Section 1.6 (Interpretation) of the NPS-IB.

The indigenous biodiversity within the Project area includes that which is subject to a notified Significant Natural Area (SNA, or SEA as per the Auckland Unitary Plan (Operative in Part), NPS-IB), some of which occurs within the Special Purpose Quarry Zone (SPQZ) under the Auckland Unitary Plan (Operative in Part), as well as indigenous biodiversity that is not subject to SNA.

The NPS-IB requires that indigenous biodiversity that is not protected by an SNA:

a. is managed by applying the effects management hierarchy (avoid, minimise, remedy, offset, compensate), where those effects are significant; and
b. is managed to give effect to its Objective and Policies, where those effects are not significant (Section 3.16 (2)).

The NPS-IB requires that adverse effects on indigenous biodiversity within an SNA be avoided, except where required for the purposes of aggregate extraction (3.11 (1 a iii)) that provides significant national or regional public benefit that cannot be otherwise achieved using resources within New Zealand.

2.3 Regional plans and policies

The Auckland Unitary Plan (Operative in Part) (AUP) is the principal statutory planning document for Auckland. It was prepared by Auckland Council for the purpose of giving effect to the RMA as a regional council and as a territorial authority.

The Project area sits within a SPQZ. The SPQZ provides for significant mineral extraction activities in a way that ensures adverse effects are minimised and managed.

AUP overlays within the Project area which pertain to ecology include a SEA overlay (SEA_T_6454; Figure 5).

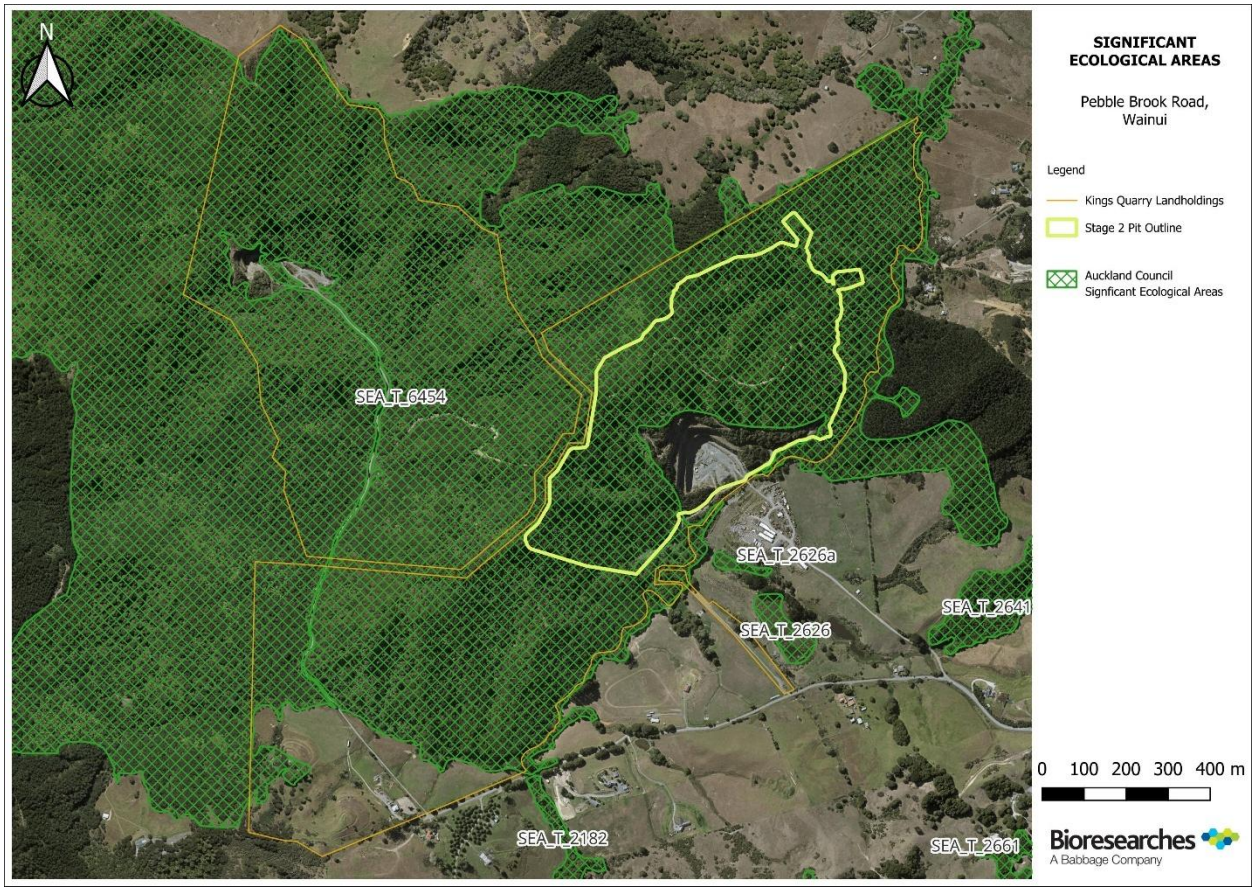

Figure 5. SEA_T_6454 overlay, and other local SEA overlays, in relation the Kings Quarry Landholdings and the Project area.

3 ASSESSMENT APPROACH AND METHODOLOGY

3.1 EcIA Assessment

This assessment generally follows the EcIA Guidelines for use in New Zealand published by the Environmental Institute of Australia and New Zealand (EIANZ) (Roper-Lindsay *et al.,* 2018). The EcIA Guidelines provide a standardised matrix framework that allows ecological effects assessments to be clear, transparent, and consistent. The EcIA guidelines framework is generally used in Ecological Impact Assessments in New Zealand as good practice, and a detailed analysis of this methodology is presented in Appendix A.

3.2 Tangata Whenua as Partners

The NPS-IB recognises tangata whenua as kaitiaki of, and partners, in the management of indigenous biodiversity (NPS-IB, Policy 2). At the time of preparation of this report, no acknowledged taonga species have been identified with respect to this Project or are currently listed in the public domain.

Mana whenua, Ngāti Whātua o Kaipara Hapu Ngāti Rango, who hold ahi kā (long-term occupation and influence over the land), were consulted during the development of this ecological assessment. The site at Pebble Brook Road is part of the traditional whenua of the Hapu Ngāti Rango and falls within the recognised settlement boundary of Ngāti Whātua o Kaipara.

Ngāti Whātua o Kaipara acknowledge a long history of occupation in the surrounding area (ahi kā). The provided cultural assessment[3] expects that species such as waikaka (mudfish), tuna, kokopu, pekapeka (bats), mokomoko (gecko) along with manu (birds) are inhabiting these environments, and identifies a requirement for cultural induction prior to any clearance of vegetation, particularly with respect to potential for accidental discovery of kōiwi (human remains) or artefacts. The measures recommended to minimise adverse ecological effects, as identified in this assessment (e.g. avoiding bird nesting season and other plans that provide for their survivability), are considered essential in the supplied cultural assessment.

Ngāti Whātua o Kaipara recognise that the proposal would involve removal of 29 ha of unique whenua and the importance of balancing this against a ‘need for aggregate and materials’ and ‘considerable offsetting’ (Te Kia Ora Marae-Kakanui Ngāti Rango, 2023). They therefore urge ongoing engagement and regular meetings (at least annually) be implemented to grow the relationship between Ngāti Whātua o Kaipara/hapu and Kings Quarry.

3.3 Zone of Influence

The zone of influence (ZOI) of the Project relates to an area occupied by habitats and species that are adjacent to and may extend beyond the physical footprint of the project as well. It is defined in the EIANZ Guidelines as “the areas/resources that may be affected by the biophysical changes caused by the proposed Project and associated activities.”

[3] Ngāti Whātua o Kaipara provided a Cultural Values Assessment (CVA) as part of the previous Covid-19 Fast Track application however no specific comments or concerns have been received as it relates to this application.

The distance of the ZOI and type of effect from the Project can be different for different species and habitat types. ZOI is used throughout this report to describe the impacts of the project (construction and operation) on adjacent or connected terrestrial, freshwater and wetland habitats and associated native species. For example, all Significant Ecological Areas (SEAs) within the vicinity of the Project area have been included in the desktop review, along with connectedness and context to the Project area. This is to ensure that important features, such as mobile species or wetland areas within the wider landscape, can inform the effects assessment where appropriate.

3.4 Desktop review

A desktop review of various online GIS databases was undertaken to determine the extent of ecological protection overlays (e.g., covenants, conservation land, SEAs, 'ecosystem type' classifications), and to visualise historical land-use using historical aerial images. The scheduling of SEAs and classification of ecosystems provides a means for Councils to protect and maintain indigenous biodiversity within Districts and Regions. The desktop review also included a search for local fauna records from various information sources.

Specifically, the following databases and reports were reviewed:

- Department of Conservation Bioweb records for herpetofauna and bats[4];
- Auckland Council herpetofauna records;
- iNaturalist records for herpetofauna and birds within approximately a 5 km radius from the site[5];
- New Zealand Bird Atlas eBird database[6].
- NIWA's New Zealand Freshwater Fish Database records were accessed for affected stream catchments[7];
- Auckland Council Geomaps[8];
- Department of Conservation Threat Classification Series[9];
- Auckland Council conservation status reports for vascular plants (Simpkins *et al*., 2022), bats (Woolly *et al*., 2023), and reptiles (Melzer *et al*., 2022);
- Retrolens historic aerial imagery[10];
- Indigenous terrestrial and wetland ecosystems of Auckland (Singers *et al.,* 2017);
- 'Ecological and Archaeological Characteristics of the Former Kings Quarry Area' report (Bioresearches, 1998);
- 'Survey of the Botanical and Herpetological Characteristics of Part of Wainui Quarry, Rodney District' report (Bioresearches, 2008);
- 'Summer Reptile Survey of Wainui Quarry, Rodney District' report (Bioresearches, 2009); and
- Auckland Council SEA information data sheets, supplied to Bioresearches by the Auckland Council Bioinfo team.

[4] https://www.doc.govt.nz/our-work/monitoring-reporting/request-monitoring-data/
[5] https://inaturalist.nz/home
[6] https://ebird.org/atlasnz/block/blkV65
[7] https://nzffdms.niwa.co.nz/
[8] https://geomapspublic.aucklandcouncil.govt.nz/viewer/index.html
[9] All Department of Conservation Threat Classification Documents are listed in the below webpage. When individual reports are referenced hereafter, they are referenced in-text.
https://www.doc.govt.nz/aboutus/science-publications/conservation-publications/nz-threat-classification-system/
[10] https://retrolens.co.nz/

Where specific desktop searches were undertaken for in depth habitat information or fauna records, the methodologies are detailed in greater depth below.

3.4.1 Invertebrates

A review of invertebrate species potentially present within the Project area was undertaken using a range of literature. In addition, iNaturalist records within 5 km of the Project area were reviewed.

3.4.2 Frogs

Desktop investigations involved a review of:

- the Department of Conservation's Amphibian and Reptile Distribution Scheme (ARDS) database (accessed March 2017);
- Auckland Regional Council records;
- the iNaturalist website for frog records within 5 km of the project area; and
- previous ecological reports for the project area.

In addition, to help inform targeted habitat searches, as an analysis of aerial and topographic imagery for the presence of first and second order streams (where potential habitat is most likely) was undertaken.

3.4.3 Lizards

The desktop review for lizards involved searching the same databases and historic reports as were searched for frog records; within a 5 km buffer of the Project area.

3.4.4 Birds

A desktop analysis involved a review of the New Zealand Bird Atlas data, iNaturalist, New Zealand eBird and previous ecological reports for the Project area.

iNaturalist records for native birds within a 5 km buffer of the Project area were recorded. For the New Zealand bird atlas data, birds are recorded in 10 km^2 grid squares. As the Project area is located close to the corner of a grid square, data for four grid squares; Y65, Y66, Z65 and Z66 (Figure 6). For both of these databases, records of coastal or marine birds were discounted due to a lack of suitable habitat within the Project area.

Figure 6. Positioning of New Zealand Bird Atlas grid squares relative to the site (red circle).

3.4.5 Bats

A review of the following databases and reports was undertaken to generate a list of previous bat records within the vicinity of the project area:

- Department of Conservation bat records;
- iNaturalist records; and
- Previous ecological reports for the Project area.

3.5 Site Investigations

3.5.1 eDNA sampling

To assist in the collection of data on the presence of both terrestrial and aquatic species within the Project area, nine eDNA samples were collected within or adjacent to the Project area, targeting the confluences of the impact streams and the Waitoki Stream. eDNA samples were collected using kits supplied by Wilderlab, and returned to Wilderlab for analysis. Refer Appendix G for stream sample locations.

3.5.2 Vegetation and Flora

3.5.2.1 Survey and Mapping

Survey of terrestrial vegetation was initially undertaken in August 2020, and updated and expanded in August to October 2023 and December 2024 to January 2025, to assist in classifying areas of vegetation in accordance with Singers *et al.* (2017).

Areas of indigenous and exotic vegetation within the Project area were traversed, where accessible, and their ecological features described using standard non-plot methods. The extent of each habitat type was mapped using a combination of walkover data, observations from vantage points, and observations from current and historic aerial imagery for the least accessible areas.

The bulk of the site assessments were completed from August 2020 to October 2023, however, at this time, some parts of the Project area were not accessed, including some south-western parts of the site, areas of particularly steep topography, and areas deemed dangerous to access following extensive areas of slips created during significant weather events of late summer and autumn 2023. However, site revisits

were undertaken in late 2024 and early 2025 and these enabled refinements to vegetation mapping, including regarding isolated areas of young podocarp-type forest. Vegetation assessments relied on representative data collected from accessible locations, vantage point observations and detailed Recce plot data.

During the site walkovers, incidental records were made of any nationally or regionally threatened plant species which were observed.

3.5.2.2 Recce plots

Detailed data on the biodiversity values of indigenous vegetation within the proposed works area was obtained in September 2020 and August and September 2023, and December 2024, using a series of standard 20 m x 20 m Recce plots. Locations of these plots are detailed in Figure 7.

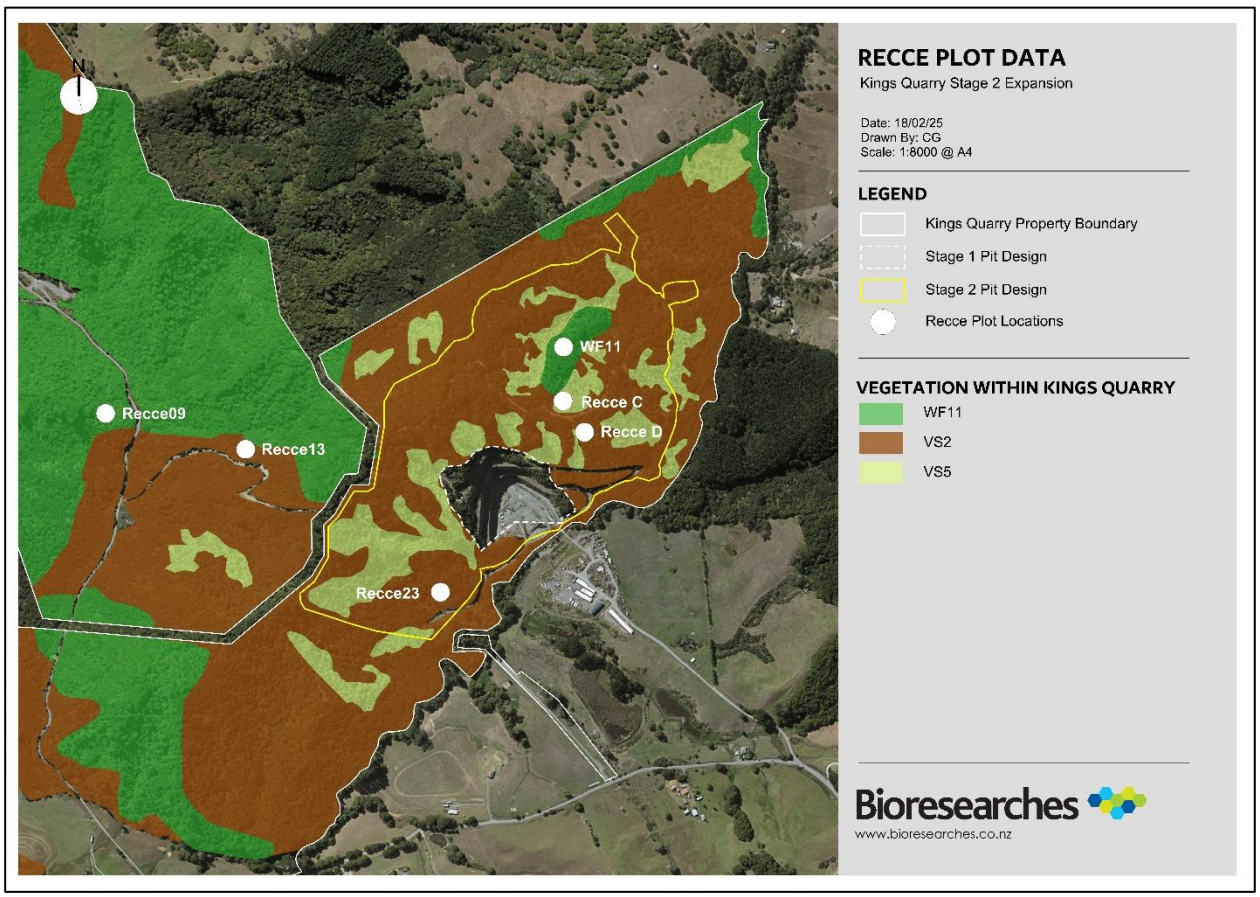

Figure 7. Recce plot locations

These plots were undertaken within representative native vegetation types across the site; using standard methods described by Hurst & Allen (2007). The GPS location of each plot was recorded, and photographs which were representative of the vegetation present within the plot were taken. The following key measurements were made:

- Average top height;
- Ground cover percent composition;
- Percent cover by cover class within standard Recce tier heights 1 - 6, including canopy, subcanopy, understorey, groundcover;
- Species present and their percent cover by cover class in each tier; and

- Basal area of all trees >10 cm dbh.[11]

These plots provided information on vegetation structure, tree density and biomass, species diversity and natural regeneration.

The plots sampled in 2023 also recorded additional information on log-fall biomass, and leaf litter depth, which are not standard measures to be recorded in a Recce plot and were not collected in 2020. Recce plot 'C' was revisited to collect this additional information.

In December 2024 an additional Recce plot was assessed in an area previously inaccessible due to slips. This plot identified regenerating vegetation that better aligned with podocarp forest, and is identified in Figure 7 as 'WF11'.

Due to the steepness of many parts of the Project area, Recce plot 13 was undertaken at a representative site of the same habitat type within the wider Kings Quarry Landholdings.

3.5.3 Terrestrial Fauna

Fauna surveys included targeted search and survey for invertebrates, lizards (skinks and geckos), avifauna and long-tailed bats. These methods are detailed below.

3.5.3.1 Invertebrates

Opportunistic habitat searches for native invertebrates were undertaken throughout the Kings Quarry footprint. Searches involved targeted searches through all Recce plots, and opportunistically lifting logs and nīkau fronds throughout the wider project area, where such features were observed. Particular focus was placed on potential habitats of the rhytid snail, *Amborhytida dunniae*, given that this At-Risk species was recorded in its preferred mature forest leaf litter habitats beyond the Stage 2 area.

3.5.3.2 Frogs

Streams surveyed for frog presence, where potential habitat was present were searched. All frog habitat assessments and searches were undertaken by, or under direct supervision of Chris Wedding (WA 37604-FAU) (Appendix B). All footwear and equipment were sanitised using Trigene prior to survey.

Suitable potential habitat for Hochstetter's frogs was considered to be first and second order bedrock, stony stream banks under forest canopy, with occasional small pools or waterfalls and a gently sloping bank. Such streams are less prone to flooding than larger streams and have plenty of searchable habitat.

Marginal potential habitats were also searched. Such areas were considered to provide some of the attributes of suitable potential habitat, although searchable areas were patchy along the watercourse. Unsuitable habitats were viewed but not searched. Such watercourses were either dry or highly channelized, indicating potential for high flows to wash frogs and habitat downstream.

Habitat assessments and stream searches were undertaken over August and November 2020, December 2022, April 2023, December 2024 and January 2025 to determine the extent of suitable potential habitat.

[11] Diameter at breast height (1.35m above ground level)

While drier summer months (e.g. January-March, when frogs are more likely to be found closer to or within the stream corridor), than those generally applied to searches in this study are generally better suited to frog searches, the assessments relied in part on previous search effort as well as eDNA analysis (Section 3.5.1). eDNA samples were undertaken in nine locations within, and within close proximity to the Stage 2 expansion (Figure 24).

Significant weather events over February and March 2023 resulted in substantial silt and slips, impacting both access and habitat suitability of some watercourses in subsequent assessments.

Searches were undertaken during the day, between 1000 and 1500 hours. Searches involved moving slowly upstream with a headlamp to increase visibility of search areas. All potential refuges were examined by carefully lifting stones, logs and leaf litter along both stream banks, up to one metre from the water's edge. Overhanging vegetation and rock crevices were also examined under torch light. All lifted substrates were replaced in their original position.

3.5.3.3 Lizards

A qualitative assessment of lizard habitat values for native lizards (skinks and geckos) were undertaken during site assessments over 2020, 2023 and 2024. The habitat assessments focused on identifying suitable groundcover habitat such as rotting logs, deep leaf litter, scrub vegetation. Where available, opportunistic searches were undertaken of logs and debris where lizard encounters (particularly ground based skinks) were considered most likely.

During all site visits, any incidental sightings of lizards were recorded. In addition, an Artificial Retreat (AR) survey and nocturnal Visual Encounter Surveys (VES) were undertaken. The specific methodologies for these are listed in Sections 3.5.3.3.1 and 3.5.3.3.2.

3.5.3.3.1 Artificial Retreat (AR) Survey

Two artificial retreat surveys were undertaken (November to December 2022) in accordance with the Department of Conservation's Biodiversity and Monitoring toolbox for using artificial retreats (Lettink, 2012). Twenty-one (21) AR stations were installed within and around the proposed Project area (Figure 8). Each AR station comprised of a cluster of four covers (total: 84 covers each survey).

The locations where ARs were installed were considered to represent the most likely places for native lizard encounters. These areas supported dense leaf litter and edge vegetation that would be suitable potential habitat for terrestrial lizards, especially skinks. ARs were left in situ to acclimatise for a minimum four weeks to allow time for resident lizards to habituate to and use them. A minimum of four inspections were undertaken for all AR locations (total 336 cover inspections throughout the Project area).

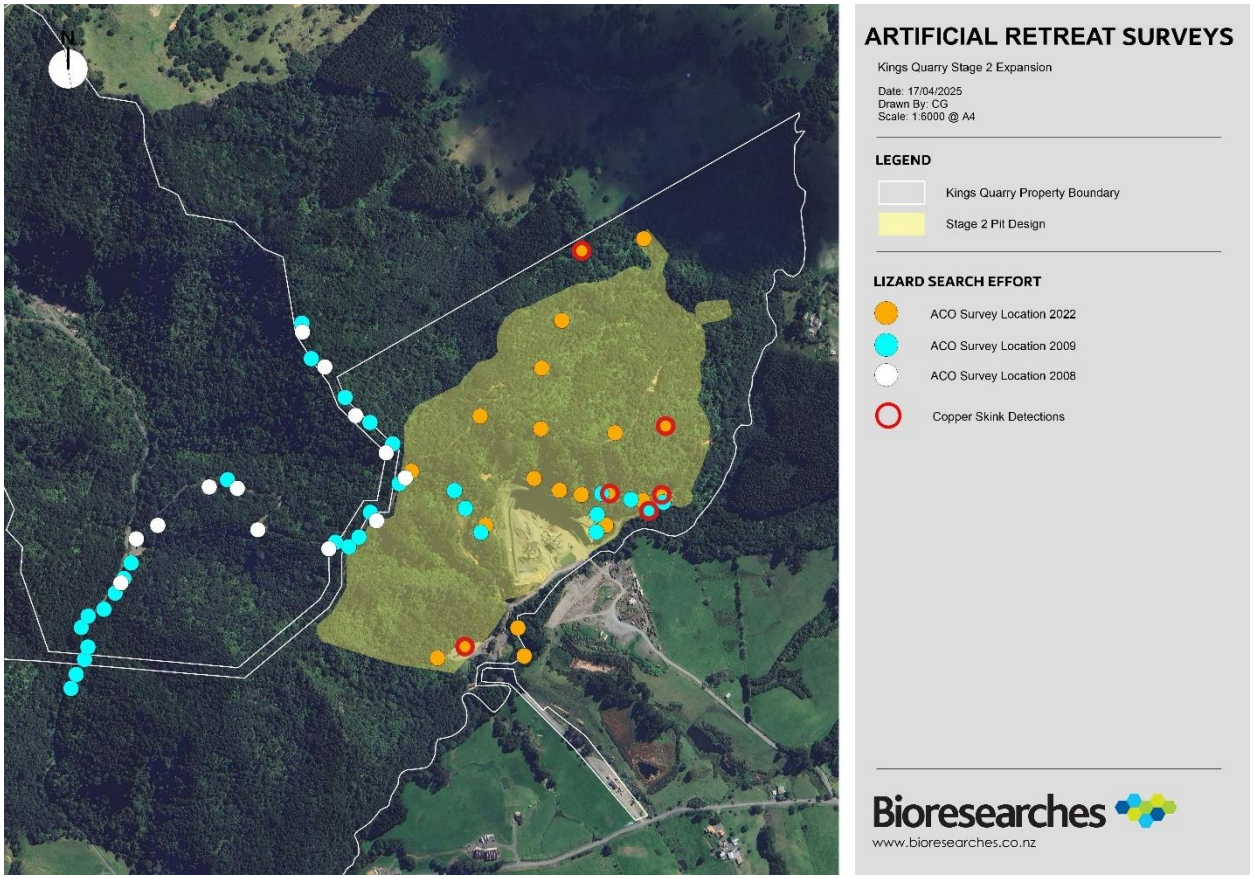

Figure 8. Artificial Retreat Surveys (2008, 2009, 2022) and previously reported skink locations

3.5.3.3.2 Nocturnal Visual Encounter Survey

Three nocturnal visual encounter searches were undertaken in March/April 2022, per the Department of Conservation's Biodiversity and Monitoring toolbox for systematic searches (Hare, 2012). Powerful headlamps, (LED Lenser™ H19R), aided by Nikon Monarch™ 8 x 42 binoculars, were used to search for geckos on the ground, on tree branches, and in foliage. Arboreal geckos are generally easier to detect at night by slowly scanning potential habitat with a focused light beam, while searching for the lizards' distinctive body shapes and reflective eye-shine (Whitaker, 1994), typically by an experienced searcher with a developed search image. Searches began after dusk, during settled and dry weather, and targeted vegetation edges, typically along formed tracks where a full habitat profile (forest floor to canopy) is most visible.

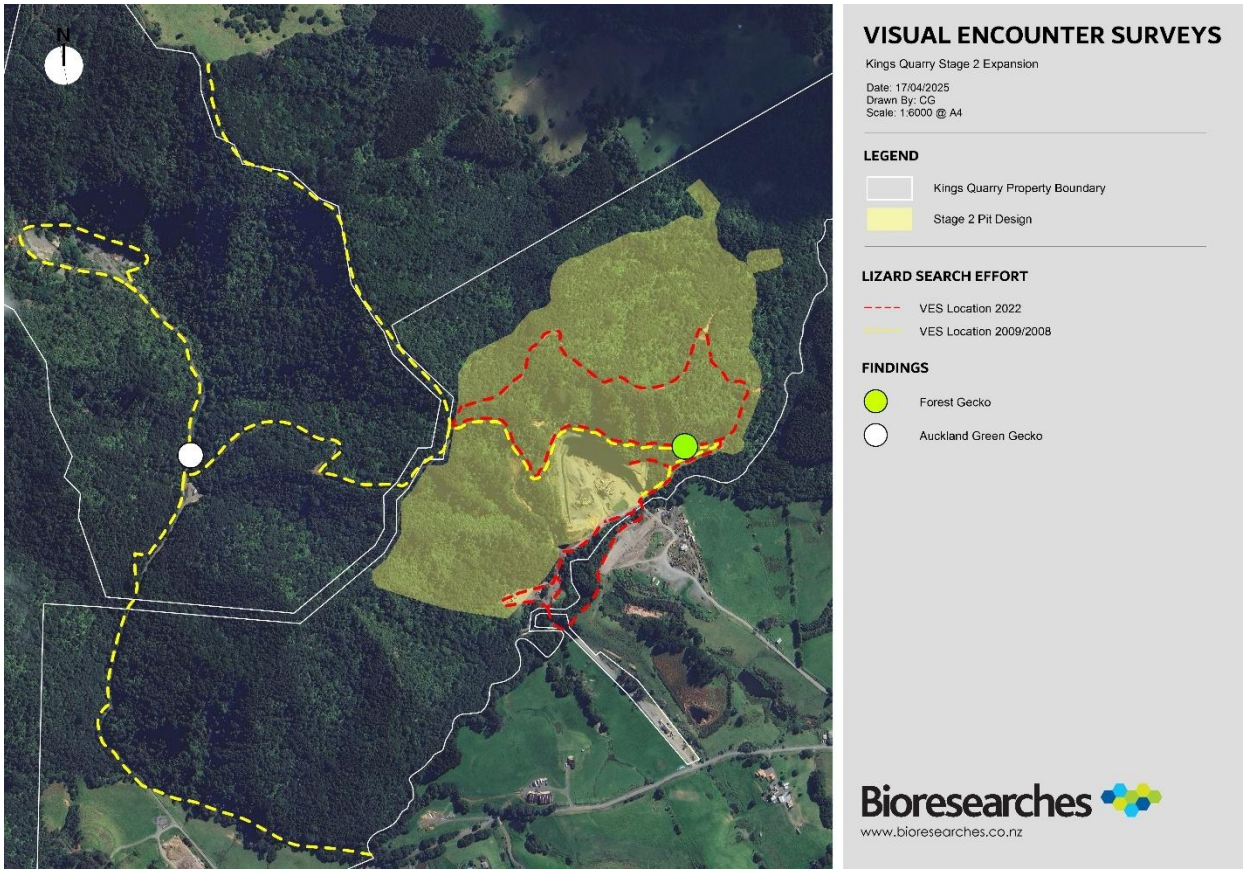

Figure 9. Nocturnal Visual Encounter Surveys (2008, 2009, 2022) and previously reported gecko locations

3.5.3.4 Birds

During the multiple site investigations carried out, incidental native bird observations were recorded. This included both birds seen or heard within the ZOI.

In addition, in September and October 2023, 5-minute bird counts (5MBCs) were undertaken at 19 stations across the Kings Quarry site (Figure 10), in areas that represented forest ecosystem types onsite, including regenerating kānuka, broadleaved scrub and podocarp-type forest). All birds seen and/or heard in a c. 100 m radius were recorded in the counts. The number of stations that could be located within the site was limited by area and standard spacing requirements for 5MBCs, i.e. being at least 200 m apart. Additional 5MBC stations were added, but care was taken to only compare those that are the same ecosystem type or restrict those from within the pit area for measures of impact.

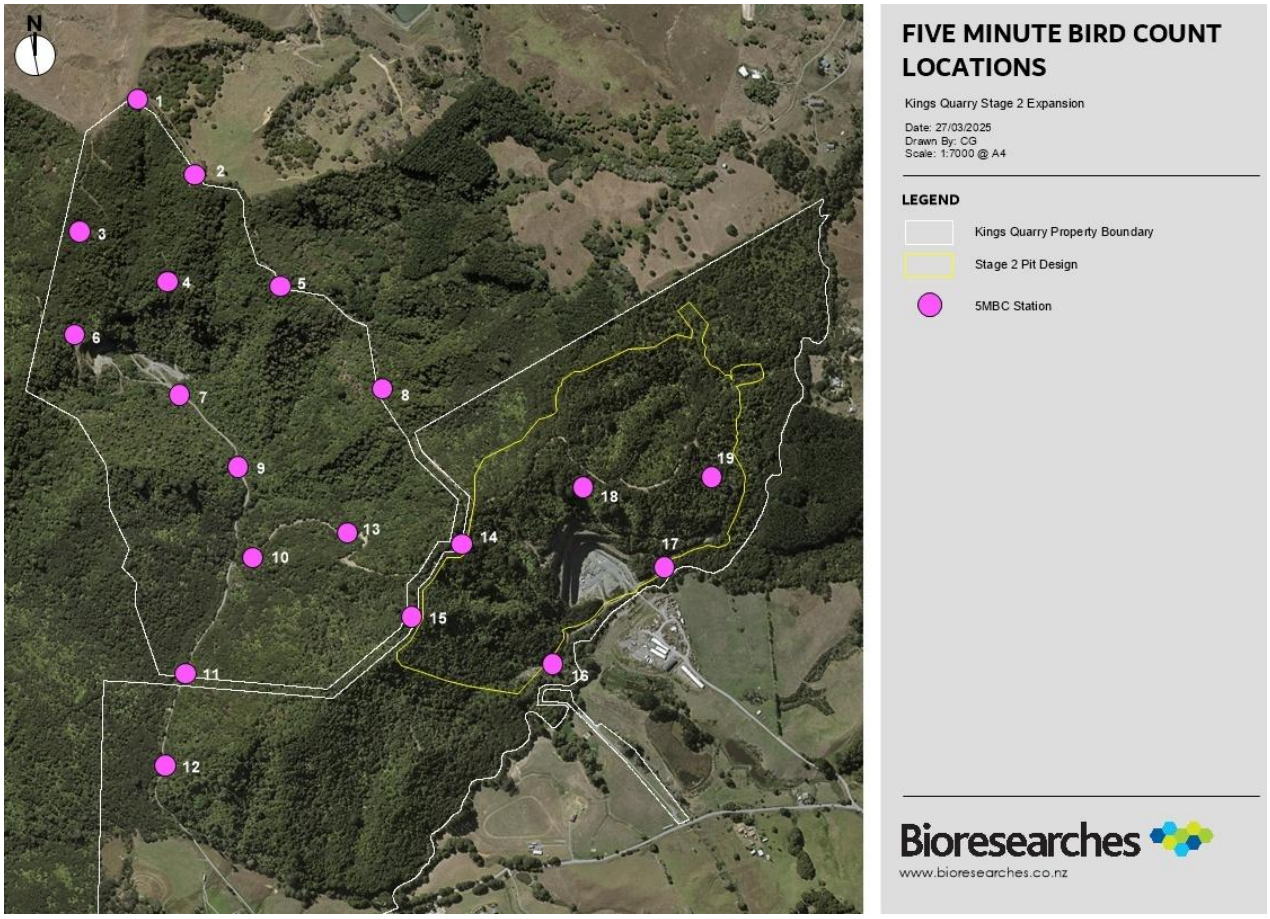

Figure 10. 5MBC locations

3.5.3.5 Bats

3.5.3.5.1 ABM Survey

Four formal bat surveys, using acoustic bat monitors (ABMs), were undertaken, all between October 1 and April 31, within the optimal survey period for survey and monitoring long-tailed bats in accordance with the Department of Conservation's biodiversity and monitoring toolbox for bats (Sedgeley, 2012) and Bat Roost Protocols (Department of Conservation, 2021).

Surveys were undertaken over November and December 2020, December 2022 to March 2023, and October 2023. A fourth survey was undertaken by HabitatNZ and covered the period January and February 2025. During the surveys, the ABMs were set to begin recording at least 1 hour before sunset, and to turn off 1 hour after sunrise.

Echolocating bats, including our native species, tend to vocalise consistently as they fly in order to navigate. Consequently, ABMs have proved a very effective tool for surveying and monitoring. They function either by transforming the inaudible ultrasound of bat's echolocation calls into lower frequency audible signals, or by capturing an image (spectrogram) of the sound which can be visually assessed. The specific ABMs used for the surveys included DOC AR4 (V1.4, set to 'Bat' mode) and the Department of Conservation's preceding 'Otterbox' acoustic recorder. Captured data can provide information about species present, level of activity, and whether bats are foraging or socialising. The range of the detectors used is considered to be approximately ~50 m, but this can vary with environmental conditions and clutter (e.g., 30 – 60 m for AR4s, (DOC, 2024)).

ABMs were fixed at locations along vegetation edges, watercourses or other linear habitat features where potential for detection of bat passes was considered most likely (Figure 11; Photo 1 and Photo 2).

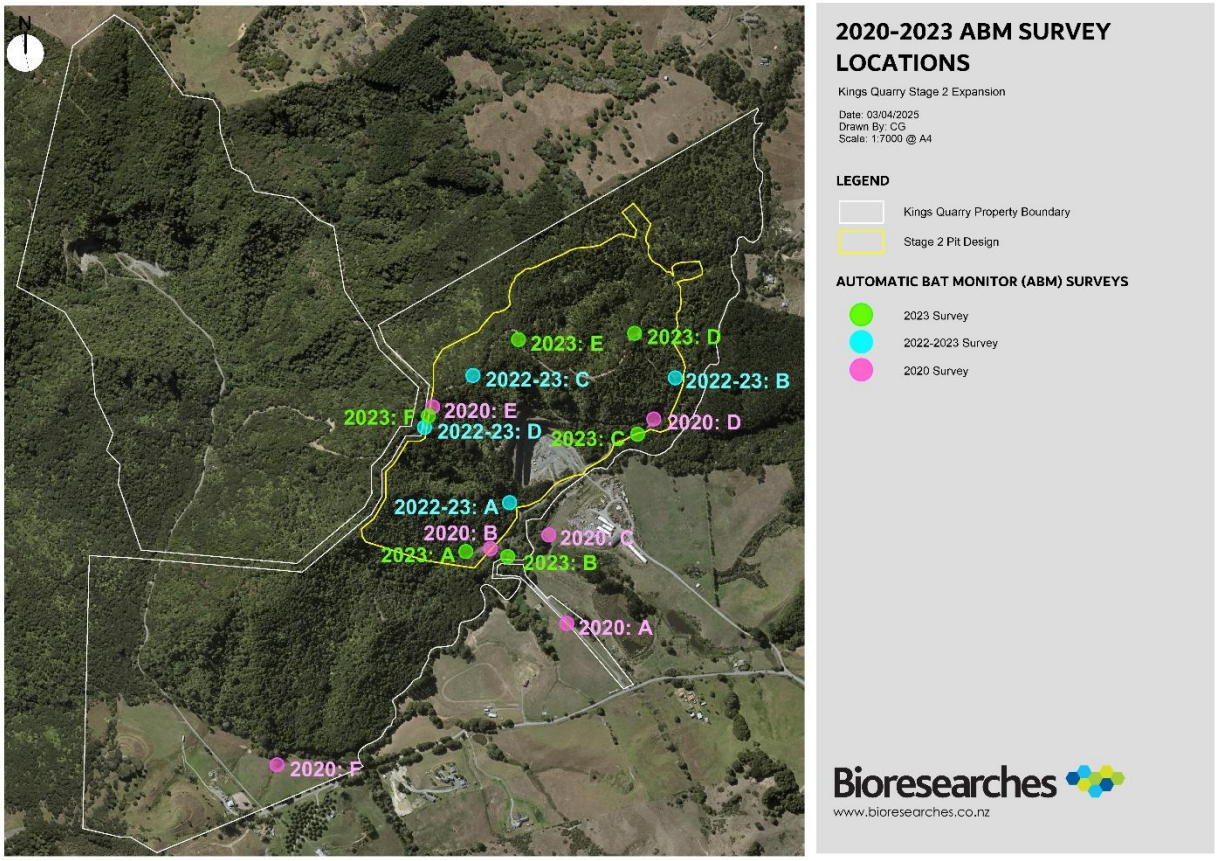

Figure 11. ABM locations in the 2020, 2022-2023 and 2023 ABM surveys

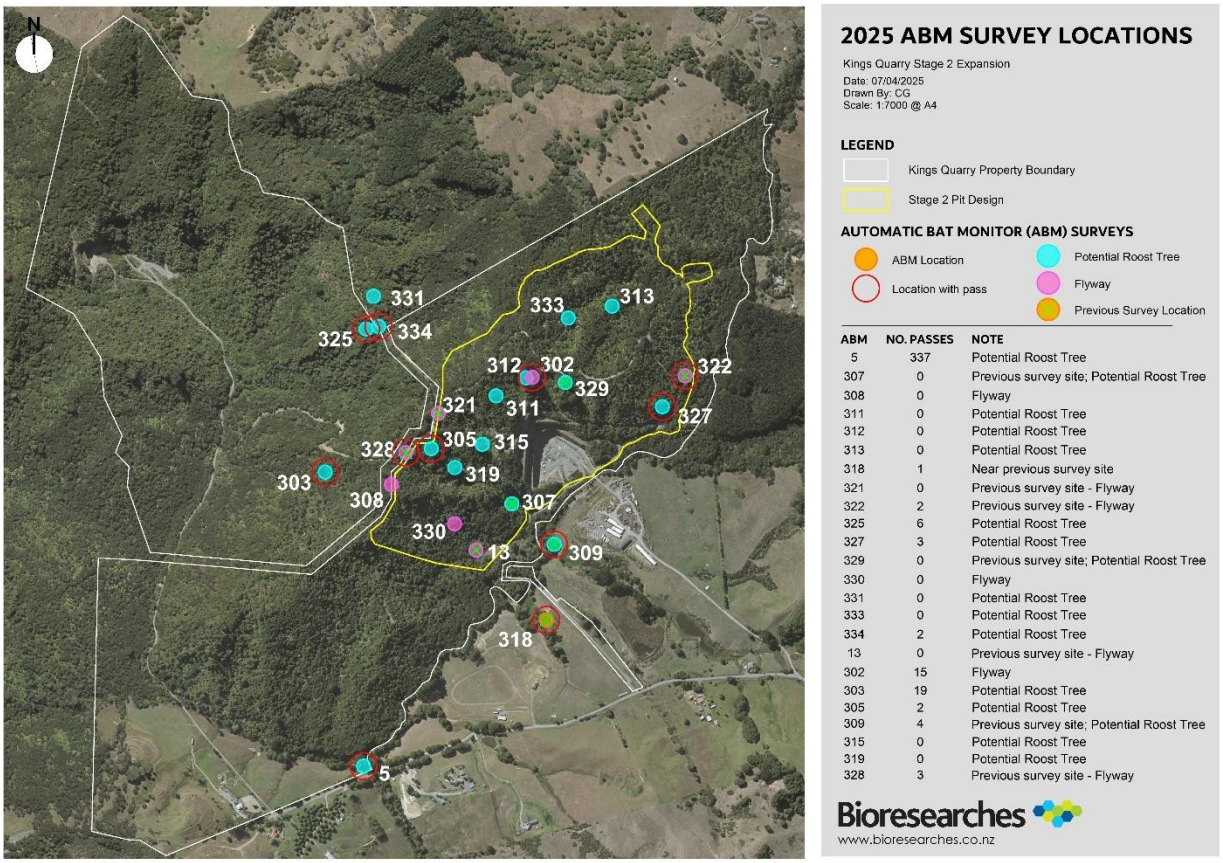

Figure 12. ABM locations in the 2025 ABM surveys

Photo 1. ABM facing a clearing above a watercourse (ABM 1).

Photo 2. Placing ABM along a track (ABM 3).

3.5.3.5.2 ABM data analysis

Acoustic data was downloaded from the ABMs and analysed using software developed by the Department of Conservation (BatSearch v3.12). Bat echolocation passes were distinguished from other noises (e.g., wind, rain, invertebrates) and each 'pass' was time (hour/minute/second) and date (year/month/day) stamped, providing timing information for activity.

As bat activity can fluctuate with rainfall, wind, and temperature, the total number of 'valid' survey nights was determined using climate data from local weather stations (CliFlo, New Zealand's National Climate Database, NIWA; Auckland, North Shore Albany AWS Station) and recording analyses (e.g. when the recorder log indicated a noise switch pause for a period of more than half the night). Nights were considered 'valid' using the criteria provided by DOC at the time of survey (Department of Conservation, 2021), and updated with the 2025 survey. Sunset times for Auckland were retrieved from the Time and Date website.[12]

3.5.3.5.3 Habitat Assessment

During site walkovers, notes were made on the suitability of the site and of the vegetation present for bats. This included recording the general presence of potentially suitable roost trees, and other habitat features which were suitable for bats to use.

3.5.4 Streams

During the site assessment, the presence and extent of water was noted, reference photos were taken, and freshwater habitats were marked using a handheld GPS unit. Watercourses were classified under the AUP to determine, in accordance with the definitions in these plans, the ephemeral, intermittent or permanent status of these watercourses (Table 1).

Table 1. AUP criteria for permanent, intermittent rivers and streams and ephemeral streams[13]

Criteria	Definition
Permanent Stream	
1	The continually flowing reaches of any river or stream, but excludes ephemeral reaches
Intermittent or ephemeral stream*	
1	Evidence of natural pools
2	Well defined banks and bed
3	Retains surface water present more than 48 hours after a rain event
4	Rooted terrestrial vegetation not established across channel
5	Organic debris from flooding present on floodplain
6	Evidence of substrate sorting, including scour and deposition
***If three or more of the six assessment criteria can be met with confidence, the watercourse is considered intermittent. If at least three criteria cannot be met, the watercourse is considered ephemeral.**	

[12] https://www.timeanddate.com/moon/phases/new-zealand/auckland?year=2022; www.timeanddate.com/sun/new-zealand/Auckland

[13] Table reproduced from:
https://content.aucklanddesignmanual.co.nz/regulations/practice-notes/Documents/RC%203.3.17%20Stream%20Classification.pdf

The quality of the aquatic habitat was assessed, noting ecological aspects such as channel modification, hydrological heterogeneity, riparian vegetation extent, substrate type and any fish or macroinvertebrate habitat observed. Riparian and catchment information was also reviewed.

3.5.4.1 Stream Ecological Valuation

A detailed assessment of the streams was undertaken using the Stream Ecological Valuation (SEV) methodology (Auckland Council Technical Report 2011/009) on the 7th and 8th September 2023. In total, three SEVs were undertaken within the Project area.

Representative SEV's were undertaken within an intermittent stream in the Central and Southern Systems, and Stream 13. Spot water quality sampling to provide basic water quality measurements were undertaken at each representative SEV reach and Stream 4.

SEV methodology (Storey *et al.,* 2011; Neale *et al*., 2016) enables the overall function of the stream to be assessed and compared to the quality of other streams in the Auckland Region. The SEV assessment involves the collection of habitat data (e.g., stream depth, substrate type, riparian cover), and the sampling of fish communities and macroinvertebrates (e.g., insect larvae, snails), the latter being recognised as indicators or habitat quality. The SEV method gives a score between 0 (low quality) and 1 (high quality) for each of a number of attributes which are weighted in terms of their contribution to overall stream value. These attributes are then combined to give an overall SEV score, also on a scale of 1 to 10.

3.5.4.2 Macroinvertebrates

Macroinvertebrates were sampled from instream habitats to obtain semi-quantitative data in accordance with the Ministry for the Environments current "Protocols for Sampling Macroinvertebrates in Wadeable Streams" (Stark *et al*., 2001). Sampling was undertaken along the SEV reach, using protocol 'Cx: hard-bottomed, semi quantitative' as the streams were predominantly hard-bottomed. The macroinvertebrate sample was preserved in 70% ethyl alcohol (ethanol), returned to the laboratory and sorted (using protocol 'P3: full count with sub-sampling option' (Stark *et al.,* 2001). Macroinvertebrates were identified to the lowest practicable level and counted to enable biotic indices to be calculated.

Several biotic indices were calculated, namely the number of taxa, the number and percentage of Ephemeroptera (mayflies); Plecoptera (stoneflies) and Trichoptera (caddisflies) recorded in a sample (%EPT), the Macroinvertebrate Community Index (MCI) and the Semi-Quantitative Macroinvertebrate Community Index (MCI) and the Semi-Quantitative Macroinvertebrate Community Index (SQMCI) (Stark & Maxted, 2007a). EPT are three orders of insects that are generally sensitive to organic or nutrient enrichment, but exclude Oxyethira and Paroxyethira as these taxa are not sensitive and can proliferate in degraded habitats. The MCI and SQMCI is calculated using coded abundances instead of actual scores (raw macroinvertebrate data is presented in Appendix J). For MCI and SQMCI, respectively, scores of:

- ≥ 120 and ≥6.0 are indicative of excellent habitat quality;
- 100 – 119 and 5.0 – 5.9 are indicative of good habitat quality;
- 80 – 99 and 4.0 – 4.9 are indicative of fair habitat quality' and
- <80 and <4.0 are indicative of poor habitat quality (Stark and Maxted, 2007b)

3.5.4.3 Fish Survey

Due to the steep topography and narrow flow paths of the intermittent streams within the ZOI, fish communities were sampled using a combination of netting and trapping, and the use of eDNA. If sufficient water was present in the intermittent streams, dip hand netting was undertaken, targeting available fish habitat such as overhanging vegetation, pools, woody debris and undercut banks.

Within the permanent stream, one fyke net and four Gee-minnow traps were baited and left overnight and collected the following day. The species of each fish was determined, the size of each individual measured and the number of fish caught and fish condition taken into account, and recorded before fish were returned to their habitats. All fish handling was carried out by suitably qualified and experienced ecologists.

An Index of Biotic Integrity (IBI) was calculated for the streams based on the fish species present, (excluding large macroinvertebrates), altitudes and distance inland (Joy & Henderson, 2004).

3.5.5 Natural inland wetlands

Potential wetland areas were assessed following the Ministry for the Environment's (MfE) wetland delineation protocols (MfE, 2022), to ascertain if the area presented with the physical characteristics to be considered a Natural Inland Wetland.

The definition of a Natural Inland Wetland (as per the NPS-FM) is:

"a wetland (as defined in the [Resource Management] Act) that is not:

(a) in the coastal marine area; or

(b) a deliberately constructed wetland, other than a wetland constructed to offset impacts on, or to restore, an existing or former natural inland wetland; or

(c) a wetland that has developed in or around a deliberately constructed water body, since the construction of the water body; or

(d) a geothermal wetland; or

(e) a wetland that:

(i) is within an area of pasture used for grazing; and

(ii) has vegetation cover comprising more than 50% exotic pasture species (as identified in the National List of Exotic Pasture Species using the Pasture Exclusion Assessment Methodology (see clause 1.8)); unless

(iii) the wetland is a location of a habitat of a threatened species identified under clause 3.8 of this National Policy Statement, in which case the exclusion in (e) does not apply."

Consequently, the first step in delineating a Natural Inland Wetland is to ensure it meets the definition of a wetland under the Resource Management Act (RMA), referred to as 'the Act' in the above definition.

A wetland is defined by the RMA as:

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

If the potential wetland met the definition of an RMA wetland, then it was also checked to see if any of the exclusions in the Natural Inland Wetland Definition applied to the area. Finally, if the potential wetland did not meet any of the exclusions, the remainder of the MfE wetland delineation process was carried out to determine if the area was a natural inland wetland (Figure 13).

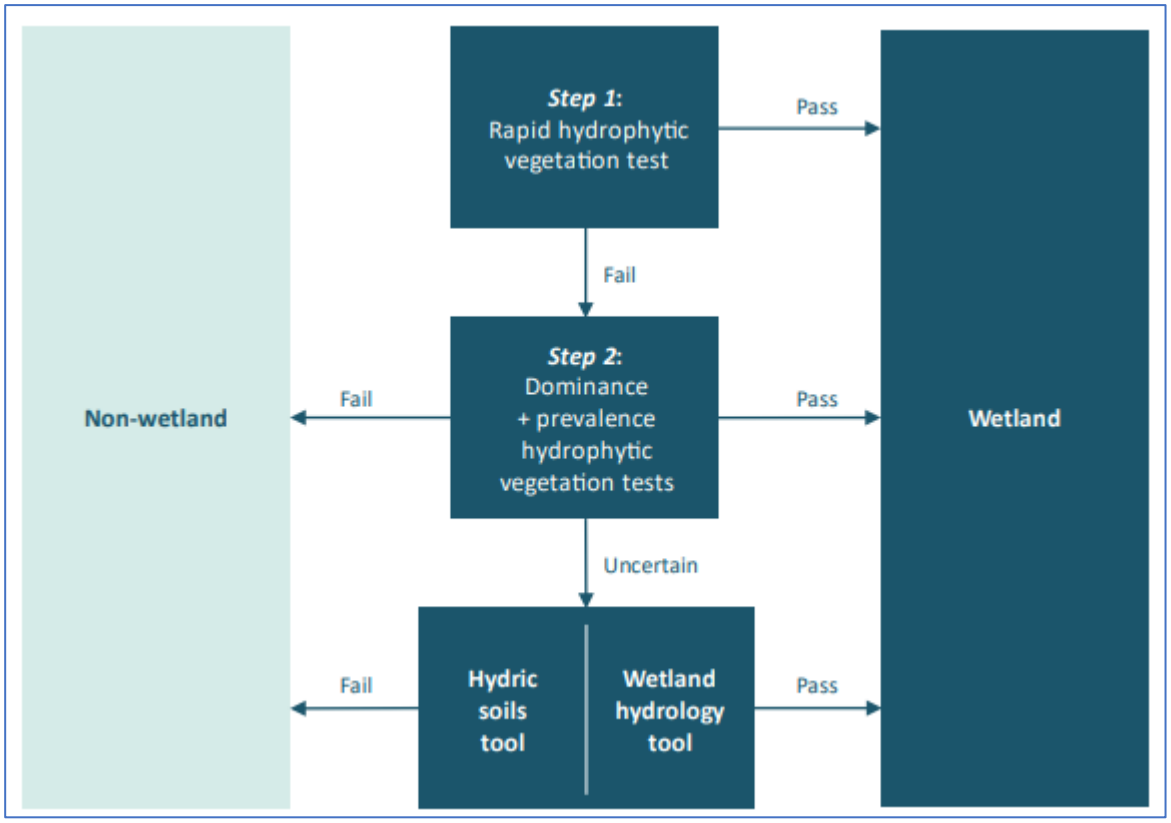

Figure 13. Simple flow chart of steps for delineating a Natural Inland Wetland using the hydrophytic vegetation, hydric soils and wetland hydrology tools. Reproduced from MfE (2022).

When following the MfE wetland delineation process, if the rapid test was not appropriate for determining if an area was an RMA wetland, vegetation assessment in accordance with Clarkson (2013) was undertaken; based on the dominance and prevalence of plant species assigned the following 'wetland plant indicator ratings' within a vegetation plot:

- Obligate wetland vegetation (OBL) – almost always a hydrophyte, rarely in uplands;
- Facultative wetland (FACW) – usually a hydrophyte but occasionally found in uplands;
- Facultative (FAC) – commonly occurs as either a hydrophyte or non-hydrophyte;
- Facultative upland (FACU) – occasionally a hydrophyte by usually occurs in uplands; and
- Upland (UPL) – rarely a hydrophyte, almost always in uplands.

Within the Project area, the wetland delineation protocols were applied to four areas which were identified as potential wetlands (Figure 14).

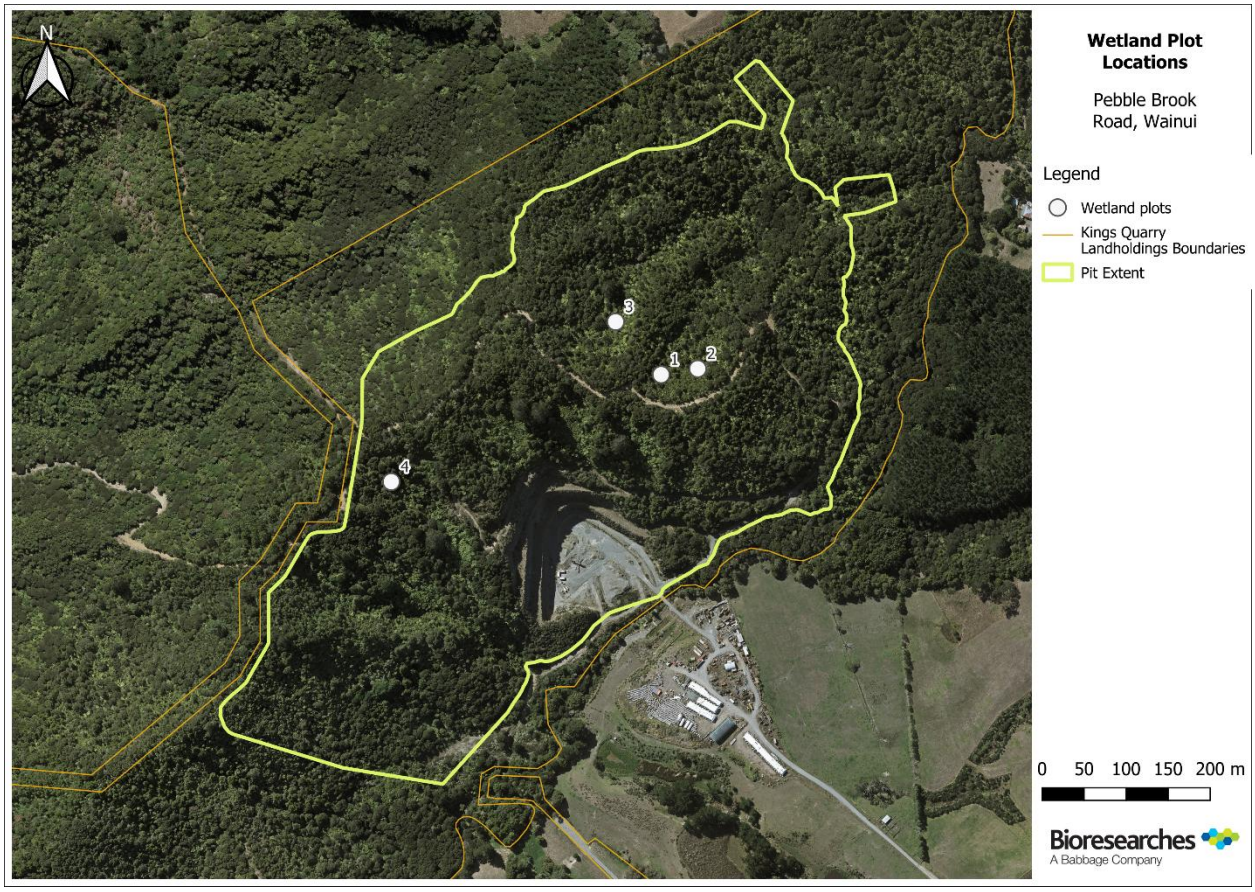

Figure 14. Wetland vegetation plot locations

4 EXISTING ENVIRONMENT AND ECOLOGICAL VALUE ASSESSMENT

4.1 Site history

Prior to human settlement, it is predicted by Auckland Council that the Project area would have predominantly been vegetated with WF9 Taraire, Tawa Podocarp forest[14] (Figure 15). The wider Kings Quarry Landholdings would also have almost entirely been vegetated with WF9 forest, with the lowest portion of the property in the south-east vegetated with WF11 Kauri, Podocarp Broadleaved forest.

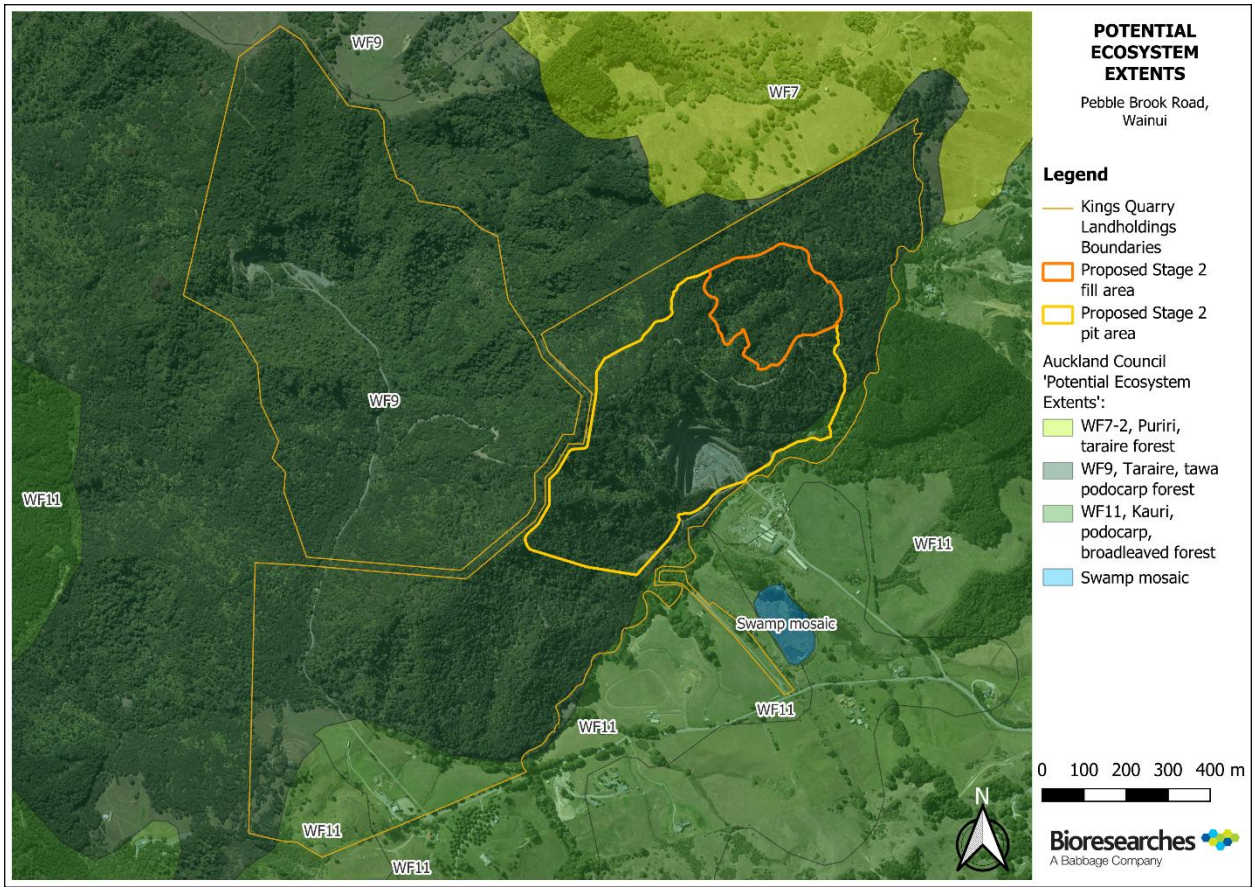

Figure 15. Auckland Council 'Potential Ecosystem Extents' layer in relation to the proposed Stage 2 project area

A review of historic aerial imagery indicates that by 1940, almost all of the original forest cover within the Project area had been cleared and replaced with pasture (Figure 16). The only existing forest cover which looked at least semi-mature was located in a patch along the south-eastern site boundary, and in the base of the southern-most gully system.

Younger, regenerating, tree fern-dominated scrub appeared to be regenerating in two of the gullies, and young, regenerating scrub was present in the two northern most gully systems, and in other localised areas throughout the Project area.

By 1968, young scrubland had established through much of the site, and the quarry had been established within the Project area (Figure 17). This was much the same in 1988 (Figure 18) and since then, little has

[14] Habitat classifications as per Singers *et al*. (2017)

changed within the site and the vegetation has largely regenerated to the point where it can be considered to be a 'young forest'.

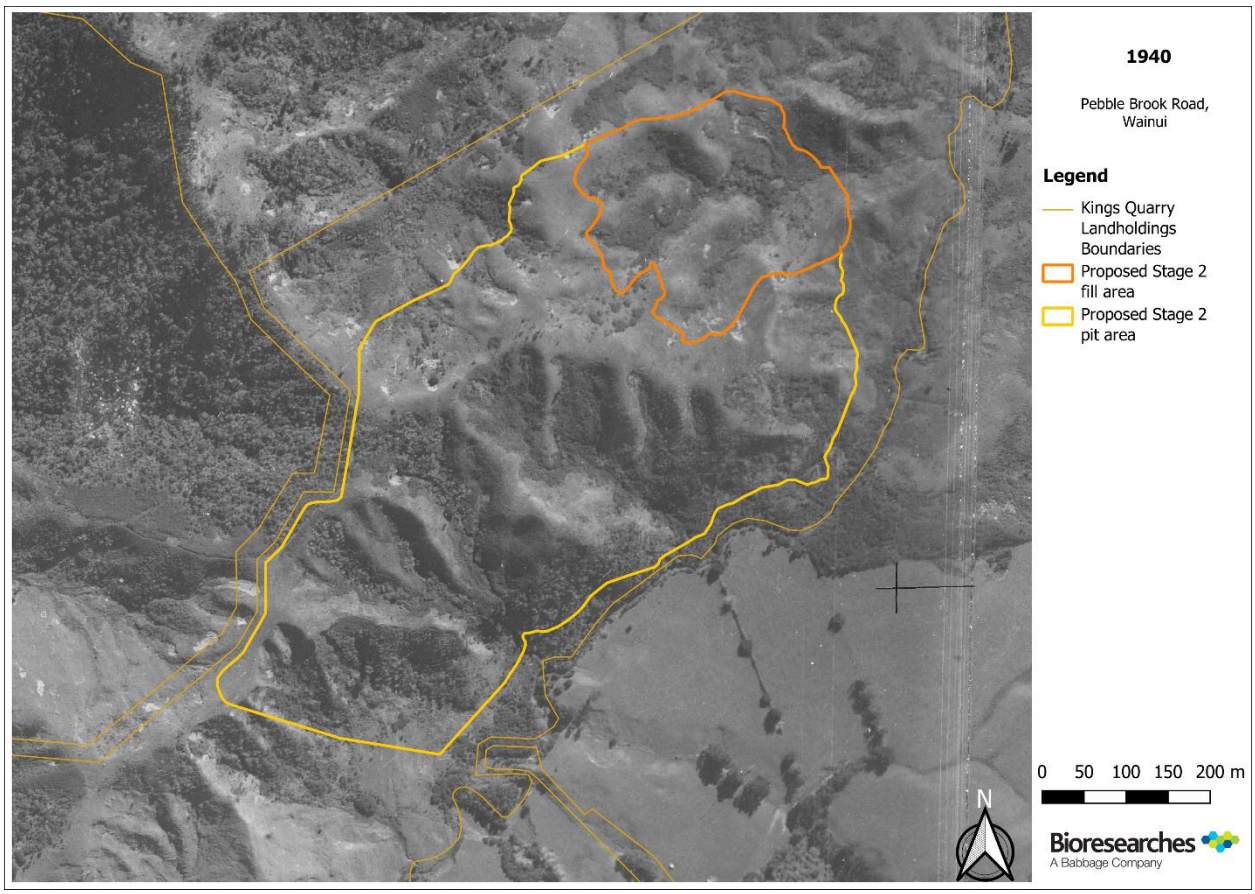

Figure 16. Historic aerial imagery of the Project area, dated 1940. Imagery from Retrolens.[15]

[15] https://retrolens.co.nz/

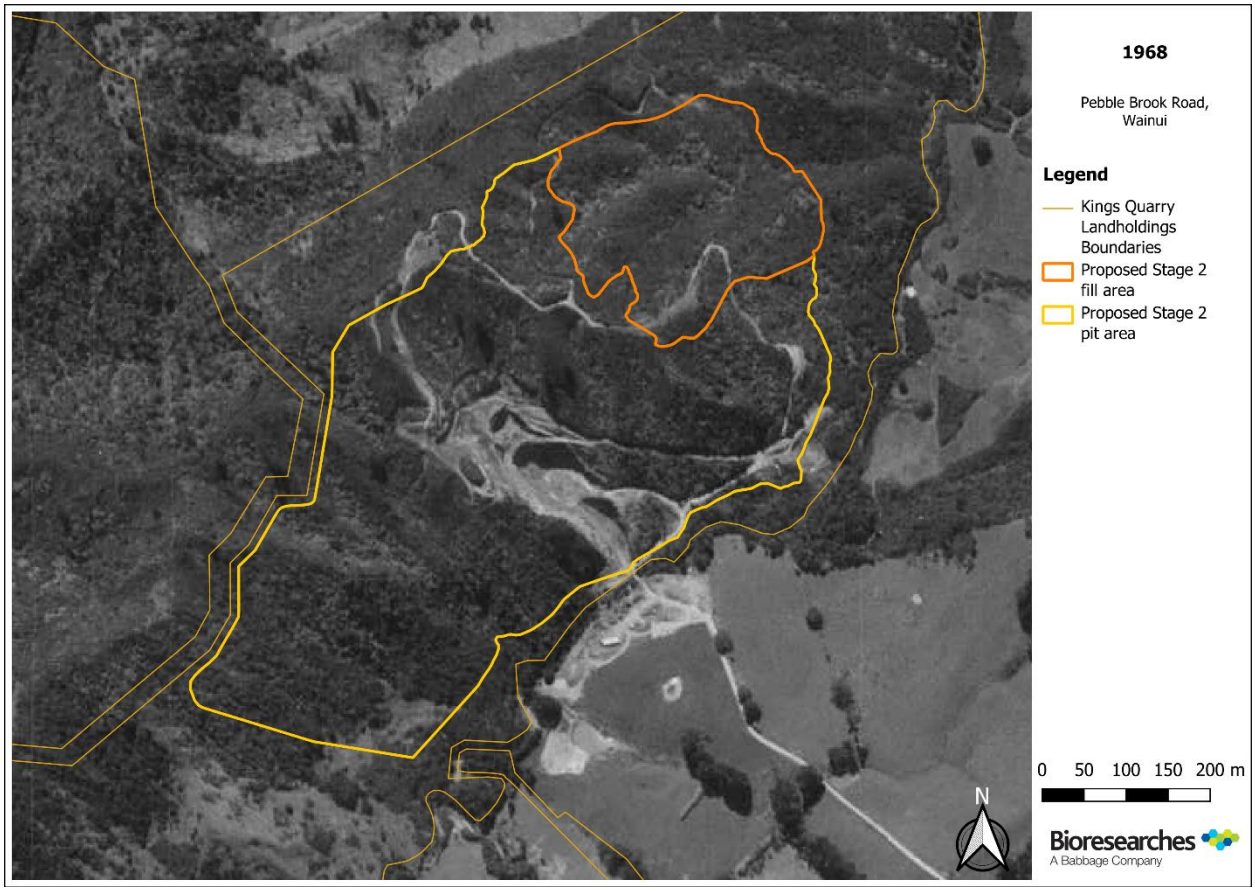

Figure 17. Historic aerial imagery of the Project area, dated 1968. Imagery from Retrolens.

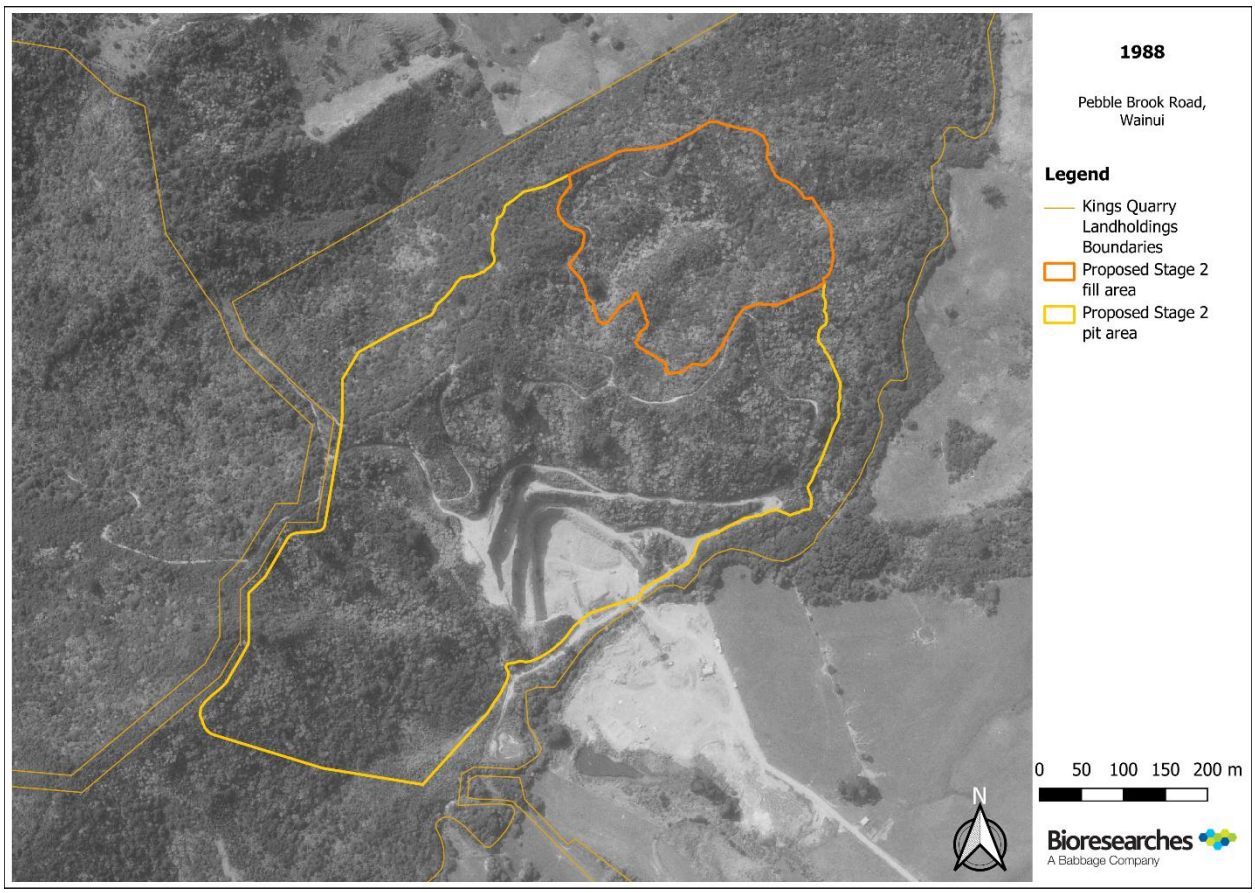

Figure 18. Historic aerial imagery of the Project area, dated 1988. Imagery from Retrolens.

4.2 Terrestrial habitats

4.2.1 Desktop Assessment

The King's Quarry property sits within an approximately 560 ha fragment of vegetation, comprising indigenous ecosystems (c. 330 ha) and pine plantation (c. 200 ha). The various indigenous ecosystem extents as mapped by Auckland Council (AUP Geomaps; Figure 19) and described by Singers *et al.* (2017), and are:

- Regenerating broadleaved species scrub/forest (VS5, Singers *et al.* 2017), which occurs immediately around the existing pit edge and in a band to the southwest.
- Regenerating kānuka scrub/forest (VS2, Singers *et al.* 2017), which covers most of the vegetation surrounding VS5 and the wider fragment edges.
- Kauri, podocarp, broadleaved forest (WF11, Singers *et al.* 2017), which covers a core area to the northwest of, and beyond the Project area.

Almost all of the indigenous vegetation within the Project area is subject to a SEA overlay (SEA_T_6454;Figure 5). SEA_T_6454 is considered to meet Criteria 2 (threat status and rarity; due to the presence of the rare species *Stuckenia pectinata*, three species of At-Risk freshwater fish, and the At Risk – Declining elegant gecko (*Naultinus elegans*)) and 3 (Diversity; due to the presence of WF11, VS2 and VS3 habitats).

Previous assessments (Bioresearches 1998, 2008, 2009) would support these criteria on the basis of the presence of 'At Risk' species (elegant gecko, forest gecko (*Mokopirirakau granulatus*) and *Amborhytida dunniae*), and that it supports typical, expected species richness and assemblages for its ecosystem type.

Auckland Council 'current ecosystem extents' layer indicates that the Project area is vegetated with a mixture of VS5 broadleaf forest and scrub, and VS2 Kānuka scrub/forest (Figure 19).

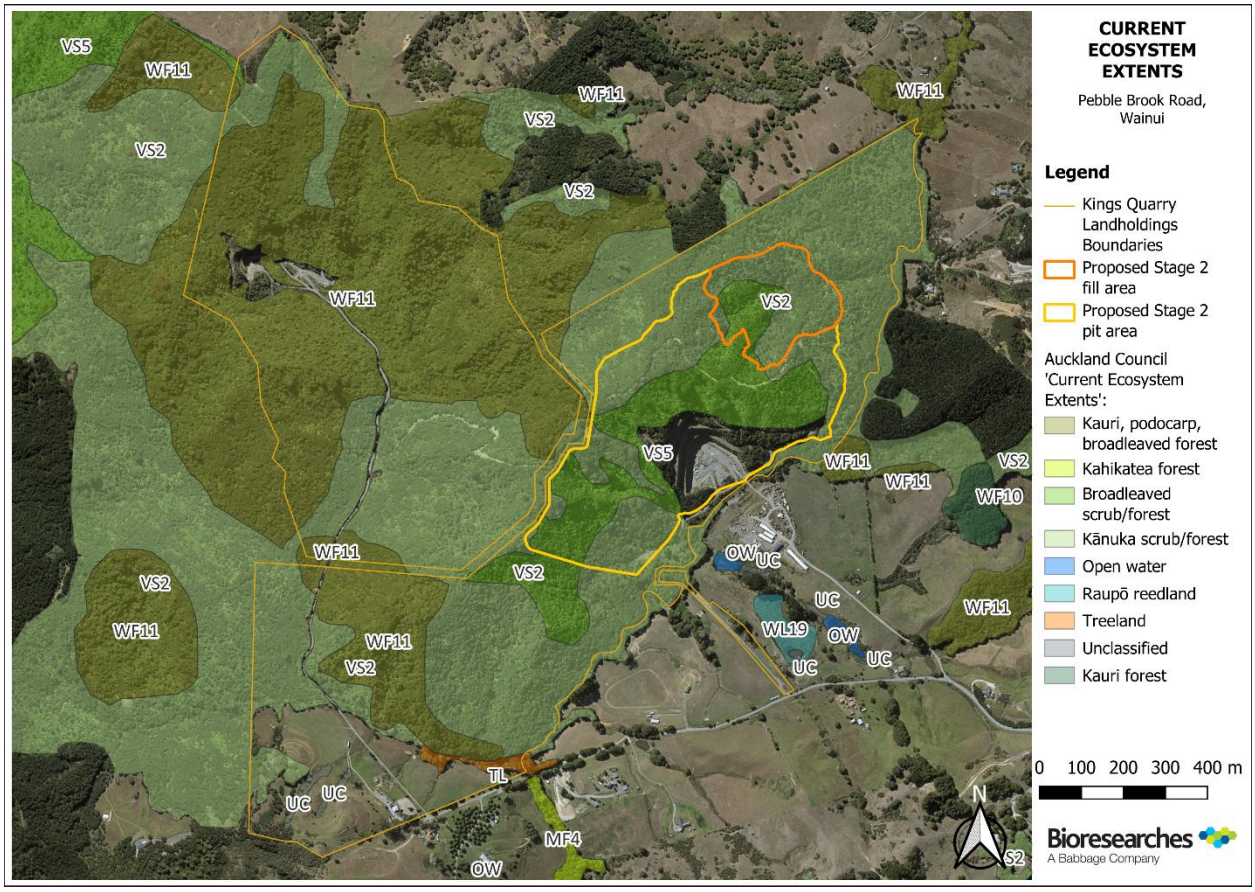

Figure 19. Auckland Council 'Current Ecosystem Extents' layer in relation to the proposed Stage 2 project area

4.2.1.1 Previous Habitat Assessments

Bioresearches (1998) describes the Kings Quarry Landholdings as being dominated by scrub of various types. Much of this is a closed-canopy growth of 10-15 m tall kānuka over ponga, but there are smaller areas dominated by mānuka, and on the very steep face west of the existing quarry, a scrub of bushy small trees including māhoe and māpou. The larger kānuka of this vegetation zone are currently (2024) likely to be c.70-80 years old – in their size and their form there is nothing to suggest that they may be substantially older (kānuka may live for a hundred years or more).

The areas defined as 'forest' in 1998 consisted of a greater density of larger trees and lesser amounts of tall kānuka. These were considered to be the most significant habitats within the Project area at that time. The subcategories of forest consist of podocarp-kauri stands, mixed hardwood-podocarp and tōtara-dominated areas.

The older forest (outside of the Project area) was generally dominated by taraire and other hardwood species, or locally by kauri and podocarps. The hardwoods may be well over 100 years old, but no very large kauri, rīmu etc., were found – the largest of these are slightly less than 50 cm diameter at breast height.

The younger forest, in which kānuka was approximately 10-15 m tall, was reported as being overtopped by a relatively strong regeneration of podocarps, particularly tōtara, which are typically 12-15 m tall and 15-25 cm trunk dbh. The ages of five such regenerant trees were determined by coring and ring-counting. The youngest of these was found to be c.35 years old, and the oldest one, c.90 years old.

The 1984 Protected Natural Areas surveys data provides information on two plots that appear to have been measured within the quarry property, of which the easterly plot (D2021) is within, or close to the proposed quarry expansion area. The plot record shows vegetation in two height tiers: 1 – 3 m and <1 m. The canopy dominants were kānuka (*Kunzea robusta*) and mānuka (*Leptospermum scoparium*) with a range of common broadleaved scrub species and future canopy species such as tanekaha (*Phyllocladus trichomanoides*), tōtara (*Podocarpus totara*) and rewarewa (*Knightia excelsa*).

The existing information suggests that since being cleared of native vegetation some time prior to 1940 the area has reverted to native vegetation over the past 80 years. From rough pasture and low scrub, it had regenerated to low (1-3 m) kānuka/mānuka scrub by the 1980s and to tall kānuka with tanekaha, tōtara and rewarewa becoming increasingly more frequent by the early 21st century. It appears from the reports that browsing by ungulates has influenced the vegetation composition by preventing palatable canopy species from establishing and reducing plant diversity.

4.2.1.2 Threatened or At-Risk plants

de Lange & Cameron (1997) compiled a list of native higher plant species that are uncommon, or were becoming so, in the Auckland Conservancy of the Department of Conservation. This area is bounded on the north by a line between the Kaipara Heads and Mangawhai. This formed the basis of habitat searches made by Bioresearches (1998) and August-December 2020 for threatened or At-Risk plant species. Special searches were made in the Bioresearches 1997-98 and 2007-08 and 2020 surveys for two of their listings: the orchid *Danhatchia australis* (formerly *Yoania australis*) which is presently listed as nationally and regionally 'At Risk – Naturally Uncommon' (de Lange *et al.* 2017; Simpkins *et al*., 2022), and the mistletoe *Ileostylus micranthus* which is presently listed nationally as 'Not Threatened' (de Lange *et al.* 2017), but regionally as Threatened – Regionally Endangered (Simpkins *et al.* 2022).

In 2009, a single stem of the endemic orchid *Danhatchia australis* was found in forest east of Pebblebrook Quarry, within the wider Kings Quarry Landholdings. Several other places were then searched throughout this vegetation zone, but no more plants were found. No mistletoe was found throughout the landholdings.

In the 1998 Bioresearches' report, the presence of two regionally uncommon plants were noted. The first of these, a willowherb (*Epilobium nerteroides*) which ocurred along the edges of Pebblebrook Stream. In the wider (New Zealand-wide) context this plant is not presently considered to be an uncommon species and is listed as 'Not Threatened' (de Lange *et al*. 2017); however, it is listed as Regionally At Risk – Declining (Simpkins *et al.* 2022).

The second, a pondweed (*Stuckenia pectinata*, formerly *Potamogeton pectinatus*) was found in a pond on the 'Wainui Kings Quarry' floor and is listed as 'At Risk – Naturally Uncommon' (de Lange *et al.* 2017). It is also listed by Auckland Council as being present within the SEA, however it is presumed this is the same record. In the intervening years the pond has silted up and the plant was not observed there during the recent study. The pond no longer provides suitable habitat for the species. It has a threat status of 'At Risk - Naturally uncommon' under the Department of Conservation (DOC) National Threat Classification System (de Lange *et al.*, 2024), and is regionally considered to be data deficient (Simpkins *et al*., 2022). de Lange (2020) notes that fennel- leaved pond weed is probably more overlooked than actually threatened.

It is not endemic, and its population is secure overseas although its distribution within New Zealand is sparse.

4.2.2 Site Investigations

The site investigations confirmed the presence of the two habitat types (VS2 and VS5) mapped as present by Auckland Council within the Project Area (refer Figure 19) and additionally identified an area of WF11 habitat along a spur within the Pit 2 extent.

Within the project area, VS2 habitats are predominantly limited to drier areas such as ridges and exposed slopes and are kānuka dominated; whereas VS5 habitats are generally more concentrated in sheltered areas, such as gullies, and are dominated by tree ferns. WF11 ecosystems are more mature forest types dominated by kauri, podocarp and broadleaved canopy forest tree species, such as rimu, totara and tanekaha, and typically occur on drier ridges and slopes, often regenerating from seral kānuka habitats.

The VS2, VS5 and WF11 habitat types are described in greater detail below. Full results of the Recce plot surveys are presented in Appendix C, and a species list of native and exotic plants recorded within the project area is presented inAppendix D. A map showing the vegetation ecosystem extents within the Kings Quarry landholdings can be found in Figure 20.

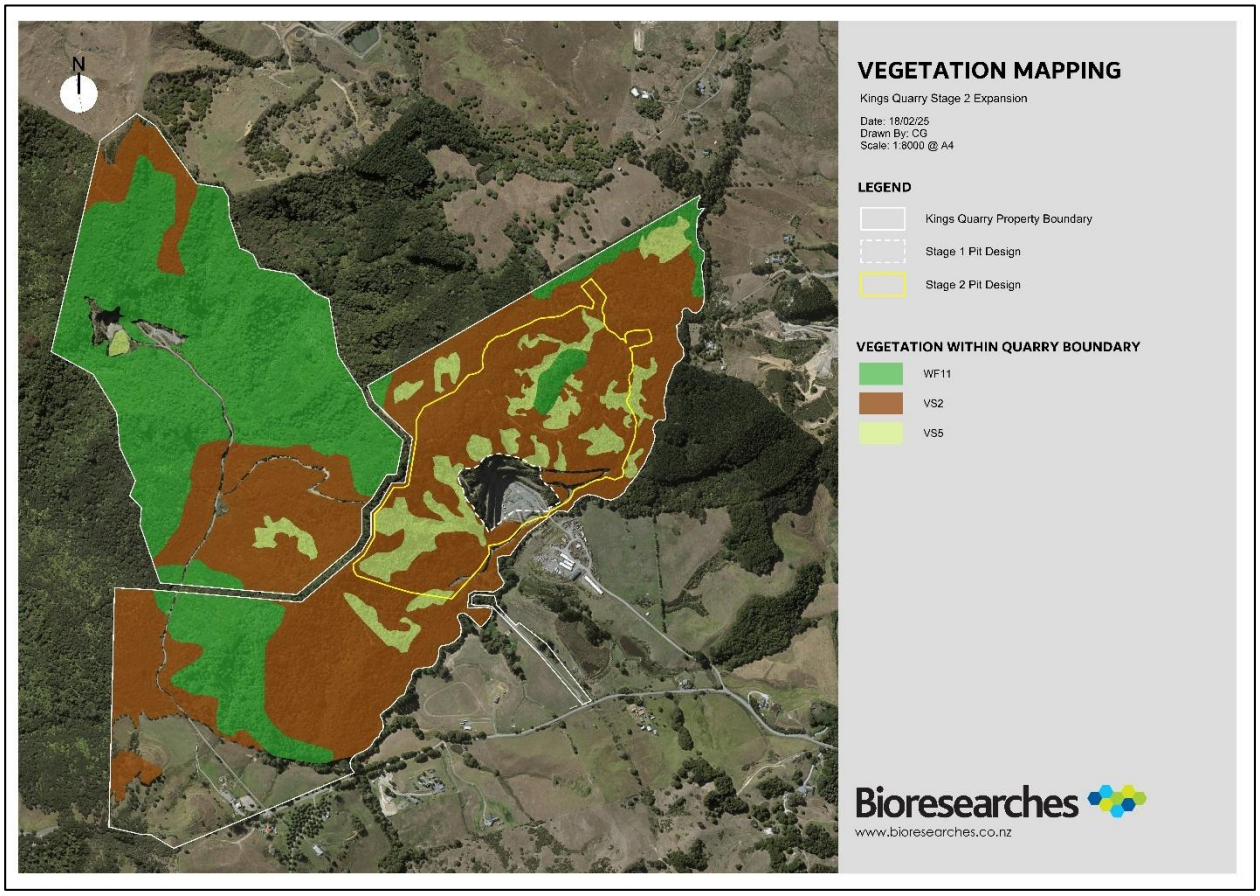

Figure 20. Map showing the ecosystem extents within Kings Quarry property boundaries

4.2.2.1 VS5 Habitats

In Plot C, pole tōtara and old kānuka were co-dominant, and in Plot D large tanekaha (up to 37 cm dbh) were dominant with tōtara a secondary canopy species. In both plots, tree ferns accounted for a

proportion of the understory, and other regenerating species were generally representative of a broadleaf forest type. Twenty-five species were recorded in Plot C, and 19 in Plot D. One epiphyte species was identified in Plot D, and none in Plot C.

No exotic plant species were recorded in either plot. Summaries of the vegetation characteristics of the VS5 plots are presented in Table 2.

Table 2. Summary of VS5 plot vegetation characteristics

Biodiversity Component	Kings Plot C	Kings Plot D
Mean top height/m	13	15
% canopy cover	25	50
Canopy tree count/ plot	50	Not available*
Canopy species richness	2	3
Total canopy tree basal area/m^2ha^{-1} (trees > 10cm dbh)	12.39	Not available*
Total species richness/ count	25	19
Groundcover species richness/ count	15	12
Sub canopy % cover (5-12m)	15	5
Understorey % cover (0.3-5m)	15	15
Ground cover % cover (<0.3 m)	2.5	10
Epiphyte species richness	1	0
Aspect (°)	20	148

* this metric was calculated by counting all of the trees greater than 10 cm DBH; however, this data was not recorded in this plot

4.2.2.2 VS2 Habitats

VS2 habitats are represented with Recce plots '13' and '23'. In Plot 13, canopy species (in order of most to least abundant) included rewarewa (*Knightia excelsa*), kānuka, kahikatea and tanekaha. A total of 38 species were recorded within the plot.

In Plot 23, canopy species included kānuka, tanekaha, tōtara, lancewood, māhoe and māpou. A total of 20 species were recorded within the plot.

No exotic species were recorded in either plot. In plot 23, epiphyte species richness was far greater, which was attributed to the older age of the vegetation within the plot and the proximity to more mature forest, which was likely enhancing the rate of regeneration of secondary species. No species of conservation significance were recorded in either plot. Both plots are representative of late-stage kānuka forest which is regenerating. Summaries of the vegetation characteristics of the VS2 plots are presented in Table 3.

Table 3. Summary of VS2 plot vegetation characteristics

Biodiversity Component	Kings 23	Kings 13
Mean top height/m	11	12
% canopy cover	70	85
Canopy tree count/ plot	54	110
Canopy species richness	0	4
Total canopy tree basal area/m^2ha^{-1} (trees > 10cm dbh)	54.60	60.50
Total species richness/ count	20	34
Groundcover species richness/ count	17	17
Sub canopy % cover (5-12m)	15	5
Understorey % cover (0.3-5m)	15	15

Ground cover % cover (<0.3 m)	2.5	10
Epiphyte species richness	1	10
Aspect (°)	135	320

4.2.2.3 WF11 habitat

In the 2024 Recce plot, the canopy was composed of tanekaha and tōtara, with sparse emergent rewarewa. In the subcanopy silver fens were most abundant, followed by māpou, kānuka, māhoe and lancewood. Regenerating species present were representative of a kauri, podocarp, broadleaf forest. Ungulate browsing was resulting in greater proportions of unpalatable species in the lower forest tiers. Kauri trees within this ecosystem were represented by seedlings only, and no trees were observed within the wider Project.

A total of 43 species were present in this plot, of which 42 were native. Five epiphytic species were recorded growing within this plot.

Table 4. Summary table of WF11 plot vegetation characteristics

Biodiversity Component	2024 plot
Mean top height/m	8.35
% canopy cover	30
Canopy tree count/ plot	Not available
Canopy species richness	3
Total canopy tree basal area/m^2ha^{-1} (trees > 10cm dbh)	33.24
Total species richness/ count	43
Groundcover species richness/ count	20
Sub canopy % cover (5-12m)	45
Understorey % cover (0.3-5m)	30
Ground cover % cover (<0.3 m)	5
Epiphyte species richness	5
Aspect (°)	59

4.2.2.4 Habitat Summary

Both seral habitats, but in particular the VS2 habitat, represent late-stage successional variants of their respective ecosystem types. However, the habitats are somewhat modified in their compositions when compared to 'true' VS2 and VS5 habitats, and to some extent contain characteristics which lean towards classification as AVS1 (Anthropogenic tōtara forest) habitats, due to the relatively high densities of tōtara (and to a lesser extent, tanekaha) throughout.

The areas which leant the most towards classification as AVS1 habitats were those where the kānuka was oldest and was dying out (likely from natural causes) and being replaced with young tōtara.

In the VS5 habitats, these podocarp species are appearing to overtop the tree ferns, which in historic aerial imagery appear to be more dominant in the present day. Generally, species diversity was less in the VS5 habitats than in the VS2 habitats. This may be because the dense tree fern canopy which appeared to establish relatively quickly shaded out many tree seedlings, a process that has been recorded as occurring in other tree fern-dominated early and mid-successional forests (Brock *et al.*, 2016).

The WF11 habitat represents an early stage of this ecosystem, with crowded pole tanekaha and tōtara, which will likely thin as they mature into larger trees and canopy diversity increases. While this is a young form of this ecosystem type, it has developed sufficiently that it is being shaped by canopy species expected from WF11, however it does not have the composition or structure that would be expected of a late-stage regenerating habitat type (VS2 or VS5).

As indicated in the desktop study, it was found that all habitats which were able to be accessed within the Project area are heavily impacted by pest animal browsing (predominantly goat) which has greatly reduced the proportion of palatable species regenerating within the site. Palatable species such as large-leaved coprosmas were relatively uncommon, and species such as small-leaved coprosmas and mingimingi were generally quite abundant.

It is likely that the presence of goats is further exacerbating the regeneration of the site into an AVS1-type ecosystem rather than a naturally occurring ecosystem type, such as the WF11 forest west of the project area. Mature specimens of palatable species, such as pūriri and kohekohe, which are common in the WF11 forest west of the Project area (which is much older than the forest within the Project area, as indicated by the presence of mature trees in 1940 (Figure 16)), are almost entirely absent within the understory of the project area, despite a nearby seed source and the presence of many kereru which would facilitate seed distribution.

4.2.2.5 Threatened or At-Risk plant searches

The pond where fennel-leaved pondweed was previously recorded was reinspected in 2020; and was found to have infilled to some degree with silt; with its edges colonised by weeds. The plant was not observed within the pond. In 2023, it was found that there was no vegetation present within the pond. In addition, none of the other TAR plant species identified during the desktop study were identified within the project area.

During the site walkovers, 13 plant species with elevated threat statuses were identified within the Project area. These are listed in Table 5.

Table 5. Threatened or At Risk plant species identified during the site walkovers within the Project area

Botanical name	Common name	Regional threat classification	National threat classification
Conifers			
Agathis australis	Kauri	At Risk - Declining	At Risk - Declining
Dicot herbs			
Euchiton audax		At Risk - Declining	Not Threatened
Dicot trees and shrubs			
Kunzea robusta	Kānuka	At Risk - Declining	Not Threatened
Leptospermum scoparium	Mānuka	Threatened - Regionally Vulnerable	Not Threatened
Melicytus macrophyllus	Large leaved māhoe	At Risk - Naturally Uncommon	Not Threatened
Melicytus micranthus	Swamp māhoe	Threatened - Regionally Vulnerable	Not Threatened
Metrosideros perforata	Small white rata	At Risk - Declining	Not Threatened
Pennantia corymbosa	Kaikōmako	Threatened - Regionally Endangered	Not Threatened
Pomaderris kumeraho	Kūmarahou	At Risk - Declining	Not Threatened
Ferns & Fern allies			
Gleichenia microphylla	Tangle fern	At Risk - Declining	Not Threatened
Monocots			
Austroderia* aff. *fulvida	Toetoe	Threatened - Regionally Endangered	Not Threatened
Carex ochrosaccus	Forest sedge	At Risk - Declining	Not Threatened
Pentapogon inaequiglumis	Short hair plume grass	Threatened - Regionally Vulnerable	At Risk – Declining

Common myrtaceous species which have previously had their threat statuses precautionarily raised in response to the introduction of myrtle rust include mānuka and kānuka, however recent national-level threat classification updates however have reduced the threat status of mānuka and kānuka to Not Threatened (de Lange *et al.*, 2024) as it has been identified that these species are not particularly susceptible to myrtle rust. Although the Auckland Region threat classifications have not been updated for these species (both of which are widespread throughout the Auckland region; and also widespread throughout the project area and the wider Kings Quarry Landholdings) it is expected that with a further update to the Auckland Regional conservation statuses for vascular plants, the regional threat classification for these species will also drop.

Table 6 provides a summary of the preferred habitats of each of the plant species recorded with elevated threat classifications; however, because of their recent reduction in national threat classification, wide-ranging habitat preferences and abundance within the Project area, mānuka and kānuka have not been included.

Table 6. Habitat preferences of threatened or At Risk plant species identified during the site walkovers within the project area

Botanical name	Common name	Habitat preferences
Agathis australis	Kauri	A tree species which can form its own forest type, kauri forest. Historically, kauri forest was found on river terraces and coastal plains; and it is now believed that the hill and range occurrences of kauri forest are actually relict stands located in areas where kauri logging was more difficult, rather than preferential habitats for kauri (de Lange 2023a).
Euchiton audax	-	Lowland to sub-alpine grassland, forest margins and clearings, coastal sites, scrubland, rock outcrops, riverbeds, pasture, waste places (Drury, 1972). Often associated with both native and introduced grasses, and is repeatedly found in grazed pasture and dry, open areas such as rocky outcrops, tracks, cuttings and scrubland.
Melicytus macrophyllus	Large leaved māhoe	Lowland to lower montane forest (Eagle, 2006).
Melicytus micranthus	Swamp māhoe	Lowland forest, scrub and forest margins, especially on drier sites and on alluvial ground (Wilson & Galloway, 1993)
Metrosideros perforata	Small white rata	Coastal to montane. An abundant plant of open scrub, dense forest or rock-land. In forest and scrub situations climbing on other trees but also climbing up cliff faces, on rock outcrops, and forming a “shrubland” in loose talus (de Lange 2023c).
Pennantia corymbosa	Kaikōmako	A forest plant that favours relatively cool sites, kaikōmako occurs only sporadically in the northern part of the country (Gardner, 1998).
Pomaderris kumeraho	Kūmarahou	Coastal to lowland, in open, early to mid-successional habitats. Often on roadside banks, and in gumland vegetation. Occasionally seen in forested situations. Commonly present in track cuttings within the project area (de Lange 2023d).
Gleichenia microphylla	Tangle fern	Coastal to lowland areas, on infertile soils, clay pans and ferricrete, as well as in swamps and seepages in coastal cliffs (de Lange 2023e).
Austroderia* aff. *fulvida	Toetoe	Found from the coast to montane areas. Common alongside streams, lake margins, in damp spots within forest clearings, seepages, dunes and on hillsides, including sea cliffs (de Lange 2023f).
Carex ochrosaccus	Forest sedge	Coastal to lowland usually in damp situations within alluvial forest but also along stream banks and within coastal seepages (de Lange 2023g).
Pentapogon inaequiglumis	Short hair plume grass	There is limited information available on the preferred habitats of short hair plume grass in New Zealand, however in Australia it is described as being ‘widespread in woodlands on better soils’ by Jacobs & McClay (1993).

4.2.2.6 Botanical Value

The majority of ecosystems present within the Project area (VS2, VS5, and AVS1, which both ecosystems exhibit characteristics of) are generally not considered threatened under the IUCN Red List of Ecosystems used by the Auckland Council (Singers *et al*., 2017). WF11 is classified as endangered under the IUCN Red List of Ecosystems.

Plant species diversity is low within areas dominated by tree ferns, however the overall diversity of the Project area is relatively high with 98 vascular species recorded across the site. Two species of conservation interest were identified within the project area, short hair plume grass and kaikōmako.

4.2.2.7 Ecological values

Despite the presence of two separately described habitat units, as these units are similar in characteristics, appear to be regenerating towards a similar species composition, and are quite 'intertwined' in their extents; they have been assigned an ecological value as one unit. An ecological value assessment for the habitats is provided in Table 7. WF11 habitat has been assessed separately in Table 8.

Table 7. Ecological value assessment for the VS2 and VS5 habitats

Matter	Score and justification
Representativeness	The vegetation is dominated by indigenous species and has a typical structure, however expected species of palatable broadleaved plants are absent or sparse. The representativeness of the vegetation is considered **Moderate.**
Rarity / Distinctiveness	The vegetation type is not National Priority for Protection neither is it Naturally Uncommon. Large areas of the vegetation types present within the study area remain, both regionally and within the Ecological District (E.D.). It does not contain unusual species or assemblages. However, the site supports two locally uncommon plant species, one of which has a national conservation status of "At Risk" – Naturally Uncommon". The Rarity / Distinctiveness criterion for the vegetation is therefore considered **High.** In addition, the habitat is known to support three species of At Risk lizards with a **high** fauna value (discussed in Section4.3.3), a diverse population of native bird species (see Section4.3.4), and has been visited at least periodically by long-tailed bats with a **very high** fauna value (see Section4.3.5). Considering these values, the Rarity/Distinctiveness for the habitat unit is considered to be **very high**
Diversity and Pattern	The Project area contains a moderate level of natural diversity compared to other similar areas of vegetation. It does not contain a large range of different plant habitats and the vegetation patterns observed are considered to be typical of the vegetation types generally found on the types of landforms present at the site. Diversity and Pattern is therefore considered **Moderate**.
Ecological context	The Project area is part of a large fragment of indigenous vegetation that is relatively compact in shape. There is partial buffering by exotic forest on the northwestern side of the Kings Quarry Landholdings. The SEA as a whole is an important stepping stone habitat between native habitat on the west coast and habitats to the east north of Orewa. The ecological context of the site for vegetation is considered **Moderate.**
Ecological Value	**High**

Table 8: Ecological value assessment for WF11 habitat type

Matter	Score and justification
Representativeness	The vegetation is dominated by indigenous species, but has not yet developed a typical structure or composition that would be expected from a mature example of this habitat type. Diversity of species, particularly in the canopy and subcanopy tiers is depauperate. However, the species that are present are typical of a kauri, podocarp broadleaf ecosystem type. The representativeness of this habitat is considered **low**.
Rarity / Distinctiveness	This ecosystem type has an IUCN Red List classification of Endangered. More extensive and mature examples of this ecosystem are being retained within the SEA and avoided by this project's footprint. It does not contain unusual species or assemblages. However, the site supports two locally uncommon plant species, one of which has a national conservation status of "At Risk" – Naturally Uncommon". The Rarity / Distinctiveness criterion for the vegetation is therefore considered **High.** In addition, the habitat is known to support three species of At Risk lizards with a **high** fauna value (discussed in Section4.3.3), a diverse population of native bird species (see Section4.3.4), and has been visited at least periodically by long-tailed bats with a **very high** fauna value (see Section 4.3.5). Considering these values, the Rarity/Distinctiveness for the habitat unit is considered to be **very high**
Diversity and Pattern	While the diversity of species present in the WF11 habitat is lower than would be expected in a mature example of this habitat type, it is reasonable for this stage of development. This area of WF11 forest fits within a larger mosaic of this forest type within the wider local environment, with areas present to the east and west of the site. This fits within and enriches a stepping-stone of habitat between similar fragments to the north, east and west of the project site. The diversity of the WF11 habitat is considered **moderate**
Ecological context	This habitat is young and has regenerated over the past 80 years. While a regenerating ecosystem itself, it represents a more mature stage of regeneration compared to the composition of pioneer species around it. The surrounding vegetation provides protection from edge effects and weed incursions. This area is contiguous with surrounding forest in the SEA, which provides a significant stepping stone of habitat for fauna moving between the east and west coast and between other fragments of habitat in the Rodney, Kaipara and Tāmaki ecological districts. The ecological context is considered **moderate.**
Ecological Value	**High**

4.3 Terrestrial Fauna

4.3.1 Invertebrates

4.3.1.1 Desktop Assessment

A search of iNaturalist records within 5 km of the Project area detected records of 50 invertebrate species, of which 22 were native. Full results of this search are presented in Table 38 in Appendix E.

Not all indigenous invertebrates in New Zealand have been assigned threat classifications. Invertebrate groups which have been assigned threat classifications by DOC include:

- Orthoptera (wētā, crickets and grasshoppers) by Trewick *et al.* (2022);
- Araneae (spiders; Sirvid *et al*. 2020);
- terrestrial Gastropoda (slugs and snails) by Barker *et al*. (2020), Walker *et al*. (2020), and Walker *et al*. (2024);
- freshwater invertebrates by Grainger *et al*. (2018);
- stick insects by Buckley *et al.* (2014);
- fleas by Heath *et al.* (2014);
- parasitic mites and ticks (Acari) by Heath *et al*. (2021); and
- butterflies and moths (Lepidoptera) by Hoare *et al.* (2015).

In addition, other species groups have been assigned threat classifications in research publications such as Buckley *et al.* (2012), Mahlfeld *et al.,* (2012) and Stringer & Hitchmough (2012).

Species recorded in the desktop study which do have elevated threat classifications assigned (e.g., 'At Risk or 'Threatened' (TAR) species), include wētāpunga (*Deinacrida heteracantha*; Threatened - Nationally Increasing); Auckland tree wētā (*Hemideina thoracica*; At Risk - Relict); and kauri snail (*Paryphanta busbyi*; At Risk – Declining).

Despite this, the record for this species has been discounted as potentially originating from within 5 km of the Project area, because the photos were of an empty shell, taken inside a dwelling, and the record was also located directly over a dwelling. It is therefore considered most likely that this shell was from elsewhere and photographed/uploaded to iNaturalist from the dwelling. When combined with known information on the distribution of *Paryphanta* spp. in New Zealand (discussed further in Section 4.3.1.3), the shell was considered highly unlikely to have originated from the posted location.

A review of historic local reports found that a range of terrestrial invertebrates, but no species of particular note, was captured in a limited pit trapping exercise by Bioresearches in 1997-98. Four species of small to medium sized native land snails were present, including the medium-sized Rhytid snail *Amborhytida dunniae* (At Risk - Declining). *Amborhytida dunniae* were recorded from tall, established, old-forest to the west of the existing quarry.

4.3.1.2 Site investigations

Habitat searches for the current study identified millipedes (Class: Diplopoda, including pill millipedes (Order Sphaerotheriida)), landhoppers (Amphipoda) and small (>10 mm diameter) land snails as the most common invertebrates recorded. Other, less common species identified included:

- slaters (Isopoda);
- cockroaches (Blattodea);
- ground wētā (Anostostomatidae), most likely Auckland tree wētā (At Risk - Relict) and/or the ground wēta, *Hemiandrus pallitarsis* (Not threatened); and
- banded tunnel web spiders (*Hexathele hochstetteri*; Not Threatened), which were observed occasionally.

Amborhytida dunniae was not recorded from any searches. Most of the taxon observed were native, and none have a national threat status of nationally 'At-Risk' or greater.

In addition to terrestrial invertebrates, multiple burrows of kōura (*Paranephrops zealandicus*; At Risk - Declining) were recorded up to 2 m from the stream banks in terrestrial vegetation at Stream 10 (Photo 3a and b; see Figure 24 for stream location), and additional invertebrates were recorded during the collection of instream macroinvertebrate samples. As these species are aquatic, the significance of their presence is assessed within the freshwater sections of this report.

Photo 3a and b. Terrestrial kōura burrows

4.3.1.3 Habitat Assessment

Most native invertebrates are not directly protected under the Wildlife Act 1953. Protected invertebrates are listed in Schedule 7 of the Wildlife Act, and include various species, including the kauri snail, (*Paryphanta busbyii*) and wētāpunga (*Deinacrida heteracantha*). Both of these species occur in the Auckland Region, although have restricted distributions that do not naturally extend across the Kaukapakapa – Wainui area. For example, wētāpunga are only found on island sanctuaries in the Haruaki Gulf (DOC, n.d.). Given this, and as the desktop study iNaturalist record for this species was 'obscured', this species is not considered to be present within the Project area.

Kauri snails have natural southern distribution limit at Warkworth, although have localised introduced ranges beyond this (e.g., Little Huia and Kaimai Ranges) (Stringer & Montefiore, 2000). Given this, and the unreliability of the iNaturalist record's location, this species has also been discounted as potentially present.

Other invertebrate species that are not listed as protected may also contribute to qualify habitats as significant by their presence. This includes species with recognised threat classifications such as the Auckland tree wētā. This species was recorded in the desktop study; is widely distributed in the northern two-thirds of the North Island; and is known to occupy forest and scrub habitats (Bugarella *et al*., 2014), such as those within the site. Despite the potential for the record to have originated from more than 5 km from the Project area, this species is considered potentially present given the habitat suitability and the detection of Anostostomatidae within the site.

In addition, the rhytid snail (*Amborhytida dunniae*), a medium sized carnivorous land snail is classified nationally as At Risk - Declining (Walker *et al.,* 2024). Rhytid snails require cool, moist areas of leaf litter

in native forest and scrub. They can be found in deep leaf litter and in association with rotten logs and fallen nīkau fronds, generally in more mature forest ecosystems. Given that this species was not recorded in dedicated searches, and that the habitat within the Project area is not their preferred, mature forest habitat, they are considered unlikely to be present.

4.3.1.4 Ecological Value

In accordance with the EIANZ Guidelines, the site supports a range of nationally and regionally common native invertebrate species of low value. Potentially-present higher values species, such as the At-Risk rhytid snail, have not been recorded and are not generally associated with regenerating ecosystems. The overall value for invertebrate species assemblages is low.

4.3.2 Frogs

4.3.2.1 Desktop Assessment

The closest population of Hochstetter's frogs identified in ARDS and iNaturalist database searches are located in the Moirs Hill area, approximately 15 km north-east of the site; whilst a second population is located within the Waitakere area, approximately 30 km south of the site. No native amphibian species were observed during the Bioresearches 1997-98 surveys.

4.3.2.2 Site investigations

Streams 4, 6, 7, 8, 9 and 13 were searched for frog presence in November 2023 and December 2024 (see Appendix F). Streams 4, 6, 7, 8 (e.g. Photo 4), 9 and 13 were considered to have potential to support frogs, as characterised by bedrock-type substrates (noting that Stream 6 was modified and channelised, but supported some quarry rock at the vehicle track). No frogs were found from these searches.

Watercourse lengths beyond these areas are considered unsuitable for frog habitat due to more heavy incision and sedimentation of instream stones.

Photo 4a and b. Examples of bedrock streams (stream 8) with overhanging vegetation at Kings Quarry

No native frogs were detected in any of the eDNA samples collected. Full eDNA sample results are presented in G.

4.3.2.3 Habitat Assessment

Hochstetter's frog (Lei*opelma hochstetteri*) is a small, endemic frog that occurs in scattered, fragmented populations throughout the northern half of the North Island (Green & Tessier, 1990). It is regarded as "Vulnerable" on the IUCN Red List 2009 (Bell *et al.,* 2010).

The two populations of Hochstetter's frogs are present to the north and the south of the site; and are considered to be separate Evolutionarily Significant Units (ESUs) of Hochstetter's Frog; with the north-east populations being part of the "Northland" (*Leiopelma* aff. *hochstetteri* "Northland") ESU, and the south populations being part of the "Waitakere" (*Leiopelma* aff. *hochstetteri* "Waitakere") ESU (Burns *et al*., 2018).

Kings Quarry sits between these two ESUs. Therefore, while not sufficient to represent a different species, a population at Kings Quarry would be of significant scientific and conservation interest from a phylogeographic understanding. Both ESUs ("Waitakere" and "Northland") are separately classified as At Risk - Declining (Walker *et al*., 2025) and either would have high ecological value (Roper-Lyndsey *et al.,* 2018) if present in the Project area, unless they are genetically different from either, in which case their status would probably be 'Threatened'.

Hochstetter's frog are most commonly associated with shaded stony streambeds or seepages under mature native forest. However, it is capable of tolerating modified habitats, such as exotic forest (Douglas, 1999; Bell *et al.,* 2004; Stephenson & Stephenson, 1957). Hochstetter's frogs are sensitive and vulnerable to environmental disturbances, such as floods and sedimentation (Najera-Hillman *et al*., 2009) because they tend to occur in small and localised populations (Newman, 1996).

4.3.2.4 Ecological value

In accordance with the EIANZ Guidelines, any species with an 'At Risk – Declining' or 'Threatened' conservation status is considered to have a 'High' ecological value. Hochstetter's frogs are known to persist in some environments at very low levels which makes their detection very difficult, particularly when pest control is minimal or not occurring. Consequently, while it is not possible to exclude the possibility of these species being present within the site given the presence of potential habitat within their natural range, the failure to detect frogs during repeated habitat surveys and eDNA sampling; as well as the limited availability of suitable habitat on site, indicates that the project area is unlikely to support native frogs. However, it should be acknowledged that potential stream habitats beyond the Project area, particularly where they are associated with mature forest and have not been surveyed in the last decade, may still support isolated populations where habitat stability would be greater over time.

4.3.3 Lizards

4.3.3.1 Desktop Assessment

The search of the Department of Conservation Amphibian and Reptile Distribution Scheme (ARDS) database, Auckland Council records, and iNaturalist records identified records of three native lizard species within 5 km of the site. This included (and mapped in Figure 21):

- elegant gecko (*Naultinus elegans*);
- forest gecko (*Mokopirirakau granulatus*); and
- copper skink (*Oligosoma aeneum*).

In addition, records for both copper skink and forest gecko were present within the Project area or within habitats contiguous with the Project area following a formal survey of the Project area and surroundings over 2008 and 2009 (Bioresearches 2008, 2009).

One elegant and one forest gecko were also recorded within the wider Kings Quarry Landholdings from 28-person search hours (autumn) and 21.5 person search hours (summer), respectively (Bioresearches, 2008; Bioresearches, 2009). This equates to a catch per unit effort (CPUE) of:

- 0.036 elegant geckos per search hour (Bioresearches, 2008); and
- 0.047 forest geckos per search hour (Bioresearches, 2009).

The elegant gecko was recorded from outside the Project area (Figure 21), however, the forest gecko was recorded from inside the Project area.

Similarly, the only native skink recorded from a previous summer survey was copper skink (At Risk, Declining).

4.3.3.2 Site investigations

Habitat searches revealed a gecko slough in a crevice of a clay bank beneath a clump of flax bushes (Photo 5). The slough was marked with light bands along the tail section, consistent with either a Pacific gecko or forest gecko. Forest gecko have been recorded within the Project area; however, the location of the slough and particular tail banding are also consistent with patterns more typical of a Pacific gecko.

Plague skinks (*Lampropholis delicata*) were also detected in multiple locations across the site during the site investigations. As this species is introduced and naturalised and is listed as an 'unwanted organism' by MPI, it is not considered further within this report.

Photo 5a and b. Left: gecko skin slough. Right: flaxes above clay bank where the skin slough was identified.

4.3.3.2.1 Artificial Retreat surveys

The 2022 artificial retreat surveys detected nine copper skinks from five stations within the Project area. No other species of lizard was detected.

4.3.3.2.2 Nocturnal Surveys

No lizards were detected during the 2022 nocturnal visual encounter surveys.

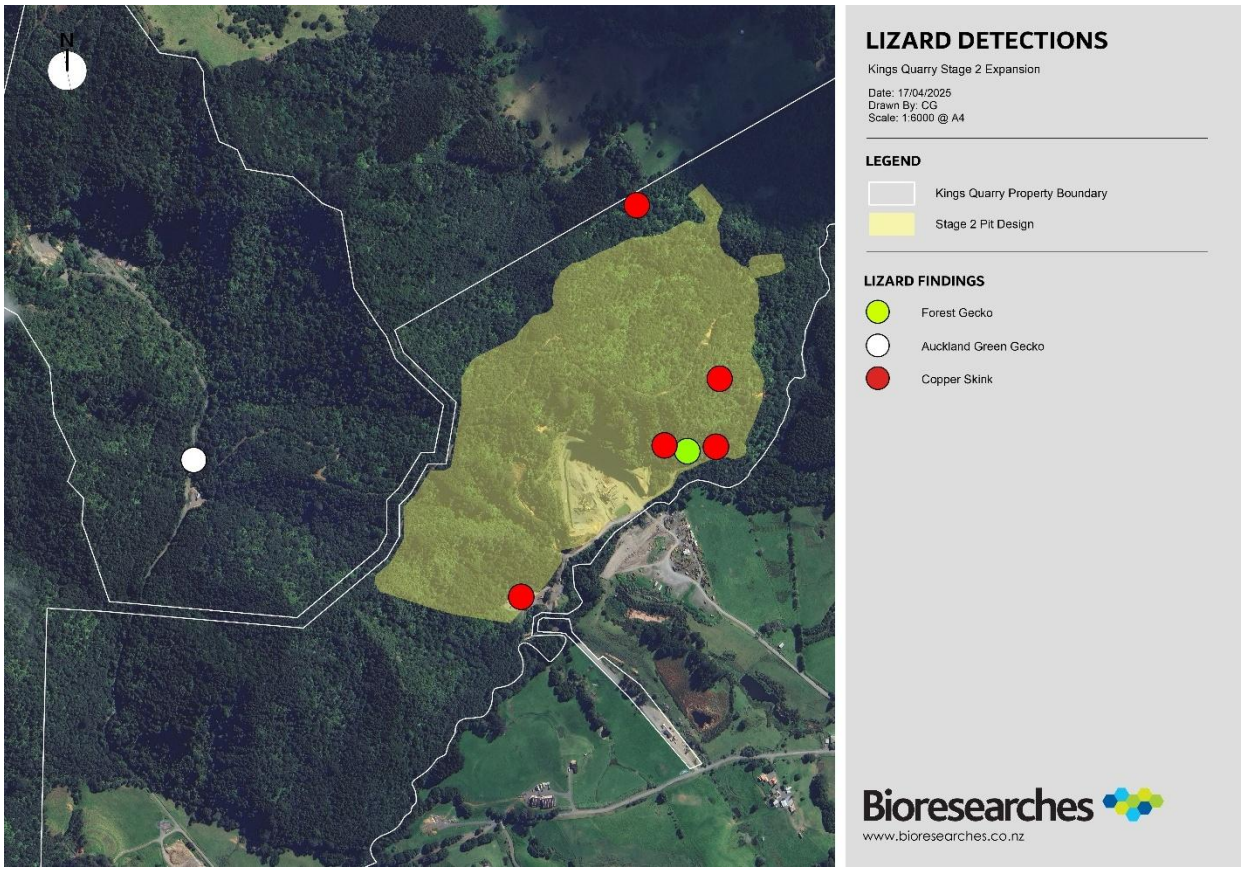

Figure 21. Native lizard records within and around Kings Quarry

4.3.3.3 Habitat Assessment

Herpetofauna (reptiles and amphibians) comprise a significant component of New Zealand's terrestrial fauna. Over 120 endemic taxa are currently recognised (van Winkel, *et al*., 2018; Hitchmough *et al*., 2021) and more than 80% are considered 'Threatened' or 'At Risk' of extinction (Hitchmough *et al*., 2021). All indigenous reptiles and amphibians are legally protected under the Wildlife Act 1953, and vegetation and landscape features that provide significant habitat for native herpetofauna are protected by the Resource Management Act 1991. Statutory obligations require management of resident reptile and amphibian populations where they or their habitats are threatened by disturbance or land development.

The indigenous lizard fauna of the mainland Auckland Region (excluding species confined to islands such as Little Barrier and Great Barrier Islands) includes twelve terrestrial taxa; eleven native species and one exotic species (van Winkel *et al*., 2018). These species are listed in Table 9. The paragraphs which follow Table 9 discuss the suitability of the site for the species listed within Table 9, based upon both the site's geographical location, the habitats available on site, and the species where presence has been confirmed through search and survey efforts.

Table 9. Terrestrial herpetofauna of the Auckland region, corresponding NZ conservation statuses and reported occurrence within 5 km of the Site.

Common name	Species name	New Zealand Conservation Status*	Regional Conservation Status***	Reported within 5 km of the Site	Likelihood of occurrence within project area

Dactylocnemis pacificus	Pacific gecko	Not Threatened	At Risk – Regionally Declining	✓	Potential
Mokopirirakau granulatus	Forest gecko	At Risk – Declining	At Risk – Regionally Declining	✓	**Confirmed within Project area**
Naultinus elegans	Elegant gecko	At Risk – Declining	At Risk – Regionally Declining	✓	**Confirmed within wider landholdings. Likely to be present.**
Woodworthia korowai	Korowai gecko	Threatened - Nationally Vulnerable	Threatened – Regionally Vulnerable		No
Woodworthia maculata	Raukawa gecko	Not Threatened	At Risk – Regionally Recovering		No
Oligosoma aeneum	Copper skink	At Risk – Declining	At Risk – Regionally Declining	✓	**Confirmed within Project area**
Oligosoma aff. *smithi "Three Kings, Te Paki, Western Northland"*	Tātahi skink	At Risk – Declining	At Risk – Regionally Declining		No
Oligosoma moco	Moko skink	At Risk – Relict	At Risk – Regionally Relict		No
Oligosoma ornatum	Ornate skink	At Risk – Declining	At Risk – Regionally Declining		Potential
Oligosoma smithi	Shore skink	At Risk – Declining	Regionally Naturally Uncommon		No
Oligosoma striatum	Striped skink	At Risk – Declining	At Risk – Regionally Declining		Potential
Oligosoma suteri	Egg-laying skink	At Risk – Relict	At Risk – Regionally Recovering		No
Lampropholis delicata	Plague skink	Introduced and Naturalised**			Confirmed

* Hitchmough *et al*. (2021)
** Also listed as an 'unwanted organism' by MPI
*** Melzer *et al.* (2022)

4.3.3.3.1 Species unlikely to be present

Muriwai gecko (*Woodworthia "Muriwai"*) and **tātahi skink** (*Oligosoma "Three Kings, Te Paki, Western Northland"*) are both limited in their distributions to coastal areas of the west coast; whilst **shore skink** (*O. smithi*), **egg-laying skink** (*O. suteri*), **moko skink** (*O. moco*) and raukawa gecko (***Woodworthia maculata***) are limited in their distributions to coastal areas of the east coast. Consequently, these species are not considered to be potentially present on site.

4.3.3.3.2 Species potentially present

Striped skink (*Oligosoma striatum*) are generally associated with arboreal habitats in mature forest canopies. Mature forest vegetation is not present on site, although it is noted that this species is occasionally recorded in pastoral land and regenerating forests, where logs or epiphytes from former

forest ecosystems provide habitats with elements of relict components. The Auckland Region is a recognised national stronghold for striped skinks, and nearly 50% of all records for this species in the last 30 years are from Aotea. Therefore, while unlikely, this species may be encountered.

Ornate skink (*Oligosoma ornatum*) inhabits forested areas and shrubland. They are widespread throughout the North Island; however, populations are sparse and with 'patchy' distributions. Unlike copper skink, which are more common and will persist in more marginal and modified habitats (such as rank scrubland); ornate skink generally require some connectivity to forest habitats to persist in a location. Nonetheless, potentially suitable habitats for ornate skink are present on site, with linkages to mature forest areas, and consequently this species is considered to be potentially present.

Pacific gecko are associated with native forest habitats, and are therefore potentially present on site, given the suitability of the habitat which is present and the potential that the gecko slough found belonged to a pacific gecko.

An **elegant gecko** was found in 2008-9 within the wider Kings Quarry Landholdings. Given the proximity to the Project area, they are considered likely to be present.

4.3.3.3.3 Species confirmed to be present

As described above, copper skink and forest gecko are confirmed to be present within the Project area. The encounter rates for geckos during spotlighting are very low (0.036 to 0.047 geckos/hour), suggesting low density populations are present at Kings Quarry for both species (forest gecko and green gecko) throughout the vegetated area; and, if present, even lower densities of pacific gecko.

For comparison, an average encounter rate of 0.34 forest geckos/hour was recorded in twelve other locations where forest geckos have been detected throughout the Auckland Region between 2008-2015 (Bioresearches, unpub. data)). It is, however, noted that this species was not detected from a further 26 locations surveyed by the author (WA 37604-FAU) within comparable potential habitat (regenerating kānuka forest) over the same period, and this information supports their conservation status of 'At Risk'.

Considering the low encounter rates for geckos, and the low numbers of copper skink encountered during ACO surveys, it is considered that the site has low species abundance for these species, and, if present at all, likely even lower abundances of the species which are considered 'potentially present' above.

4.3.3.3.4 Habitat Suitability

The entire Kings Quarry generally contains good quality habitat for native skinks and geckos throughout, although patches that are dominated by tree ferns support fewer retreats for skinks and less connective foraging habitat for geckos (Photo ***6***). These particular areas are low value habitats.

Photo 6. Tree fern-dominant areas at Kings Quarry are of low-value habitat for native lizards.

4.3.3.4 Ecological value

High numbers of lizards were not found throughout the Project area, which may be reflective of the site's historic clearance, which likely greatly reduced the density of lizards throughout the site. In addition, the limited pest control and consequent high predator numbers throughout the site likely continues to contribute to low densities.

In accordance with the EIANZ Guidelines, any species with an 'At Risk – Declining' or 'Threatened' conservation status is considered to have a 'High' ecological value. Given that three species of lizard with a threat classification of 'At Risk – Declining are known to be present, the Project area has been assigned a **High** ecological value for lizards.

4.3.4 Birds

4.3.4.1 Desktop Assessment

A desktop assessment for bird records, which involved searching eBird and iNaturalist databases, recorded 70 bird species. Of these; 25 species were exotic and therefore excluded from further assessment.

Full results of the desktop study are presented in Appendix H.

4.3.4.2 Site investigations

4.3.4.2.1 Five-minute Bird Counts

The 5MBC counts detected 15 species of bird within the site, nine of which are native. None of the bird species had elevated threat classifications. Bird abundance within the Kings Quarry Landholdings was found to be remarkably high (greater than that of many benchmark sites of similar habitat types within Auckland). In particular, kereru and tūī were present in high numbers. No threatened or at risk bird species were identified during the five-minute bird counts within the Kings Quarry Landholdings.

Full five-minute bird count results are presented in Appendix I.

4.3.4.2.2 Incidental Observations

The only native bird species which was recorded within the site investigations (within the Kings Quarry Landholdings but not within the Project Area) was a tomtit (*Petroica macrocephala*; Not Threatened).

4.3.4.3 Habitat assessment

Table 10 presents an assessment of the potential suitability of the site for the TAR bird species identified during the desktop assessment.

North Island brown kiwi (*Apteryx mantelli*)

North Island brown kiwi (Not Threatened) are addressed here because this species has been raised in previous comments on Kings Quarry applications. Kiwi have not been recorded at Kings Quarry or the surrounding environment and are not considered to be present within the Kings Quarry property. Remnant populations are absent from the mainland in the Auckland region, and current populations only occur in and around managed areas where they have been translocated in relatively recent history. Such locations are almost all associated with predator- fenced sanctuaries, including Tāwharanui Regional Park (translocated 2005); Shakespear Regional Park (translocated 2017); Kaipara Kiwi Sanctuary (Glorit). More recently, an unfenced pest managed area of Mt. Tamahunga received kiwi in 2023.

Table 10. Habitat assessment for TAR bird species identified in the desktop assessment.

Threat classification	Common name	Scientific name	Habitat assessment
Threatened – Nationally Critical	Australasian Bittern, Matuku Hūrepo	*Botaurus poiciloptilus*	Bitterns are known to inhabit wetlands, and occasionally rank grass areas along paddock or drain edges (Williams, 2023a). Given that there is no suitable freshwater habitat within the site, they are considered unlikely to be present.
Threatened – Nationally Vulnerable	Caspian Tern, Taranui	*Hydroprogne caspia*	Caspian tern are a marine species and consequently are not expected to visit the site.
	Grey Duck, Pārera	*Anas superciliosa*	Individuals of this species within urban and modified environments are almost always hybrids with introduced mallard ducks (*Anas superciliosa*); these hybrids are not a threatened species (Williams, 2013c). True, non-hybridised pārea are limited in their distribution to forested, headwater streams in large forest blocks where mallards have not reached. Due to the modified site history and the location of the site in the middle of an otherwise rural environment, pārera are considered unlikely to be present within the project area and have not been considered further.
	South Island (SI) Takahe, Takahē	*Porphyrio hochstetteri*	Takahe are limited to pest free offshore islands and predator proof enclosures within the Auckland Region (Maxwell, 2013). Consequently, the potential for their presence within the site has not been considered further.
Threatened – Nationally Increasing	New Zealand (NZ) Dabchick, Weweia	*Poliocephalus rufopectus*	Dabchick generally require areas of open water with wetland habitats on the periphery (Szabo, 2022). This habitat is not considered to be present within the Project area and consequently dabchick have not been considered further.
At Risk – Declining	Banded Rail, Moho Pererū	*Gallirallus philippensis assimilis*	Banded rail is restricted within the North Island to mangroves and saltmarshes in the estuaries of Northland, Auckland, Waikato and Bay of Plenty (Bellingham, 2013). Such habitat is not present within the site and consequently, the potential presence of this species has not been considered further.
	New Zealand (NZ) Pipit, Pīhoihoi	*Anthus novaeseelandiae*	Pipits utilise rough, open habitats such as pasture, felled forest and wetlands (Beauchamp, 2013). Such habitat is not present within the site and consequently, the potential presence of this species has not been considered further.
	North Island (NI) Fernbird, Mātātā	*Poodytes punctatus*	Fernbirds occur and breed in dense freshwater and coastal wetland vegetation, and 'open' dry shrubland throughout New Zealand (Miskelly, 2013). Such habitat is not present within the site and consequently, their presence is considered highly unlikely.
	Red-Billed Gull, Tarāpunga	*Chroicocephalus novaehollandiae*	Red billed gulls are found in most coastal areas of New Zealand, and are also opportunistic scavengers and therefore are commonly found in towns, however they are seldom found inland (Mills, 2013). Consequently, they are not expected to be present within the site and have not been considered further.

	South Island Pied Oystercatcher (SIPO), Tōrea	*Haematopus finschi*	South Island pied oystercatchers are a coastal species and consequently are not expected to visit the site.
	Spotless Crake, Pūweto	*Zapornia tabuensis*	Spotless crakes occur and breed in freshwater wetland dominated by dense emergent vegetation (particularly raupō) throughout the North Island (Fitzgerald, 2013). Such habitat is not present within the site and consequently, their presence is considered highly unlikely.
At Risk – Recovering	North Island (NI) Kaka, Kākā	*Nestor meridionalis*	Kākā are rare to uncommon in native forest on the mainland, with strongholds on pest free offshore islands. Kākā however disperse widely during winter and regularly visit forest fragments and pine plantations in the Auckland area (Moorhouse, 2013). Consequently, it is possible that they are an infrequent visitor to the site for foraging, but highly unlikely they would breed within the site.
	Northern New Zealand (NZ) Dotterel, Tūturiwhatu	*Charadrius obscurus*	New Zealand dotterel are a coastal species and consequently are not expected to visit the site.
	Pāteke, Brown Teal (North Island)	*Anas chlorotis (North Island)*	Pāteke utilise estuaries and wetlands, including forested wetlands. They are greatly impacted by introduced pests however (Williams, 2013b). Given the lack of suitable freshwater habitat within the site however, they are considered unlikely to be present.
	Pied Shag, Kāruhiruhi	*Phalacrocorax varius*	Pied shag are predominantly a coastal species, however they may visit areas of open water, streams or wetlands inland (Powlesland, 2013b). Given the lack of suitable freshwater habitat within the site however, they are considered unlikely to be present.
	Variable Oystercatcher (VOC), Tōrea	*Haematopus unicolor*	Variable oystercatchers are a coastal species and consequently are not expected to visit the site.
At Risk – Relict	Black Shag, Kawau Tuawhenua	*Phalacrocorax carbo*	Black shags are found in a variety of habitats, including coastal waters, harbours, estuaries, streams, rivers, ponds and lakes (Powlesland, 2013a). However, due to the minimal freshwater habitat present within the site, this species is considered unlikely to be present.
	Cook's Petrel, Tītī	*Pterodroma cookii*	Cook’s petrel are a marine species and consequently are not expected to visit the site.

	New Zealand (NZ) Red-Crowned Parakeet, Kākāriki	*Cyanoramphus novaezelandiae*	Kākāriki are largely restricted in their distribution to pest-free offshore islands or pest-free mainland reserves, however occasionally birds are spotted on the mainland, which are considered to be vagrant birds, escaped or released captive birds, or birds dispersing from nearby reserves (Greene, 2013). It is therefore possible, although low in likelihood, that birds from Hauraki Gulf offshore islands and Pest free sanctuaries such as Shakespeare Regional Park could visit the site, however if occurring at all this is likely to be highly infrequent.
At Risk – Naturally Uncommon	Little Black Shag, Kawau Tūī	*Phalacrocorax sulcirostris*	Little black shags occur mostly on lakes and harbours, and also occur on muddy edges of inland and coastal inlets, braided river systems, and on lakes and ponds, including sewerage ponds (Armitage, 2013). Due to a lack of suitable habitat within the site, this species is considered unlikely to be present.
	Royal Spoonbill, Kōtuku Ngutupapa	*Platalea regia*	Royal spoonbills are a coastal species and consequently are not expected to visit the site.

Despite the absence of TAR bird species within the site; the site is known to support a diverse range of native forest birds at very high abundances.

4.3.4.4 Ecological value

In accordance with EIANZ guidelines, nationally and locally common indigenous species are assigned a low ecological value. Species with an 'At Risk – Declining' or higher ecological value are considered to be of high ecological value. The desktop study identified one such species as a potential infrequent visitor to the site, the kākā (At Risk - Declining). However, given that this species is highly unlikely to visit the site for more than occasional foraging, the ecological value of the site for this species is not considered to be high.

However, when considering the very high abundance of bird species within the site, in particular kereru, which, in a modified landscape, where most of the larger native forest birds are not present, become important vectors for dispersal of native plants which have large seeds and/or fruits; as well as the local presence of the less-common, albeit 'Not Threatened' tomtit within the wider Kings Quarry Landholdings, the value of the site for birds is considered to be **moderate.**

4.3.5 Bats

4.3.5.1 Desktop Assessment

Department of Conservation bat records were accessed within the vicinity of the Site (Figure 22). The closest record was for a long-tailed bat (*Chalinolobus tuberculatus*; LTB), immediately outside of the southern boundary of the Kings Quarry Landholdings. Multiple other local LTB records are present in the local landscape, including:

- A record 1 km north of the project area;
- Two records approximately 2.8 km west of the Project area;
- Two records approximately 2.8 km north-west of the Project area;
- A record approximately 4 km east of the Project area;
- Two records approximately 5.5 km south-west of the Project area;

The closest records of short-tailed bats (*Mystacina tuberculata*; STBs) are on Hauturu/Little Barrier Island, 64 km from the Project area, and within the Coromandel Ranges, over 100 km away.

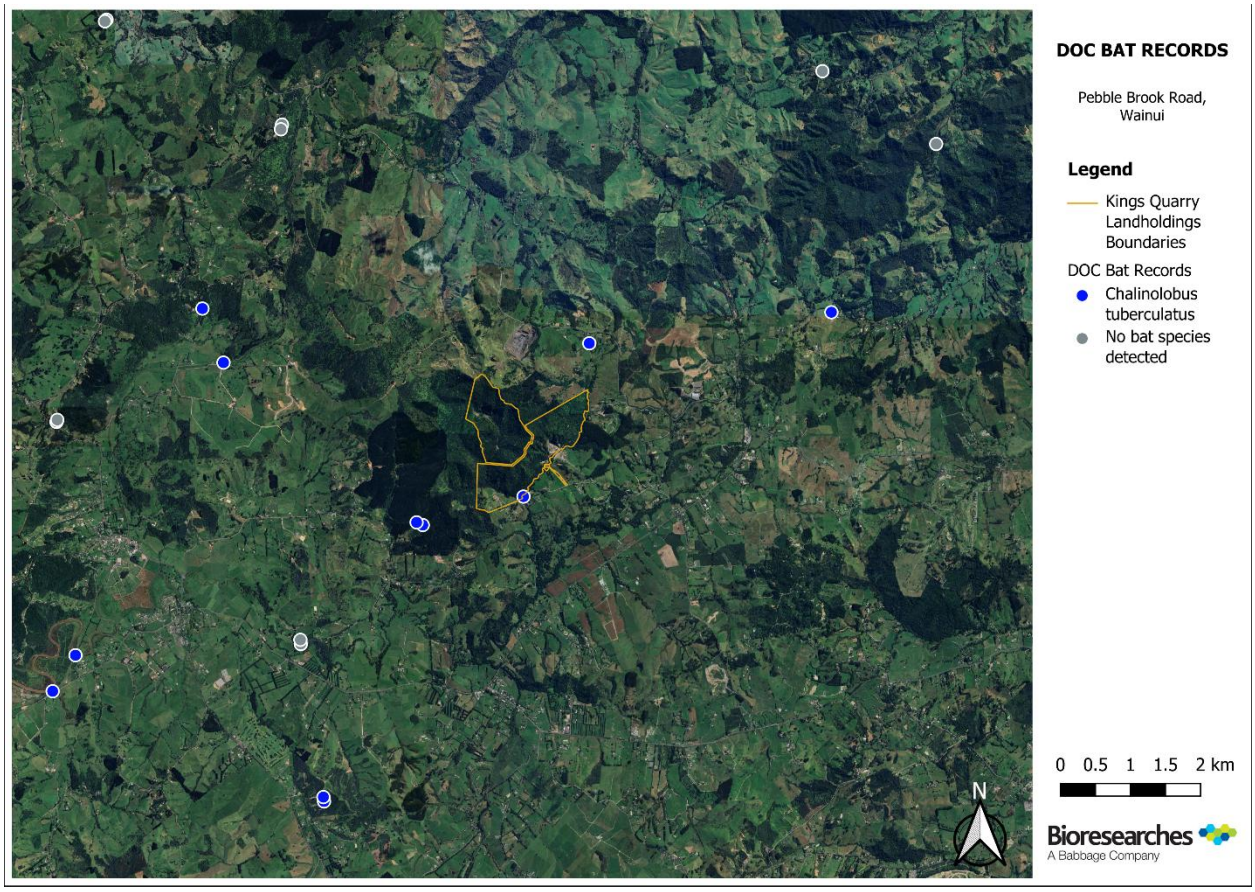

Figure 22. Bat records within the vicinity of the Site

4.3.5.2 Site investigations

4.3.5.2.1 ABM survey results

Of the four surveys (undertaken in spring 2020, summer 2022-23, spring 2023, and summer 2024) bats were detected in three of the surveys (spring 2020, summer 2022-23 and summer 2024) (Table 8, Figure 23). However, detections occurred at very low levels. Detections were recorded even if they occurred on nights not considered 'valid' due to weather conditions, however, nights with unsuitable conditions were excluded from the total number of survey nights.

During the 2020 spring survey, eight nights were excluded due to unsuitable weather. During the three-month survey undertaken in the 2022- 2023 summer, weather conditions were generally suitable for bat surveying (no nights with temperatures below 10 °C, however, twelve days with more than 2.5 mm of precipitation in the first 2 hours after official sunset were excluded). During the spring 2023 survey, twelve nights were also removed due to < 10 °C temperatures, but no nights were removed due to rainfall.

Across the four surveys, a total of 1704 valid survey nights recorded a total of 302 passes, including eight 'possible' passes. Of the 302 passes, most of these (187) were recorded from a single recorder, approximately 600 m to the west of Stage 2 (outside the quarry footprint) in an area near large podocarp trees that support roost characteristics. This activity included 30 nights with bat activity, including 16 passes within 1 hour of sunrise.

Table 11. Overview of bat survey results (PRT = potential roost tree)

Survey	ABM	Location type	Survey timeframe	Valid survey nights	Number of bat passes	Nights with passes
Spring 2020	2020 A	Large PRT	17 November to 7 December 2020	13	0	-
	2020 B	Flyway	17 November to 24 November 2020	4	0	-
	2020 C	Large PRT	17 November to 11 December 2020	17	0	-
	2020 D	Flyway- track edge	17 November to 11 December 2020	17	1 possible	1
	2020 E	Near PRT	17 November to 28 November 2020	7	0	-
	2020 F	Flyway	17 November to 11 December 2020	17	1 confirmed and 2 possible	1
Summer 2022-2023	2022 A	Near PRT	16 December 2022 to 17 March 2023	80	5	
	2022 B	Fly way-near riparian	16 December 2022 to 17 March 2023	80	6	
	2022 C	Flyway- track edge	16 December 2022 to 17 March 2023	80	2	
	2022 D	Large PRT	16 December 2022 to 17 March 2023	80	0	-
Spring 2023	2023 A	Flyway- open area	Did not record – device malfunction	0	N/A	-
	2023 B	Large PRT, riparian	03 October to 19 October 2023	5	0	-
	2023 C	Fly way-near riparian	03 October to 19 October 2023	5	0	-
	2023 E	Flyway- track edge	03 October to 19 October 2023	5	0	-
	2023 F	Large PRT	03 October to 19 October 2023	5	0	-
Summer 2024	2025 5	Large PRTs- west of Stage 2	31 December 2024 to 02 February 2025	49	187 confirmed and 2 possible	30
	2025 307	PRT / Previous survey site	31 December 2024 to 18 February 2025	49	0	-
	2025 308	Flyway	01 January 2025 to 18 February 2025	49	0	-
	2025 311	PRT	31 December 2024 to 18 February 2025	49	0	-
	2025 312	PRT	31 December 2024 to 18 February 2025	49	0	-
	2025 313	PRT	31 December 2024 to 18 February 2025	49	0	-
	2025 318	Flyway / near previous site	31 December 2024 to 18 February 2025	49	1 confirmed	1
	2025 321	PRT	31 December 2024 to 18 February 2025	49	0	-
	2025 322	PRT	31 December 2024 to 18 February 2025	49	2 confirmed	2
	2025 325	PRT / Northwest of Stage 2 in older growth	01 January 2025 to 18 February 2025	49	6 confirmed	4
	2025 327	PRT	31 December 2024 to 18 February 2025	49	1 confirmed	1
	2025 329	PRT	31 December 2024 to 18 February 2025	49	0	-
	2025 330	PRT	31 December 2024 to 18 February 2025	49	0	--
	2025 331	PRT / Northwest of Stage 2 in older growth	31 December 2024 to 18 February 2025	49	0	
	2025 333	PRT	01 January 2024 to 18 February 2025	49	0	-
	2025 334	PRT / Northwest of Stage 2 in older growth	31 December 2024 to 18 February 2025	49	2 confirmed	2

	2025 13	Flyway / near previous site	31 December 2024 to 03 February 2025	34	0	
	2025 302	PRT	31 December 2024 to 07 March 2025	66	15 confirmed	1
	2025 303	PRT / Northwest of Stage 2 in older growth	04 January 2024 to 07 March 2025	66	21 confirmed	7
	2025 305	PRT	31 December 2024 to 07 March 2025	66	2 confirmed	2
	2025 309	PRT / South of Stage 2- riparian vegetation	31 December 2024 to 07 March 2025	66	4 confirmed	4
	2025 315	PRT	31 December 2024 to 07 March 2025	66	0	-
	2025 319	PRT	31 December 2024 to 07 March 2025	66	0	-
	2025 328	Flyway / near previous site	31 December 2024 to 04 March 2024	66	3 confirmed	2

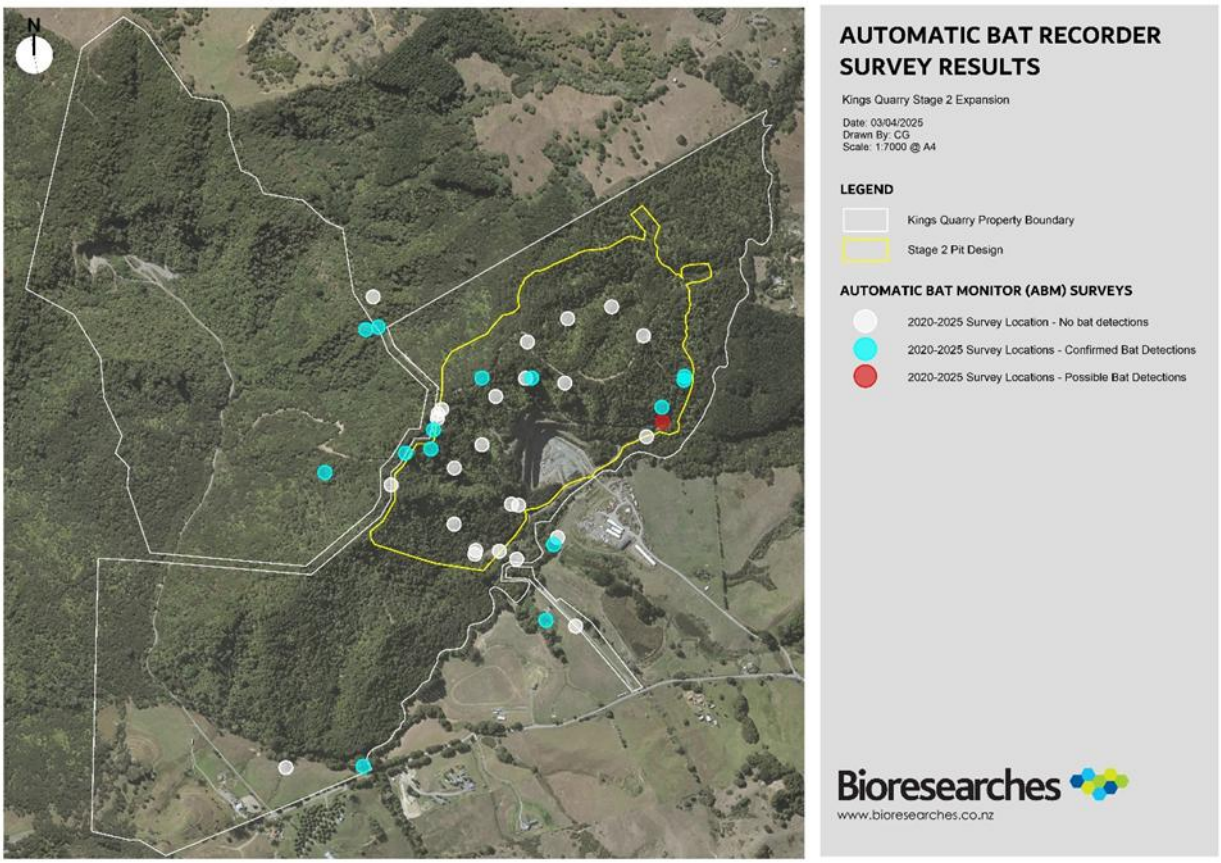

Figure 23. ABM survey locations and results.

One pass was detected with a social call and/or feeding buzz across the four surveys, which occurred during the 2024 survey and exhibited both behaviours. Information on the timing of bat passes relative to sunrise and sunset was analysed, for the 2022, 2023 and 2025 surveys; however, was not able to be analysed for the 2020 survey due to a data loss. In total, 40 passes were recorded within one hour of sunrise or sunset: one pass at 2022 C (within Stage 2), 31 minutes after sunset; and 39 passes at 2025 5 (outside the Stage 2 area), all within one hour of sunrise.

4.3.5.2.2 Potential Roost tree Risk Assessment

While vegetation throughout the Kings Quarry Project area represents a predominantly seral community consisting of mostly of regenerating kānuka, māhoe and ponga that are generally less than 15 cm dbh (as per DOC, 2024 - but acknowledging that bats may roost in a variety of other features within young vegetation, such as within hollow tree ferns or frond skirts), the Project area does support some larger trees throughout that are suitable for roosting habitat, and (more importantly) communal roosting – such as maternal roosts, which provide safer and more stable thermal environments than smaller trees, and are particularly important for females and pups to ensure maintenance and growth of a bat population. These trees are represented by emergent pines or occasional large, often multi-stemmed tōtara, and support cavities, hollows, splits, cracks, knot holes and large bark peels (e.g. Photo 7).

The 2025 bat survey targeted a sample of 20 of these trees within and around Project where recorders achieved 34-66 valid survey nights each, and during the bat breeding season (January – February inclusive). One location (Monitor 5) was considered to be within close proximity to / at a potential roost tree during the survey. This monitor identified multiple passes within 1 hour of sunrise / sunset and additionally recorded by far the most passes during the survey (208, including 39 within 1 hour of sunrise). This monitor was located approximately 600 m to the west of (beyond) the Project area where there are several multi-stemmed tōtara and large pine trees.

Of the other 19 recorders that were positioned at high-risk potential roost trees in 2024-2025, none recorded activity within an hour of sunrise or sunset during the survey- therefore it is considered that the possible roost behaviour observed from monitor 5 was not associated with the vegetation with Project during the survey period. While the 2025 survey cannot rule out that large trees within Project may support potential communal roosting previously or in the future, the overall pattern of consistently low activity recorded within the Project area over the 2020, 2022, 2023 and 2025 surveys indicates that the Project area is unlikely to represent a significant communal roost resource to bats.

Figure 12 identifies 24 acoustic recorder locations, of which 19 site-wide locations are associated with such high risk trees.

Photo 7a, b, and c. Left: Some multi-stemmed tōtara supported small cavities or hollow limbs. Middle: Emergent pines within the Project area are highly likely to support typical roost characteristics; Right: a large pine trunk showing signs of cavity –formation near the base.

4.3.5.2.3 Habitat assessment

Short-tailed bats , New Zealand's other extant bat species, are associated with extensive areas of old-growth native forest (Lloyd, 2001) and are only recorded on Little Barrier Island within the Auckland region. Due to the lack of nearby historical detections, absence of suitable habitat at Kings Quarry, and absence in ABM surveys, we consider this species highly unlikely to be present, even on an intermittent basis. This species is not considered further for the purpose of this assessment.

Long-tailed bats typically use linear landscape features such as bush edges, gullies, and water courses to transit between roosting and feeding sites (Borkin and Parsons 2009; Griffiths 1996). They also tend to forage in open areas, including clearings (Borkin and Parsons 2009; Griffiths 1996), along forest edges (Alexander 2001; O'Donnell & Sedgeley 1994), over wetlands, open water, and along rivers (Borkin and Parsons 2009; Griffiths 1996). Long tailed bats may travel tens of kilometres each night between roosting and foraging areas (O'Donnell, 2001).

Bats are dependent on roosting cavities with specific micro-climates, which are typically rare in landscapes. They require large trees (including exotic and standing dead trees) with cavities (e.g., knot holes, hollows), and from summer, communal roosts are dominated by females and young. However, individual bats may still refuge beneath other suitable features such as within epiphytes, loose bark, hollow tree ferns, or under dense tree fern skirts.

4.3.5.3 Ecological value

While long-tailed bat activity has been recorded across the Project area, such activity has been consistently low across multiple years (Table 11). Activity has generally been sporadic and has not occurred with any frequency. Only one social calls and feeding buzz has been detected in the ABM data.

Generally, potential roosting habitat for bats is considered to be present within the site, such as emergent pines and a few multi-stemmed totara (Photo 7). However, these trees represent occasional features within a mostly pioneer ecosystem, including the area identified as WF11- which is characterised by pole tanekaha and totara. None of the activity recorded has indicated any probability that the larger trees were used for roosting during surveys (e.g. activity around dawn or dusk), and not for communal-type roosting (multiple bat passes at dawn or dusk). Overall, the potential roosting habitat for bats is limited in quality in comparison to what would be expected within mature forest, and the Stage 2 area of Kings Quarry is not considered to provide important (communal / maternal) roosting habitat.

In accordance with the EIANZ Guidelines, any species with a 'Threatened' conservation status is considered to have a 'Very High' ecological value. Given the detection of long-tailed bats within the site, but also considering the low number of passes recorded during the survey and the limited number of potentially suitable roost trees within the site, the Project area is considered to have a **High** ecological value for bats.

4.4 Freshwater Ecology

Thirteen streams were identified within the Project area during the site investigations. No wetlands were identified (Figure 24).

Stream morphologies throughout the Project area are similar between each stream, largely consisting of small (on average 0.25m to 0.55 m wide and shallow) flow paths with a mix of hard substrates and clay, often forming trickle flow between pools as the streams cascaded down the steep gullies. Within the Waitoki Stream, a concrete weir is present separating the three “systems” and acts as a complete barrier to fish passage.

The results of the detailed stream assessments and site characteristics are provided in Section 4.4.1. Water quality results are then detailed in Section 4.4.2, and results of the macroinvertebrate sampling and freshwater fish records are presented in Sections 4.4.3 and 4.4.4. Finally, Section 4.4.5 summarises the identification and tests applied to potential natural wetlands within the Project area.

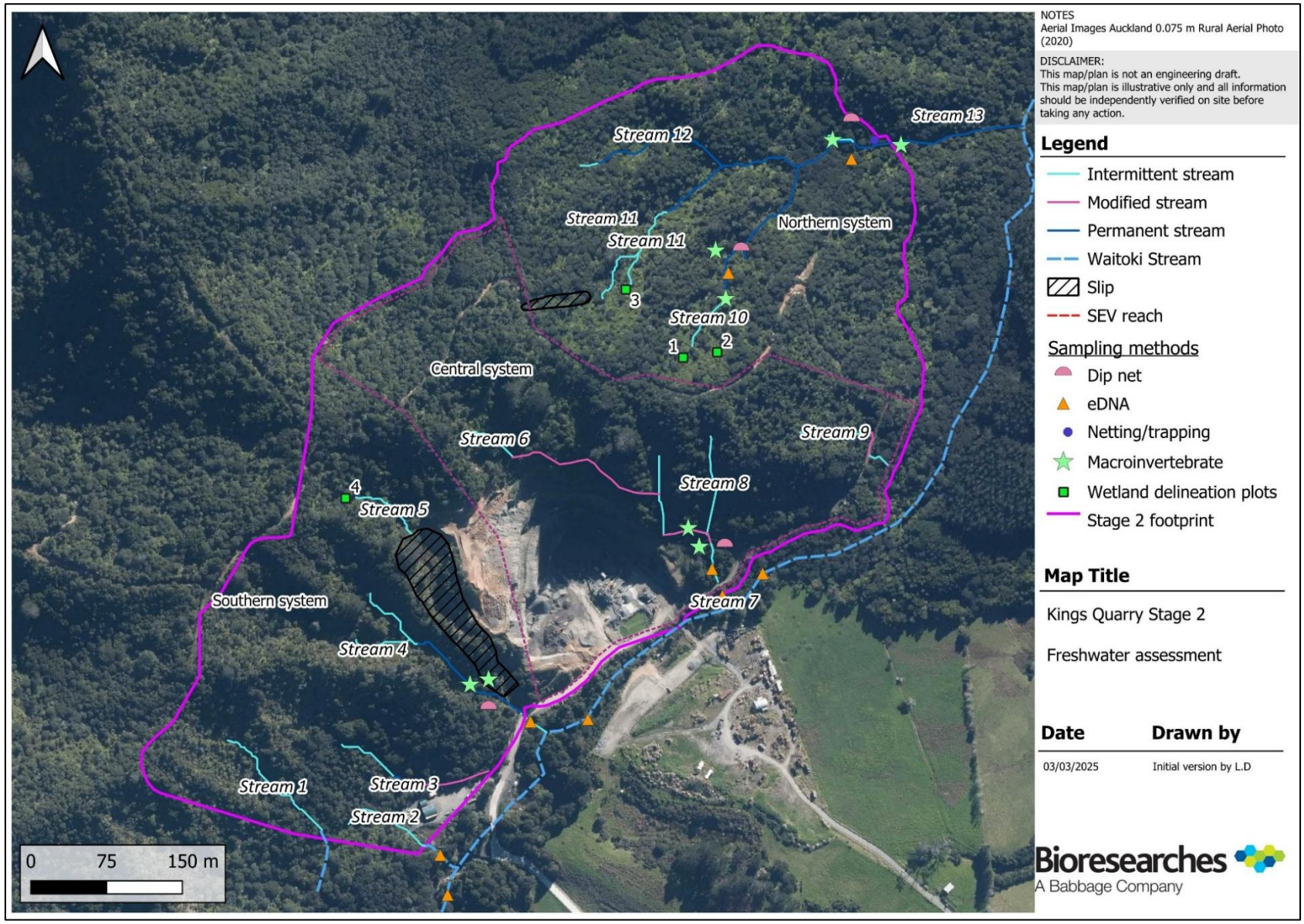

Figure 24. Freshwater habitats identified within the project area

4.4.1 Physical habitats

4.4.1.1 Southern System –Streams 1 – 5

The Southern System is located on the Southern side of the existing quarry footprint. Streams located within the Southern System drain in a north-west to south-east direction and flow into the Waitoki Stream, west of the existing quarry footprint. Five intermittent streams (Stream 1 – 5) varying in length from 78 m to 180 m were present in the Southern System. The Southern System streams were small, on average 0.22 to 0.64 m wide and shallow, often forming shallow runs within incised channels.

Stream 3 and Stream 4 supported sections of permanent flow, while Stream 1, Stream 2 and Stream 5 supported intermittent flow; 162 m of permanent stream and 636 m of intermittent stream are present within the Southern System. Whist Stream 3 and Stream 4 support permanent water, this was very shallow (<0.05 m) during the dryer, summer months.

Deposited slip material was present in the upper reaches of Stream 1 and Stream 2; however, a flow path is still present (Photo 8, Photo 9). Stream 5 has been heavily impacted by the Auckland Anniversary flooding, with approximately 200 m of stream length destroyed through slips (Photo 11). The remaining stream length, located above the slip is approximately 78 m in length.

SEV2 is representative of streams present within the Southern Catchment (Photo 13). Basic stream characteristics within Stream 4 were undertaken, and was chosen as representative of the Southern System. Whilst Stream 4 and Stream 3 are permanent, and the remaining Southern System Streams intermittent, the incredibly shallow depth (0.05 m) limits the provision of permanent aquatic habitat. A large sheet-flow waterfall is present in Stream 4 (Photo 10), however similar habitat is absent from the remaining Southern System Streams.

Photo 8. Stream 1 intermittent flow path

Photo 9. Stream 2

Photo 10. Rock face within Stream 4.

Photo 11. Significant slip destroying 200 m of Stream 5.

The Southern streams formed incised flow paths within the base of steep gullies with Stream 4 ranging between 0.52 m to 0.86 m wide (average 0.64 m) with an average water depth of 0.05 m (between 0.01 to 0.11) and occasional pools of 0.2 m depth. The substrate was dominated by gravels and bedrock providing good macroinvertebrate habitat, however fine sediments were present throughout the streams. Water flow was good with a low variation in hydrology with shallow channels forming steep run to pool sequence. Undercuts were present throughout Stream 4, between 0.23 to 0.35 m.

Extensive (>20 m) native riparian vegetation was present throughout the Southern System, which provided high shading, filtration and bank stability. The upstream catchment is predominately forested, providing high water quality control. The riparian vegetation observed included parataniwha, nīkau, kānuka, māhoe and ponga. Bare ground was common, and often covered with a dense layer of leaf litter and woody debris.

Aquatic habitat throughout Stream 4 and the Southern System was considered to be of low abundance and quality. Habitats present throughout consist of woody debris, shallow pools and occasional undercut banks. The depth and gradient of the streams would restrict the accessibility to freshwater fish to the upper reaches to juvenile climbing species. Bank scouring at the base of Stream 2 would limit fish passage due to the concaved stream bed (Photo 15).

Despite the modified nature, the stream provides good quality habitat for macroinvertebrate species with cobble substrate, overhanging vegetation and woody debris present, however interstitial space is reduced due to silts in-filling spaces. Fish habitat was largely limited to small pools, due to the shallow water present within runs and riffle sections. However, complete fish barriers were present in the form of perched culverts and subterranean reaches throughout the Central System.

Photo 12. Stream 3

Photo 13. Lower reach of Stream 4

Photo 14. Example of indigenous riparian yard throughout the Southern System.

Photo 15. Bank scouring where Stream 2 falls into the pool

The representative SEV scores for the Southern System were Stream 10, however macroinvertebrate communities taken from Stream 4 were used. The SEV for the Southern System was 0.84 and would score high for the highly forested catchment providing good riparian yard functions, however aquatic habitat provisions are limited. The streams within the Southern System (Stream 1 - 5) were considered to be of **High** ecological value due. The streams are very shallow with low hydrological diversity restricting aquatic habitat to occasional scour pools. The streams are highly forested with native vegetation throughout, however severe weather impacts are apparent throughout this stream system.

Table 12. Ecological values of the Southern System

Matter	Score and justification
Representativeness	**Moderate** Small intermittent headwater streams which have been impacted by slips and deposited sediments. Water flow slow on average and shallow in depth with no variation in water flow types limiting aquatic habitats.
Rarity/distinctiveness	**High**

	No fish species detection, with kōura present in Stream 4. May provide temporary habitat for At -Risk species, such as long fin eel, however the overtly shallow nature of the streams would restrict size class residing within the reaches. Invertebrate communities within Stream 4 dominated by amphipod and mayfly with MCI scores reflecting 'Good" (MCI = 102) habitat quality with high (46%) proportion of EPT taxa. Stream bed soft with a good proportion of gravels however a high loading of fine sediments.
Diversity and pattern	**Moderate** Low habitat variability and low pattern of present due to shallow flows into pools. Riparian vegetation provides very good shading functions to the streams with a diverse range of indigenous vegetation. Streams impacted by slips, with deposited sediment altering flow regime and pattern, limiting presence of aquatic habitat, however bank diversity and variation in substrates good.
Ecological context	**High** Small, first to second order intermittent and permanent headwater streams with shallow flow. Stream channel natural with some hard substrates with impacts due to natural events (i.e. slips). SEV scores 0.84 with largely unmodified habitat and indigenous riparian vegetation. Good and dense forest with canopy, sub-canopy and ground-cover complex and providing good riparian yard functions.
Ecological Value	**High**

4.4.1.2 Central System – Intermittent Streams 6- Stream 9

The Central System is located on the immediately northern border of the existing quarry footprint. Streams located within the Central System drain in a west to east direction and flow into the Waitoki Stream, north-east of the existing quarry footprint. Four intermittent streams (Stream 6 – 9) varying in length from 53 m to 216 m were present and on average small and narrow, 0.27 to 0.47 m wide forming shallow runs within incised channels.

All watercourses within the Central system were intermittent as the streams contained defined banks, lacked rooted terrestrial vegetation and showed evidence of substrate sorting process and, with the exception of Stream 9, contained surface water resulting in flow (Photo 16 to Photo 19). Surface water was present within Stream 9; however, this was extremely shallow (>0.01 m) and subterranean flows observed along this reach. Stream 7 was used as the representative stream of the Central System.

Photo 16. Unmodified reach of Stream 6

Photo 17. Unmodified reach of Stream 7

Photo 18. Unmodified reach of Stream 8

Photo 19. Unmodified reach of Stream 9.

Historically, the central system streams would have flowed through the quarry footprint prior to its establishment, however Stream 6 – 9 have been modified through the creation of the existing pit and associated access, diverting streams to create flow paths which run along the haul roads/quarry banks before flowing back under dense bush (Photo 20 to Photo 23). Within the Central System, 238 m of stream length has been diverted into the roadside drains, representing 38% of this system.

Photo 20. Modified reach of Stream 6

Photo 21. Modified Reach of Stream 7

Photo 22. Stream 8 flowing into modified Stream 7

Photo 23. Scour channel in road due to Stream 9. Note modified stream not flowing at time of assessment.

4.4.1.3 Central System – Representative Intermittent Stream 7 - SEV3

As the Central System streams have been subject to historic modification through diversion, the diverted channel of Stream 7 was incorporated into the representative SEV reach.

Stream 7 was 168 m in length, flowing in a north to south direction, with approximately 50 m of stream length, with diverted to flow to the east before re-entering a natural flow path. Stream 7 was variable in width, ranging between 0.29 m to 0.98 m (average width 0.47m), with an average water depth of 0.04 m, ranging between 0.01 m to 0.17 m (Photo 24). Within the downstream reach, the banks were severely incised and eroded, with bank height >2 m for large sections of the reach (Photo 25). The dominant substrate throughout Stream 7 was gravels and clay bed rock, with a high proportion of large cobbles and boulders present throughout the downstream reach. This variation in substrates results in high hydrologic heterogeneity with runs, small pools, and chutes present, with a sheet flow waterfall present.

Photo 24. Lower reach of Stream 7

Photo 25. Scoured banks within Stream 7

Within the upper reaches of Stream 7, the 20 m riparian yard was well vegetated contained native vegetation such as nīkau, ponga, tanekaha, māhoe, tōtara, kānuka and dense leaflitter ground cover (Photo 26). The lower reach contained approximately 15 m to 20 m of riparian planting, predominantly native, with the outer edges containing some exotic vegetation. The riparian yard and topography provided high shading, filtration and bank stability functions with the upstream catchment entirely forested, providing high water quality control. Within the modified reaches, the true left bank was well vegetated with native vegetation, with the true right bank predominantly bare, with due to the roading with some long grasses (Photo 27). The topography of the Project Area provides high year-round shading to the modified reaches.

Photo 26. Riparian was well vegetated

Photo 27. The modified reach lacked riparian vegetation on the true right bank.

Despite the modified nature, Stream 7 provides good quality habitat for macroinvertebrate species with cobble substrate, overhanging vegetation and woody debris present, however interstitial space is reduced due to silts in-filling spaces (Photo 28). Fish habitat was largely limited to small pools, due to the shallow water present within runs and riffle sections. Complete fish barriers were present in the form of perched culverts and subterranean reaches throughout the Central System (Photo 29).

Photo 28. Macroinvertebrate habitat

Photo 29. Perched culvert (red circle)

The SEV score for Stream 7, representative of the Central System, was 0.47. The SEV scored highest for biogeochemical functions, and lowest in biodiversity, likely due to the poor macroinvertebrate community and riparian vegetation intactness. The intermittent streams within the Central System (Stream 10 - 12) were considered to be of **Low** ecological value due to the highly modified nature of portions of the reach, low abundance of macroinvertebrates and fish barriers and shallow depth providing no viable aquatic habitat.

Table 13. Ecological values of the Central System.

Matter	Score and justification
Representativeness	**Low** Small, intermittent reaches which are very shallow on average, however downstream reach of Stream 7 providing good habitats. The perched culvert, lack of road crossing and shallow reaches have severely reduced ecological connectivity in regards to freshwater fauna species. Large extents of the central stream have been subject to historic modification through channelisation and diversion, making up a third of cumulative stream length.
Rarity/distinctiveness	**Low** No fish or large macroinvertebrates recorded through the stream reaches. Macroinvertebrate community indicative of 'Poor' to 'Good' habitat quality, with the sample dominated by tolerant chironomids and low representation (17%) of EPT taxa. Good proportion of gravels and cobbles overlaying soft stream beds. Riparian dominated by native vegetation, however impacted reaches lacking vegetation on true right bank.
Diversity and pattern	**Low** Overall low diversity of aquatic habitat, restricted due to the shallow depth of the streams, and modification, with 43% of the Central System diverted into these roadside drainage channels. Bank form low in diversity and variation with severe erosion and undercuts. Perched culverts and modifications reduce the overall connectivity and quality of aquatic habitats, reflected in the macroinvertebrate community.
Ecological context	**Low** First order intermittent streams with perched culvert on Stream 7 and road scouring in Stream 9 significantly limiting connectivity to the wider catchment and creating a complete barrier for fish passage. SEV scores 0.66, reflecting the proportion of natural (62%) and highly modified (38%) stream character. Good proportion of forested riparian vegetation with native vegetation, with the exception of the modified reaches
Ecological Value	**Low**

4.4.1.4 Northern System – Stream 10-Stream 13

Northern System streams are located to the east of the existing quarry footprint and flow in a west to east direction and flow into the Waitoki Stream, north-east of the existing quarry, upstream of the current Stage 1 area. Three streams (Stream 10 – 12) varying in length from 127 m to 245 m were present in the Southern System. The Southern System streams were small, on average 0.37 to 0.40 m wide and shallow, forming shallow runs within incised channels. Within the Northern system, 324 m of intermittent stream and 596 m of permanent stream is present

SEV2 is representative of streams present within the Northern Catchment (Photo 13).

4.4.1.5 Northern System – Representative Stream 10 - SEV2

Stream 10 was present within the Northern System with a small (15 m) tributary, flowing in a west to east direction for 245 m before joining into Stream 13. Stream 10 was representative of Stream 11 and 12 and thus utilised as the Northern System representative SEV reach.

Stream 10 was generally narrow in width, averaging 0.37 m (0.22 m to 0.81 m) with the flow path consisting of shallow (0.01 m to 0.05 m) runs dropping into pools (0.09 to 0.18 m) (Photo 30). The upper 56 m of Stream 10 was intermittent .Hydrological heterogeneity was low throughout Stream 10, with the stream reach consisting of a shallow run to pool sequence. No riffles, waterfalls or chutes were observed

throughout the reach. The dominant substrate throughout consisted of soft sediments with occasional gravels and woody debris, however high sediment loading was not present (Photo 31).

Photo 30. Stream 10 was narrow and shallow.

Photo 31. Soft substrates dominated Stream 10 and the eastern streams with some gravel substrates.

The upstream catchment is predominantly forested with the extensive (>20m) native riparian vegetation which providing high shading, filtration and bank stability. The riparian zone consisted of dense native vegetation including lancewood tōtara, tātarāmoa, putaputawētā, kānuka, and ponga with a thick layer of leaf litter and ground cover of juvenile nīkau, sparse forest sedge (*Carex dissita*) (Photo 32). The vegetation present provides a high level of shade to the stream, which is reflected in the *in situ* water quality measures.

Aquatic habitat throughout Stream 10 – Stream 12 is narrow, steep, and shallow runs and occasional pools and undercuts providing the only viable fish habitat (Photo 33). Occasional woody debris and gravel substrates provides some habitat for macroinvertebrates; however, the depth and gradient of the streams would restrict the accessibility to freshwater fish to the upper reaches.

Photo 32. Tree ferns dominated the riparian yard at Stream 10.

Photo 33. Deep pool providing the only sufficient aquatic habitat.

The SEV scores of Stream 10 and the northern system were high, 0.84. The SEV scored highest in biogeochemical functions due to the highly forested riparian yard and associated functions, and scored lowest for habitat provision, reflecting the minor intermittent nature of the streams and lack native fish

habitat quality and spawning. The intermittent streams within the Northern System (Stream 10 - 12) were considered to be of **High** ecological value due to the shallow depth providing no viable aquatic habitat with a low diversity in water flow, however the streams are highly forested with native planting throughout.

Table 14. Ecological Values of the Northern System

Matter	Score and justification
Representativeness	**Moderate** Shallow intermittent headwater streams with permanent lower reaches. Natural channel flow paths and good forested riparian vegetation throughout the length of the streams. Substrates naturally soft but good proportion of gravels with heavy loading of leaf litter and woody debris. Flow good in relation to stream sizes and unmodified channel.
Rarity/distinctiveness	**Moderate** Fish communities present include longfin eel, an 'At Risk' indigenous species, however shallow depth would limit the permanency and age of those species. Macroinvertebrate community indicative of 'Excellent' to 'Good' habitat quality, with the sample dominated by amphipod and chironomid with low proportion (22%) of EPT taxa. Good proportion of gravels and cobbles overlaying soft stream beds. Riparian dominated by native vegetation
Diversity and pattern	**High** Low diversity of in-stream habitat and due to shallow depth, however natural and unmodified channel. Natural stream banks and bed with proportion of hard and soft substrates. Low variety in water flows due to depth, with streams predominantly formed by trickle runs to pools. SEV scores 0.70.
Ecological context	**High** Small, first order intermittent headwater streams which transition to permanent streams with good forest riparian vegetation providing high shade, filtration and bank stability. Stream would frequently contain low water depth to support aquatic life. SEV scores 0.84, reflecting natural, forested catchment.
Ecological Value	**High**

4.4.1.6 Permanent Stream 13 – SEV1

Stream 13 is the northern most stream within the Kings Quarry Stage 2 ZOI, and was considered to be of high ecological value. There was a continuous depth and presence of water and large catchment size (9.2 ha). Stream 13 was classified as a permanent stream, and flows in a west to east direction for 284 m before forming a confluence with the Waitoki Stream. Stream 13 has been assessed independently of Streams 1 – 12 due to its larger catchment size, high stream order and different natural character to the streams within the Project Area.

The stream varied in width from 0.67 m to 1.16 m (averaging 0.93 m), with an average water depth of 0.11 m, ranging between 0.01 m to 0.61 m, excluding deep pools (Photo 34). Incised banks and undercut banks (approximately 0.3 m) were present throughout the reach, with several sections of bank collapse. Water flow was good throughout the reach with pools, runs, riffles, chutes and minor drops/waterfalls present (Photo 35). Stream 13 was dominated by hard substrates with gravels and small cobbles present, with some silt/sand substrates, woody debris providing macroinvertebrate and fish habitat (Photo 36). There was a high degree of aquatic habitat diversity and abundance with stable substrates, woody debris, riffles, pools, undercut banks and small waterfalls present throughout the length of the stream (Photo 37).

Photo 34. Stream 13 was wide and variable in depth.

Photo 35. Water flow was good with a high variation in hydrology

Photo 36. Stream 13 was hard bottomed but subject to fine sediment loading.

Photo 37. Deep pool with undercuts providing good aquatic habitat.

The riparian vegetation throughout Stream 13 was dense and extensive, over 20 m in width on both banks. Shade was high throughout the reach, provided by the topography and dense vegetation, including whekī and ponga, pate with kānuka (Photo 38). Ground cover included juvenile nīkau with a thick layer of leaf litter providing a high degree of filtration (Photo 39). Bank stability has been compromised due to the severe weather events causing incised and eroded banks which were gradually collapsing in areas at the time of assessment.

Photo 38. Indigenous riparian yard providing good shade to the stream

Photo 39. Good proportion of leaf litter providing filtration function

The SEV score for Stream 13 was 0.78. The SEV scored well in biogeochemical and hydraulic functions, due to the well forested riparian yard and range of flows, and scored poorly for biodiversity, likely due to the lack of fish observed. Stream 13 was considered to be of **Very High** ecological value due to the permanent presence of a variety of aquatic habitats that would be suitable for a range of aquatic fauna. The stream supports 'Excellent' habitat quality with well shaded and forest riparian yard with no direct anthropogenic impacts (i.e. farming, quarrying, etc) present.

Table 15. Ecological Values of the Stream 13

Matter	Score and justification
Representativeness	**High** Deep and wide permanent stream with natural channel and good forested riparian vegetation. Good flow and aquatic habitat, however recent bank erosion and incision resulting in loading of fine sediments.
Rarity/distinctiveness	**High** Two native fish communities detected, one being 'At Risk' with adult and juvenile kōura also present. Stream would provide habitat for a range of indigenous species; however lower catchment barriers restrict this. Macroinvertebrate community indicative of 'Excellent' habitat quality, with the sample dominated by mayflies with high (92%) proportion of EPT. Good proportion of gravels and cobbles, rare in the Auckland Region. Riparian dominated by native vegetation Substrates naturally soft but good proportion of gravels with heavy loading of leaf litter and woody debris.
Diversity and pattern	**High** Good diversity of in-stream habitat present year-round, including pools, runs, riffles, chutes and minor drops/waterfalls. Natural stream banks and bed however some degree of erosion, with sediments altering some flow patterns.
Ecological context	**High** Second order permanent stream creating an upper tributary of the Waitoki Stream. Stream contains high forested riparian vegetation providing high shading and filtration
Ecological Value	**Very High**

4.4.2 Water Quality

Spot water quality samples were collected to provide basic water quality measurements, one at each representative SEV: Stream 4, Stream 7, Stream 10 and Stream 13. The water temperatures ranged between 11.5°C to 13.2 °C, all within the temperature ranges suitable for indigenous aquatic life and 'Excellent' (Biggs *et al*., 2001). Oxygen saturation and concentration was high, measuring between 89% - 93% and 9.3 mg/L to 10.0 mg/L. Conductivity levels were low showing minimal signs of nutrient enrichment from the catchment, between 54.3 µS/cm to 140.7 µS/cm. The water quality measures are within the range that would cause stress to aquatic organisms and considered to be 'Excellent' to 'Good' habitat quality (Biggs *et al*., 2001; Davies-Colley *et al*., 2013).

4.4.3 Freshwater Macroinvertebrates

Macroinvertebrates were sampled in Stream 4, Stream 7, Stream 10 and Stream 13. Full results of this sampling is presented in Appendix K. Macroinvertebrate diversity, as represented by the number of taxa present, was highly variable, with the highest number of taxa recorded in Stream 13 (16 taxa), and the lowest in Stream 7 (8 taxa). The caddisfly *Polyplectropus puerilis*, was observed at each site, albeit at low abundances.

Stream 4 (representative of the Southern System) was dominated by amphipod (*Paraleptamphopus subterraneus*) and mayfly (*Zelphlebia* spp.), representing 50.4% and 41.2% of the macroinvertebrate community respectively. Stream 4 contains five EPT taxa, comprising 46% of the community sample, of which two taxa were considered to be sensitive (individual MCI ≥8). The MCI score was 107, rated 'Good' and a SQMCI of 6.00 rated 'Good', reflecting the relatively unmodified stream reach with clean water.

Stream 7, representative of the Central System streams, was dominated by Chironomid (*Orthcladiinae*), forming 58.7% of the macroinvertebrate community. A low abundance and diversity of macroinvertebrates was present in Stream 7, with only eight taxa recorded, created by 46 individuals. Stream 7 contained three EPT taxa, forming 17 % of the community sample with one taxon considered to be sensitive (individual MCI ≥8). The MCI score for Stream7 was 103, 'Good' with an SQMCI score of 2.93 'Poor', reflecting the modified nature of the Central System and lower habitat quality.

Stream 10, representative of the Northern System, contained a moderate range of taxa, with 11 taxa types recorded. Stream 10 was dominated by amphipod (*Paraleptamphopus subterraneus*), and chironomids (*Chironomus*), representing 30.1% and 28.4% of the macroinvertebrate community. The proportion of EPT taxa within Stream 10 was low, with 22% of the sample formed by a total of four EPT taxa. Of these EPT taxa, three were considered to be sensitive (individual MCI ≥8). The MCI scores 139 showing 'Excellent' habitat quality, with a SQMCI score of 5.78 'Good', and is likely a reflection of the shallow, soft bottomed stream which is relatively unmodified with low impacts.

Within Stream 13, the macroinvertebrate community was dominated by mayflies (*Coloburiscus humeralis* and *Zephlebia* sp), comprising 46.6% and 30.2% of the macroinvertebrate community. Nine EPT taxa were recorded within Stream 13, comprising 92% of the macroinvertebrate community, with five taxa recorded considered to be sensitive. The MCI score and SQMCI for Stream 13 was 139 and 7.62, showing 'excellent' habitat quality.

Overall, the macroinvertebrate communities throughout the Project area are reflective of forested, low-modified streams with the modified and impacted Central System reflecting the decreased habitat quality and water quality within the MCI and SQMCI scores.

4.4.4 Freshwater Fish Communities

Desktop reviews of the Waitoki Stream and surrounding tributaries show a diverse range of indigenous fish to be present within the local area. Records show shortfin eels (*Anguilla australis*), redfin bully (*Gobiomorphus huttoni*), common bully (*Gobiomorphus cotidianus*), smelt (*Retropinna retropinna*), īnanga (*Galaxias maculatus*) and torrentfish (*Cheimarrichthys fosteri*) were all recorded from the lower main stem, while shortfin eels and banded kokopu (*Galaxias fasciatus*) were the only fishes recorded within the tributaries. Of the six species identified only torrent fish are considered threatened, with a conservation status of 'At Risk – Declining' (Dunn et al., 2017).

Within the intermittent tributaries, insufficient water depth and wetted width prevented the setting of fykes and Gee-minnow traps. Hand netting of available fish habitat was undertaken within the intermittent streams (i.e. pools and undercut banks). Within Stream 13, no freshwater fish were captured during the fishing effort, with only two kōura captured. Dip netting within the intermittent streams only achieve the capture of kōura in Stream 4. No freshwater fish, or other large macroinvertebrates were caught during hand netting in the remaining streams.

Within Stream 13, five fyke nets and 10 Gee-minnow traps were set, in accordance with Joy *et al* (2013), and left overnight. Within Stream 13, two longfin eels, two banded kōkopu (Photo 40 & Photo 41) and seven kōura were captured. The longfin eels ranged between 450 mm and 550 mm in size, the banded kōkopu were 100 m m to 250 mm in size, and the koura ranged between 10 mm to 70 mm in size (Photo 42 & Photo 43). Whilst not captured, a large kōura, estimated to be approximately 100 mm was observed within a pool. All species were considered to be in good condition, with no obvious lesions, parasites or disease. The Fish IBI scores for Stream 13 was considered to be 'Very Good' (IBI = 48), considering the distance from sea and altitude of the stream.

Photo 40. Longfin eel captured in Stream 13

Photo 41. Large Banded kōkopu within Stream 13

Photo 42. Adult kōura

Photo 43. Juvenile kōura

eDNA samples were undertaken in nine locations within, and within close proximity to the Project area (Table 16). eDNA analysis show the genetic material of longfin eel (*Anguilla dieffenbachii*) to be present within Stream 10. No other freshwater fish species were detected through eDNA at the remaining sample reaches. Restrictions in the use of eDNA prevent the abundance or age groups being detected, however due to the shallow and narrow flow paths of Stream 10, it is predicted the longfin eel would likely be of juvenile size.

Fish communities within Stream 13 was considered to be of **High** ecological value due to the permanent presence of 'At Risk' species and the permanent recruitment of kōura. As described in Section 4.4.1, the intermittent nature of the stream's shallow depth of the permanent reaches in the warmer summer months limits the permanency of aquatic habitat available, and the size class of species able to reside within those reaches. As such, the fish communities within Stream 1 to Stream 12 was considered to be of **Moderate** ecological value due to the intermittent presence of 'At Risk' juvenile fauna.

Table 16. Sample locations of eDNA within the Kings Quarry Stage 2 Expansion Area

Test ID	Location description	Reference (NZTM)
1	Downstream of the active quarry zone	E1739480 N5947654
2	Just above the confluence of Stream 2 and the Waitoki Stream	E1739472 N5947692
3	Outlet of perched culvert discharging Stream 4 and Stream 5 to Waitoki River	E1739560 N5947829
4	100 m downstream of a weir within Waitoki Stream, presenting a partial barrier to fish passage	E1739619 N5947829
5	Within Stream 7	E1739733 N5947995
6	Additional Stream 7, on immediately outlet of perched culvert draining Stream 7	E1739745 N5947953
7	125 m upstream of the existing weir within the Waitoki Stream	E1739786 N5947974
8	Within Stream 10	E1739749 N5948288
9	Within Stream 13, downstream of its tributaries (Stream 10 – 12)	E1739871 N5948405

A significant barrier to fish passage is present within the Waitoki Stream, with a vertical weir with low wetted margins present. Only climbing capable species would be able navigate the weir to access the upstream reach. This is the likely cause of the absence and low abundances of fish within Stream 13, despite the high abundance and diversity of aquatic habitat.

4.4.5 Natural Inland Wetlands

Four areas of potential natural inland wetland were observed within the Project area (Photo 44 to Photo 47). Vegetation assessments were undertaken to determine the presence of wetlands. Vegetation within these potential wetland areas consisted of forest sedge, (*Carex dissita, Carex solandri*), and hook grass (*Carex uncinata*), with facultative upland and upland seedlings, including tanekaha, nīkau, māhoe, and coprosma's present within the sedge areas. Facultative upland and upland tree stratum surrounding the potential wetland areas included nīkau, whekī, ponga, māhoe and kānuka.

The vegetation plots failed both the Dominance Test and Prevalence Index, and as such did not meet the definition of natural inland wetlands, and no uncertainty was considered to be present within the vegetation delineation plots. No natural inland wetlands were considered to be present throughout the Project area.

Wetland delineation plot data is presented in Appendix L.

Photo 44. Plot 1

Photo 45. Plot 2

Photo 46. Plot 3

Photo 47. Plot 4

4.4.6 Stream Characteristics Summary

Table 17 provides a summary of the characteristics of the northern, southern and central stream systems within the Project area, as well as Stream 13.

Table 17. Summarised characteristics of the streams present within the project area

Characteristic	Southern System	Central System	Northern System	Stream 13
Physical Characteristics				
Total intermittent extent	636 m	398 m	243 m	-
Total permanent extent	162 m	-	698 m	284 m
Total modified extent	70 m	238 m	-	-
Representative Stream	Stream 4	Stream 7	Stream 10	-
Habitat Features				
Average width (m)	0.64	0.47	0.37	0.93
Average depth (m)	0.05	0.04	0.04	0.11
Dominant substrate	Gravels and bedrock	Gravels	Silt/clay	Gravels
Macrophyte abundance	Nil	Nil	Nil	Nil
Riparian vegetation	Mature indigenous vegetation	Regenerating indigenous vegetation, long grasses, exotic shrubs	Mature indigenous forest	Mature indigenous forest
Water Quality				
Date	08/09/2023	08/09/2023	07/09/2023	07/09/2023
Time	13:55	11:25	13:00	
Temperature (°C)	12.1	11.5	13.2	12.6
Oxygen Saturation (%)	89.1	89	89	93
Dissolved Oxygen (mg/L)	9.7	9.8	9.3	10.0
Conductivity (µS/cm)	103.1	54.3	93.6	140.7
Macroinvertebrates				
Sampling protocol	Hard bottomed	Hard bottomed	Soft bottomed	Hard bottomed
No. of taxa	10	8	11	16
Dominant taxon	*Paraleptamphopus subterraneus*	*Orthcladiinae*	*Paraleptamphopus subterraneus*	*Coloburiscus humeralis*
EPT	5	3	4	9
%EPT*	46	17	22	92
MCI	102 ‘Good’	103 ‘Good’	139 ‘Excellent’	139 ‘Excellent’
SQMCI	6.00	2.93	5.78	7.62
Fish				
Species Recorded**	*Kōura*	Nil	Longfin eel	*Kōura* *Longfin eel* *Banded kōkopu*
Number of Fish	-		1	-
Fish IBI score	-	-	30 ‘Fair’	48 ‘Good’
Stream Ecological Valuation				
SEV score	0.83	0.64	0.83	0.78

*Excluding Oxytheptera and Paroxyethira**Italics represent fish caught via nets/traps and/or hand netting

4.4.7 Summary of Freshwater Ecological Values

The ecological value of each of the streams is based on both the SEV score and the four broad matters of representativeness, rarity/distinctiveness, diversity and pattern, and ecological context, presented in Table 12; Table 13; Table 14 and Table 15 and summarised in Table 18

Table 18. Summarised stream ecological values

Stream/system	Ecological Value	SEV Score
Southern system	High	0.83
Central system	Low	0.64
Northern system	High	0.83
Stream 13	Very High	0.78

5 ASSESSMENT OF ECOLOGICAL EFFECTS

This section focuses on assessing project-related effects on terrestrial and freshwater ecological values. The assessment is based on the Ecological Impact Assessment Guidelines produced by the Environment Institute of Australia and New Zealand (EIANZ; Roper-Lindsay *et al.*, 2018) and adapted based on expert opinion.

Using this standard framework and matrix approach to determine ecological value (Step 1), determine magnitude of effect in the absence of management (Step 2), and assign a level of effect of the project on ecological values (Step 3), is good practice and provides a consistent and transparent assessment of effects. Avoidance, remediation, minimising, offsetting, and compensatory measures to address potential effects are explored under Step 3 and following the application of such measures an overall level of effects of the project on ecological values is determined.

5.1 Proposed works

The proposed works will involve completion of bulk earthworks and quarrying activities across the entirety of the Project area. This will result in the permanent, complete loss of all existing freshwater habitat within the Project area boundaries. A total of 28.97 ha of terrestrial habitat will also be removed, however, remediation of these habitats will occur sequentially, in stages, as the project progresses and quarrying and/or filling is completed within the works area.

5.2 Avoidance

Kings Quarry Stage 2 was redesigned at an early stage to avoid older, high value kauri podocarp forest (Regionally Endangered, Singers *et al.*, 2017) to the northwest, and minimise fragmentation by containing the fill within a single compact footprint. Older vegetation that occurs beyond the Project area has higher potential to support potential roost trees for long-tailed bats and birds, and is of a higher value food and habitat resource to birds, invertebrates (including At-Risk *Amborhytida dunniae*) and also the same suite of indigenous lizard species.

Further, earlier design optioneering identified a proposed fill area further north of the current proposal. Preliminary ecological assessments identified that that option would completely bisect SEA_T_6454, and significantly increase fragmentation effects. The current proposal avoids this outcome, although acknowledges that the footprint would retain substantial edge effects if unmanaged.

As the Kings Quarry Landholdings are scattered with many watercourses, avoidance of freshwater habitats was not feasible, however, the pit design avoids permanent watercourses to the greatest extent which was practicable.

5.3 Terrestrial Ecology

5.3.1 Direct Effects

The effects of the project on the terrestrial ecology values at the proposed Kings Quarry pit extension, would include the removal of approximately 28.97 ha of VS2 (19.75 ha); VS5 (8.03 ha) and WF11 (1.19 ha) habitat (and associated fauna habitats), which is of high ecological value. The proportion of vegetation to be lost is assessed at varying local scales in Table 19.

Table 19. Relative percentages of vegetation loss proposed to occur when compared at different local scales

Habitat Type	Amount within Stage 2 Project Footprint (ha)	Percentage of total habitat that the lost habitat represents within the Stage 2 project area	Area of habitat present in SEA_T_6454 (ha)	Percentage of habitat that the lost habitat represents within SEA_T_6454
VS2	19.75	100%	188.7	10.46%
VS5	8.03	100%	48.6	16.52%
WF11	1.19	100%	104.75	1.13%
Total area of VS2, VS5 and WF11 combined	28.97	100%	342	8.47%
Total area of feature, including other habitat types	29	100%-	344	8.42%

Removal of this vegetation and habitat, with no fauna management in place, would likely result in mortality to fauna, including invertebrates, lizards, flightless birds (such as unfledged chicks) and potentially also roosting bats. However, as described above, sequential remediation of vegetation will occur as areas are closed out within the works footprint and consequently, at no stage will the entire project area be devoid of vegetation. This staged approach to restoration is detailed in the Remediation Plans (Barkers, 2025).

Table 20. Staged vegetation clearance and replanting throughout the quarry lifespan

Project year	Area of vegetation cleared (m^2)	Area of new planting (m^2)	Total area disturbed (cleared and replanted areas) (m^2)
1	56,127	1,110	57,237
2	78,865	5,630	84,495
3-4	87,957	5,630	93,587
5	94,025	5630	99,655
6-10	163,000	18,326	181,486
11-15	138,173	55,450	193,623
16-20	147,321	65,218	212,539
21-25	154,802	78,726	233,528
26-30	158,513	91,425	249,938
31-35	138,071	123,688	261,759
36-40	138,545	134,211	272,756
41-45	31,253 (residual rock face area not able to be planted)	246,907	278,259

Unmanaged removal of vegetation has a higher likelihood of direct mortality, injury and / or displacement of native fauna, of which lizards, birds and bats (potential roost trees) are protected (Wildlife Act 1953).

Removal of foraging, roosting and nesting habitat would also result in displacement of fauna into the surrounding environment. Displaced fauna have a lower likelihood of survival where the carrying capacity of adjacent habitats is stressed through increased competition for fewer resources. Displaced animals have a higher probability of risk of predation by both exotic and native predators. For 'At Risk' and 'Threatened' species, this effect can be significantly greater, and greater still during important seasonal periods such as breeding.

For example, during removal of active roost trees, bats can be injured and killed (i.e. if they are occupying a tree at the time of removal). This risk is high during winter, when bats are less active, and in the breeding season, when suitable roosts are dominated by females (potentially pregnant) and their young. Such communal roosts can represent a large component of a population, having both significant immediate and long-term population-level effects across a landscape larger than the Project area.

When roost trees are removed, bat home ranges may become smaller, potentially reflecting smaller colony sizes and lower roost availability. These factors can increase colony isolation and vulnerability to localised extinction (Borkin & Parsons, 2014; Borkin *et al*., 2011).

Bat activity in the north Auckland region is typically low and associated with a heavily fragmented landscape (Bioresearches 2013, 2014), whereby those 'fragments' may provide important localised roosting habitat within a large landscape of predominantly privately owned open space. Old growth forest (WF11) occurs within SEA_T_6454, but occurs to the north-west of Stage 2 and is avoided by the application. While this older growth area has much greater potential for communal roosting, there remains some uncertainty about the possibility of such roosting within the regenerating vegetation, despite the consistently low level of bat activity. Therefore, while considered unlikely, where any communal roosting habitat occurs within Kings Quarry, it would be of very high value, and similarly, any loss would be significant for this population and its potential persistence within the surrounding landscape.

5.3.2 Fragmentation

The establishment of the Stage 2 quarry expansion would temporarily reduce connectivity to the north eastern part of the SEA; creating an approximately 24 ha fragment of native forest which would, between years 5 and 20 of the project, only be connected to the main portion of the SEA by a relatively narrow band of native vegetation, approximately 70 m in width, before restoration planting began and this band of vegetation would again widen. The poorly connected fragment would be irregularly shaped with an increased edge to area ratio. This would subject much of the vegetation within the fragment to temporarily increased edge effects, including increased wind and exposure to solar radiation, resulting in drier windier conditions. In mature forest systems, this can influence the vegetation up to 50 m from the edge, however at the Kings Quarry site, the nature of the forest, which is heavily impacted by previous clearance, does not have as dense of a canopy as mature forest and due to pest browse and immaturity lacks structural tiers, so that more sensitive species are excluded, this impact is likely less severe. Nonetheless, until restoration planting is established some level of edge effects will be present within these buffers.

The creation of new edges typically results in increased susceptibility to weed invasion particularly along roads and tracks, and alteration to the microclimate (which can exacerbate desiccation, increase light and temperatures, and introduce dust) of affected habitats, having a degradative effect. These effects, while

well understood, are not expected to be severe at Kings Quarry, which is dominated by pioneer vegetation and species communities, including those TAR species, which are well known to inhabit edge environments (e.g. short-haired plume grass, kaikōmako, skinks, geckos and long-tailed bats) and therefore are more resilient to these effects when compared to older growth forest.

The portions of the SEA subject to edge effects as a result of the project are depicted in Figure 21. While the figure does not include all areas of the SEA which are impacted by edge effects, the effects of this historic clearance have been considered, as they form part of the baseline environment and affect the ecological values of the surrounding SEA.

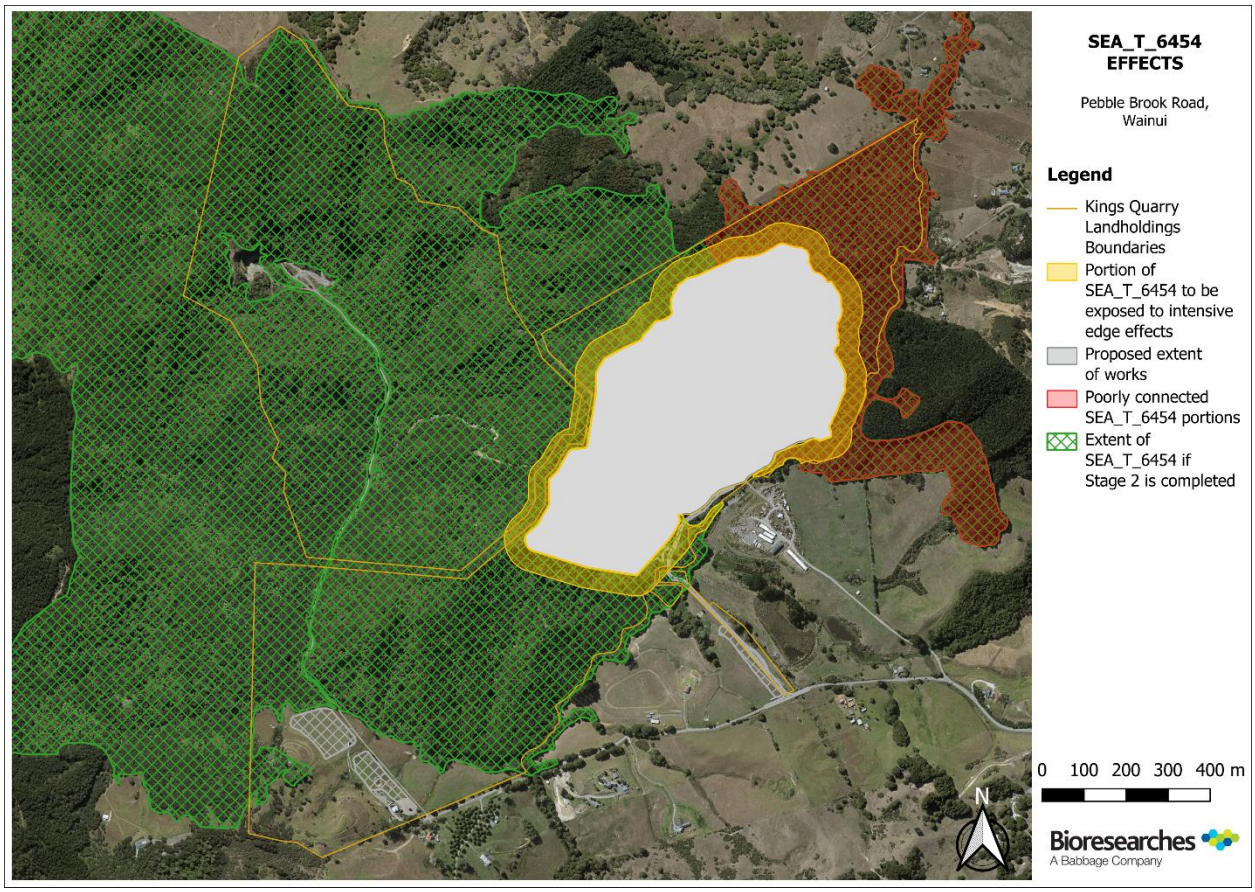

Figure 25. Figure showing the portion of SEA_T_6454 which would be greatly reduced in connectivity from the balance of the SEA, and the portion of the SEA to be subject to edge effects; if the Stage 2 quarry expansion was to go ahead.

The effects of dust generated from quarrying, and vehicles could also be expected to affect the surrounding vegetation. Dust may smother fauna habitats (including foraging areas and retreat sites) small seedlings, ferns and epiphytes, impeding their growth and increasing mortality.

The types of vegetation present in the area surrounding the project area are relatively resilient types (conifer scrub/forest and tree fern forest) however and as a whole they are generally tolerant to environmental change. However, edge effects may result in the loss of species that prefer the cooler, shaded and more humid forest interior.

5.3.3 Magnitude of effect

5.3.3.1 Habitat loss

Overall, the proposal would result in the removal of 28.97 ha of indigenous vegetation and habitats from a 560 ha fragment of indigenous and exotic (plantation) vegetation. This equates to approximately 5% of the fragment and would be of a low magnitude. However, pine plantations are unstable habitats and generally of much lower flora and fauna value, therefore the magnitude of the removal is considered with respect to the indigenous SEA component of the fragment (207 ha). The proportion of indigenous vegetation removal to the SEA is approximately 14%.

This is a relatively low magnitude, however it does not account for important fauna habitat variables, such as foraging, roosting and commuting habitats that may be used by birds and bats, or potentially localised higher densities of native lizards than recorded.

Further, the Project area would partially disconnect an approximately 25 ha area of indigenous vegetation and habitats from the main fragment and increase edge effects to approximately 12 ha of adjacent SEA, reducing the integrity of the eastern portion of the SEA (Figure 25).

Therefore, whilst it remains that there are some potentially very important fauna habitat factors affecting the current understanding of the magnitude of effect, it is considered that the of the loss of some 28.97 ha of regenerating habitats within the quarry footprint would also result in the partial disconnection and degradation of a further 37 ha of remaining SEA vegetation. This equates to approximately 31.9% of all of the forest habitat within the current extent of SEA_T_6454; and is considered to be a **moderate proportion** of the indigenous scrub within the SEA.

With management (buffer planting, pest control and ongoing remediation- refer Figure 26), this vegetation and habitat loss will not be permanent, as it is proposed that the Project area will be sequentially remediated with native vegetation as stages are progressed through, with the entire Project area largely replanted by completion of quarrying. It is therefore considered that many of the important values associated with this vegetation and habitat would be re-established within a much shorter timeframe than 80 years (approximate current age of vegetation). For example, high value fauna, such as indigenous skinks and geckos, have been recorded within 2-15-year-old planted vegetation. Similarly, 5-15 year-old vegetation would support foraging, roosting and nesting habitat for many common native bird species, and habitat for invertebrates which may attract foraging bats.

With sequential remediation, this would largely reduce habitat loss effects on lizards and most common native birds (i.e. excluding cavity nesters and probably kereru), to temporary (medium term). Surveys indicate that the habitats are exhibit minimal bat activity, and that communal or maternal roosting is unlikely (where detected, bat activity is represented by one or very few passes only). Therefore, the habitats within Stage 2 are likely to support dark foraging or fly-over areas for few bats only. Within the surrounding landscape, long-tailed bats are known to commute over unvegetated farmland or parkland. Therefore, while an open quarry pit would represent a different environment, the proposed remediation is expected to reduce potential effects, such as reduced foraging habitat, to a low level.

Given the project and associated revegetation planting is proposed to be completed in stages as sections of the Project area have works completed and the area is remediated, the sector of SEA to the south east of the Project area will retain connectivity to the balance of the SEA through:

- The links which are adjacent to the Project area;
- Via areas within the project area which are yet-to-be quarried; and
- Areas within the Project area where quarrying works are complete revegetation has been carried out.

Consequently, at no time will the project area be completely devegetated and there will always be vegetated corridors linking the two sections of SEA.

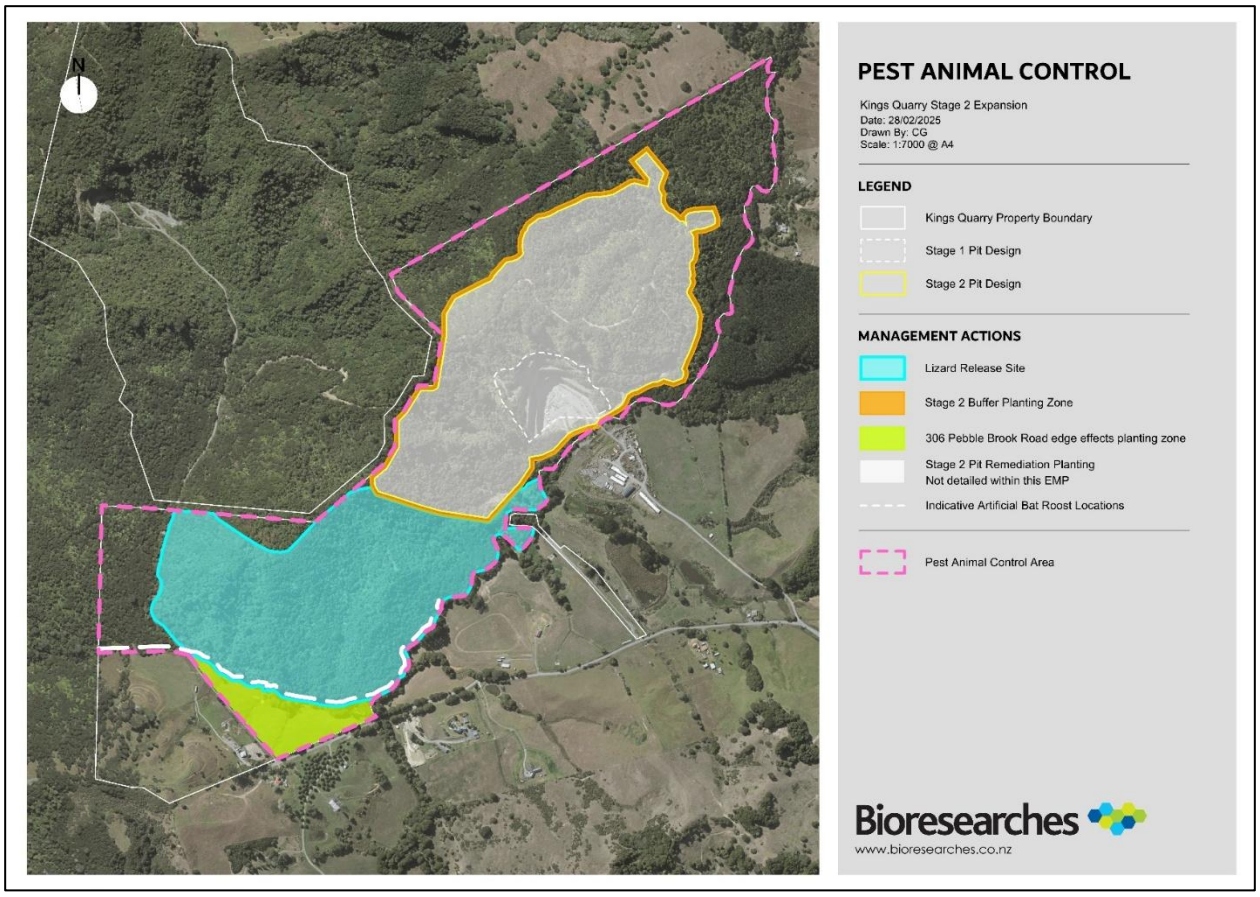

Figure 26. Map showing the location of proposed management (detailed in the EMP and Remediation Plans), including pest animal and weed control, buffer planting management throughout Kings Quarry property, which is to be detailed in a separate Pest Animal Management Plan

5.3.3.2 Effects on Threatened and At-Risk species

The Project area contains 13 species of TAR flora, two confirmed and four other potentially present At-Risk lizards; one potentially present At Risk bird species; and Threatened LTBs.

5.3.3.2.1 TAR flora

TAR flora within the Project area will be removed as vegetation removal occurs, however, as sequential remediation also will occur, it is expected that there will always be individuals of each TAR species present within the Project area as these species are incorporated into remediation plantings. In addition, direct transfer of some threatened plants may be possible from pre-clearance areas into remediated areas prior to vegetation clearance. Specific management of these species is required to ensure that they continue to persist within the project area as remediation is occurring.

The overall level of effect of Stage 2 on High value flora is considered be high, assuming a moderate overall magnitude of loss. Given the TAR flora are broadly edge-habitat species, and would be incorporated into edge and remediation planting in accordance with a TAR management plan, these effects would be reduced to **low**.

5.3.3.2.2 TAR lizards

Two species of native lizard (copper skink and forest gecko) are confirmed to be present within the Project area, whilst a further four species of lizard (elegant gecko, pacific gecko, ornate skink and striped skink) are potentially present. All of these species are regionally At Risk – Declining.

The level of effect on high value native lizards is assessed as high prior to management. As with TAR flora, those indigenous lizards both identified and potentially present are typically associated with regenerating ecosystems (except striped skink, which is strongly associated with older growth forest not represented within the Stage 2 footprint) and are often recorded at edges. The removal of vegetation within the project area will result in a loss of habitat for these species; however, sequential replanting of habitat will ensure that there is always lizard habitat present within the project area, noting that the maximum cleared area any point in the Stage 2 life of quarry, will be 15.8 ha., realised during years 26-30. At this time, there will be approximately 9.1 ha of remediation planting, especially along the northern pit boundary where edge effects will be expected. This planting will be up to five years old (all 4-5 years old at the northern edge), noting also that approximately a quarter of the A pit remediation would already be 15-30 years old, and supporting habitat for skinks and geckos with pest and weed management.

Nonetheless, lizards have the potential to be harmed or killed during vegetation removal and consequently, specific management of these species is provided for, in accordance with a native lizard and invertebrate management plan, which details capture and relocation methods for native lizards (and invertebrates such as At-Risk Rhytid snails), prior to and during vegetation removal, and associated habitat enhancement measures at the relocation site. The overall level of effect on indigenous lizards would be reduced to **low,** following management measures associated with sequential remediation, buffer and enhancement planting, and targeted capture-relocation and habitat enhancement.

Noise and blasting effects on indigenous lizards in adjacent habitats are are somewhat uncertain, however expected to be a low-level effect. Geckos and skinks occur in habitat edges of other active quarry sites, including Brookby, Hunua and Drury. Lizards are likely to habituate to regular noise and vehicle-related vibrations, and often occur in edge habitat alongside high vehicle traffic, including parks, reserves and alongside SH1 in the Auckland Region.

5.3.3.2.3 TAR Birds

Kākā are potentially an infrequent visitor to the Project area for foraging, and consequently, removal of vegetation within the Project area represent a loss of habitat for this species. However, it is highly unlikely that kākā are frequent visitors to the site and therefore the loss of this vegetation is likely to be inconsequential to a highly mobile species with a large home range and for which there is preferential habitat nearby. In addition, kākā are not expected to breed within the Project area, and therefore injury or death to kākā occurring as a result of the project is considered highly unlikely, as adult birds are able to relocate away from vegetation removal activities. No specific management is therefore required to avoid or minimise effects to kākā as a result of the Project.

Noise and blasting effects on indigenous birds in adjacent habitats would involve intermittent (blasting) and vehicle associated disturbances from 6.30 am to 5.30 pm, and blasting between 9am and 5pm. These disturbances would be localised to active areas of the quarry (refer remediation plans for active areas of the Project area). While these effects have not been well studied in relation to New Zealand fauna, adjacent habitat degradation is expected as a result of reduced ability for birds to communicate, potentially detect prey or avoid predation through vocalisation. These effects are likely to result in behavioural changes to birds, including avoidance of some habitats, and potentially hearing damage where blasting occurs adjacent to habitats. Dooling et al. (xxx) states that The proposed noise and vibration conditions provide limitations to noise levels from both the operation of the quarry activity and truck movements and blast noise. While we have not assessed the potential for avifauna to habituate to vehicle traffic during day operations, we refer also to our response to comment 41 regarding ongoing remediation of the project footprint, which would also sequentially move quarry activities, including blasting and vehicle noise, around localised parts of the quarry extent (refer Appendix 12, Remediation Plans). This is a key feature of the Project design, because it demonstrates that edges, and noise associated with vehicles and blasting, will be limited to localised areas (rather than a continuous 12 ha edge area of exposed edge at any point in time) and only as they are required for quarrying.

5.3.3.2.4 Long-tailed bats

Low-level long-tailed bat activity has been recorded consistently across the Project area, over multiple years. Generally, while potential roosting habitat for bats is considered to be present within the site, such as emergent pines and a few multi-stemmed totara, these trees represent occasional features within a mostly pioneer ecosystem, including the area identified as WF11- which is characterised by pole tanekaha and totara. None of the activity recorded within Stage 2 has indicated any probability that those larger trees were used for communal roosting during the surveys (although it is acknowledged that one pass was recorded at the northern edge of stage 2, 31 minutes after sunset in 2022). However, it is notable that the survey did identify that an active communal roost was probably present nearby Stage 2 during the 2024 / 2025 survey, and during which time activity within Stage 2 remained low. Overall, the potential roosting habitat for bats is limited in quality in comparison to what would be expected within mature forest, and the Stage 2 area of Kings Quarry is not considered to provide important (communal / maternal) roosting habitat.

The removal of vegetation within the Stage 2 area will result in a loss of habitat for these species and it is expected that this loss would represent an environment over which bats use to commute through and forage over and may occasionally roost within. With typically low-level activity within Stage 2, roost habitat is expected to support individual bats and less likely, communal roosting, acknowledging that such potential roost habitat occurs within Stage 2 and that roost behaviour (including communal) is likely to be occurring nearby Stage 2. Loss of vegetation is therefore expected to have several impacts on the local bat population these are discussed here:

- Disruption of commuting routes, reduction in foraging habitat: Bats may rely on specific vegetation corridors to navigate between roosting and foraging sites. The removal of these corridors can force bats to find alternative routes which may be less efficient or safe. At Kings Quarry, repeat surveys indicate that activity is consistently low within Stage 2, noting that the highest number of nights with bat activity recorded within Stage 2 was two nights, from a range of 34-66 valid survey nights. This indicates that the habitat within Stage 2 is not regularly used by bats, and therefore is likely to represent a low magnitude of effect on very high values. This

moderate overall effect is assessed as **low** overall, when remediation, buffer and edge planting and pest control is applied to the effects management approach, noting that long-tailed bats will commute and forage over open farmland as well as forest and scrubland.

- Loss of roosting sites: While the Stage 2 area may not be a significant roosting site for bats, it still offers roosting opportunities for bats that may have been used outside survey times. The removal of these trees can reduce availability of safe and stable thermal environments to ensure maintenance and growth of a bat population. The magnitude of this loss is considered to be low on the basis that low level activity has been recorded, and that:
- The Stage 2 area avoids older growth, mature kauri podocarp and broadleaved forest to the northwest of Stage 2, a forest ecosystem that supports a much higher proportion of potential roost trees;
    a. Higher activity recorded from the surveys is associated with the older growth forest (point a, above, and although still relatively low, monitors 303 and 325 within older growth forest recorded more nights with bat passes than within Stage 2), and potential communal roost behaviour was recorded from surveys beyond the stage 2 footprint (e.g. monitor 5).

  This moderate overall effect (very high value, low magnitude effect) is assessed as **low** overall, when remediation, buffer and edge planting , pest control, provision of artificial roost boxes and protection of potential roost trees is applied to the effects management approach.
- Mortality and injury to bats during roost tree removal: The removal of such trees while in use also has the potential for mortality and injury to bats, and very high to complete loss of a (small) bat population if used by pregnant females and pups at the time of removal. While unlikely within stage 2, the risk of this could be very high. This risk could be **avoided** through implementation of pre-felling bat surveys and adherence to the Department of Conservation's tree felling protocols (DOC, 2024, and any advancement on these procedures) and, where roost habitat is identified within the footprint, those roost habitats will be compensated in accordance with the Department of Conservation's Artificial Bat Roost Advisory not (DOC -6734955).

5.3.4 Level of Effects

The level of effects to habitats and species, without management, ranges from Low to High, noting that frogs are not considered to be impacted. In accordance with EIANZ guidelines, any level of effect of moderate or above requires effects management. Effects management, including fauna controls on vegetation removal, relocation, edge effects buffer planting and ongoing remediation throughout the life of the quarry, is expected to substantially reduce effects on fauna and loss of their habitats to no more than moderate, and temporary (> 20 years).

Table 21. Magnitude and level of effect of the proposed works to terrestrial habitats and fauna.

Habitat or species	Ecological value	Magnitude of effect	Level of Effect before mitigation	Level of residual effect after mitigation
VS2 vegetation	High	Moderate	High	Moderate
VS5 vegetation	High	Moderate	High	Moderate
WF11	High	Moderate	High	Moderate
At Risk plants	High	Moderate	High	Low
Invertebrates	Low	Moderate	Low	Very low

Frogs	NIL	NIL	NIL	NIL
Lizards	High	Moderate	High	Low (temporary)
Birds	Moderate	Moderate	Moderate	Low (temporary)
Bats	Very high	Low	Moderate	Low *

*A low level effect is expected following management, with some uncertainty.

5.4 Freshwater Ecological Effects

5.4.1 Direct Effects

The project proposes to reclaim all aquatic habitat within the Project area.

The aquatic stream habitat within the Project area comprises an estimated 1,271 linear metres of natural intermittent stream, 308 linear metres of modified intermittent stream and 860 linear metres of permanent stream, resulting in 2,439 linear metres and 1,119 m^2 of aquatic habitat bed area reclaimed (Table 22).

Table 22. Parameters of intermittent and permanent stream habitat impacted within the Project area

Stream	Classification	Length (m)	Width (m)	Stream bed area (m^2)
Stream 1	Intermittent	204	0.41	59
Stream 2	Intermittent	136	0.3	26
Stream 3	Modified Intermittent	70	0.22	15
	Intermittent	65	0.22	14
	Permanent	30	0.22	7
Stream 4	Intermittent	153	0.22	89
	Permanent	132	0.64	84
Stream 5	Intermittent	78	0.49	38
Stream 6	Intermittent	55	0.29	16
	Modified intermittent	161	0.35	56
Stream 7	Intermittent	153	0.47	52
	Modified intermittent	54	0.35	19
Stream 8	Intermittent	53	0.31	16
Stream 9	Intermittent	131	0.27	27
	Modified intermittent	23	0.35	8
Stream 10	Intermittent	58	0.37	21
	Permanent	187	0.37	69
Stream 11	Intermittent	166	0.38	63
	Permanent	77	0.38	29
Stream 12	Intermittent	19	0.4	8
	Permanent	150	0.4	60
Stream 13	Permanent	284	0.93	169
Total	-	**2,439**	-	**1,119**
Total Modified		**308**	-	**99**
Total Intermittent		**1,271**	-	**507**
Total Permanent		**860**	-	**514**

* total length includes tributaries

Table 23 presents the magnitude of effect on the proposed reclamation works upon streams identified within the Project area ZOI. This is assigned against the ecological value of each stream/representative reach to calculate the overall level of effect.

Table 23. Magnitude of direct effect of the proposed works upon streams identified within the Project area

Effects description	Stream	Ecological Value	Magnitude of effect and justification	Level of effect (without effects management)
Stream reclamation	All streams	Low to High	**Very High** Will result in the complete reclamation of 2,439 m linear metres of stream length, and 1,119 m^2 of stream bed area. The likelihood of this activity occurring is definite and will have a direct impact on the streams. The loss of stream extent will be permanent and irreversible.	Moderate to Very high
Fish injury or mortality	All streams	Moderate to High	**High** Potential loss, mortality, or harm to indigenous fauna, including 'At Risk' species. Barriers to fish passage (natural and man-made) limit density and diversity of fish expected to be present.	High to Very High
Sedimentation	All streams and downstream receiving environment	Moderate to Very High	**High** Potential for smothering of stream substrates. Transportation of excess fine sediments to the downstream receiving environment, with the effects not localised to the quarry footprint.	High – Very High

5.4.2 Indirect Effects

5.4.2.1 Downstream Hydrology

Reduction of freshwater volume has the potential to increase the stress on aquatic fauna with pressures on temperature control and aquatic habitat abundance; changing the regime from permanent to intermittent, or intermittent to ephemeral. Whilst not assessed within this application, the Waitoki Stream was considered to be of, at least, **High** ecological value, as it is a large stony bottomed stream with a range of hydrological habitats downstream of the quarry and is recorded to support a range of 'At Risk' fish species.

Topographical analysis undertaken by Williamson Water and Land Advisory (WWLA) shows the Waitoki Catchment to be 842 ha (pers. comms.). The quarry expansion will result in the diversion of 29.2 ha of catchment, assuming the diverted water will not be discharged back to the Waitoki. This represents a reduction of approximately 3.5% of the contributing catchment, assuming drainage from the excavations is diverted away from the Waitoki Stream. The contributing catchment to the Waitoki Stream will remain at sufficient to support permanent stream, and the current stream characteristics, under normal flow conditions.

The quarry has been designed to vertically avoid the Waitoki Stream and avoid significant stream depletion. Some groundwater draw-down and temporary depletion is predicted during low flow conditions, in which the maximum baseflow depletion rate is 1.3 L/s, representing 10% of the Mean Annual Low Flow. This calculation has been made from the interception of groundwater only and has not incorporated flows generated by surface run off and therefore is a conservative estimate.

Groundwater analysis undertaken by WWLA (2024) indicates groundwater draw down will be limited to a maximum of 7 m, directly north of the existing quarry works area. Draw down will be isolated to those stream reaches within the quarry expansion area with flow paths located beyond the quarry works unaffected by the draw down.

As such, the reduction of 3.5% of the contributing catchment to the Waitoki Stream should not result in more than low magnitude of effect to the hydrological regime and stream function of the Waitoki Stream, resulting in an overall **Low** level of effect.

Stream 13, from its permanent classification to its confluence with the Waitoki Stream, is 320 m in ground truthed length. Within the direct works area, 180 linear metres of Stream 13 is present, with an additional 140 m of stream length between the quarry overburden zone and the Waitoki Stream. A Sediment Retention Pond (SRP) has been placed within the downstream reach of Stream 13, outside of the overburden area; resulting in an additional 100 m of stream length being reclaimed. This has been incorporated in ECR calculations, with 284 linear metres of stream for Stream 13 accounted for. The SRP should provide sufficient treatment of sediment laden water before it is discharge, via a rock apron minimising scour and erosion within the remaining Stream 13 channel. This SRP should also ensure there is sufficient inputs to the lower reaches of Stream 13 to retain its hydrological function as permanent. However, the SRP would preferably be located adjacent to the stream to avoid the further loss of 100 m of stream length.

A monitoring station is to be established on the Waitoki Stream to monitor stream flow. In the event baseflow depletion drops below a pre-determined level (Alert and Alarm Level triggers), as set by a suitably experienced environmental practitioner, a finalised contingency and monitoring plan will be put into effect to remediate this.

5.4.3 Dilution factor and contaminant concentrations

The reclamation of streams in the catchment has the potential to impact downstream contaminant concentrations. Land-use practices influence contaminant levels within the Waitoki Stream, and the inflow from tributaries is likely to play a role in diluting these contaminants. Upstream of the quarry works area, portions of the Waitoki Stream flow through farmland with little riparian yard. Contaminants (such as fine sediment and nutrients) generated from this land use will freely enter the stream through run-off, with the limited riparian planting offering minimal filtering capacity.

Contaminants generated by the quarry should be expressly dealt with through minimisation, mitigation and best practice controls prior to entering the Waitoki Stream. This is addressed in the draft Erosion and Sediment Control Plan submitted with the application. Considering this, the loss of 3.5% of dilution factor should be minimised to contaminants generated independent of the quarry operations, such as agricultural run-off, roading run-off, stormwater.

These contaminants, alongside those generated by the quarry, contribute to reductions in the overall water quality of the Waitoki Stream. The proposed Stage 2 expansion will lead to the removal of 29.2 hectares, or approximately 3.5% of the stream catchment. Although this loss is likely to increase the distance downstream that contaminants penetrate, the loss of approximately 3.5% dilution factor should not result in a significant increase in contaminant loading under normal conditions. The reduction in

dilution factor by 3.5% is of low magnitude as it should not result in discernible changes in the quality if water within the high value Waitoki Stream, resulting in an overall Low level of effect.

Nonetheless, to ensure water quality (contamination dilution) and stream function (catchment reduction) is not compromising freshwater communities and stream function, it is recommended stream biomonitoring is undertaken on an annual basis to monitor and detect any changes to water quality, stream condition and aquatic fauna populations.

6 TERRESTRIAL ECOLOGY RECOMMENDATIONS FOR EFFECTS MANAGEMENT

The NPS-IB requires that identified adverse effects within SNAs are avoided, except were provided for under Clause 3.11, which includes aggregate extraction that provides significant national or regional benefit that cannot otherwise be achieved using resources within New Zealand (NPSIB, 3.11(1(aiii))). An explanation of the Project with respect to this exception is provided with the application, however where adverse effects are managed pursuant to subclause 3, the following is required to be demonstrated:

1. How each step of the effects management hierarchy will be applied
2. If biodiversity offsetting or biodiversity compensation is applied, how the proposal has complied with principles 1 to 6 (NPS-IB, Appendix 3 & 4, Principles of Biodiversity Offsetting and Compensation) and has had regard to the remaining principles as appropriate.

6.1 Effects Management Hierarchy (NPS-IB, 2023)

The effects management hierarchy is an approach to managing the adverse effects of an activity on indigenous biodiversity that requires that:

a. adverse effects are avoided where practicable; then
b. where adverse effects cannot be avoided, they are minimised where practicable; then
c. where adverse effects cannot be minimised, they are remedied where practicable; then
d. where more than minor residual adverse effects cannot be avoided, minimised, or remedied, biodiversity offsetting is provided where possible; then
e. where biodiversity offsetting of more than minor residual adverse effects is not possible, biodiversity compensation is provided; then
f. if biodiversity compensation is not appropriate, the activity itself is avoided.

6.2 Adverse effects that are avoided, where practicable

The proposed pit expansion avoids as far as possible, higher value, more mature forest in kauri, podocarp, broadleaved forest (WF11, Singers *et al.,* 2017) which, while within the Kings Quarry landholdings, covers a core area to the northwest of the proposed expansion. This older vegetation (WF11) has higher potential to provide roost trees for long-tailed bats and birds, and is of a higher value food and habitat resource to birds, invertebrates (including At-Risk *Amborhytida dunniae*) and potentially lizards.

6.3 Adverse effects that are minimised, where practicable

Effects associated with the loss and degradation of ecosystems and species-will be addressed in management plans that provide for edge buffer planting, sequential remediation of the footprint commencing from year 1, and targeted species-specific actions including capture-relocation, TAR plant propagation and restoration, habitat enhancement and pre-vegetation removal surveys to avoid nesting birds and roosting bats. These actions, as detailed in management plans (and remediation detailed below), would reduce adverse effects on these values, particularly on the basis that the quarry operations will be localised within the wider footprint as it progresses through the footprint.

A. **Vegetation Removal Management Plan**: to provide a clear list of the ecological management measures required to be undertaken prior to each stage of vegetation clearance commencing. This includes:

a. Survey and demarcation of the clearance area;
b. Fauna management;
c. Kauri Tree ID and any KDD management;
d. Identification of any natural resources to be salvaged; and
e. Notification of local iwi that vegetation clearance is scheduled to occur, so that iwi are offered to opportunity to salvage native logs, vegetation and soils.

B. **Avifauna Management Plan:** to minimise potential effects on native birds prior to and during removal of their potential habitats as part of an expansion of the Stage 2 pit (Figure 1). The purpose of this Avifauna Management Plan (AMP) is to detail the management measures required to minimise adverse effects on native birds associated with vegetation/ habitat clearance.

C. **Bat Management Plan**: to provide details on how injury and mortality to long-tailed bats will be avoided during vegetation removal. The Long-tailed Bat Management Plan will provide details that adhere to the Department of Conservation's tree felling protocols and, where roost habitat is identified within the footprint, those roost habitats will be compensated in accordance with the Department of Conservation's Artificial Bat Roost Advisory not (DOC - 6734955).

D. **Lizard and Invertebrate Management Plan:** to provide details on how injury and mortality to any At Risk and Threatened lizards and invertebrates within the footprint will be avoided or minimised to ensure that there is no overall reduction in the size of populations of At-Risk lizard species and occupancy across their natural ranges. The Native lizard and Invertebrate management plan will provide methods for capture, including trapping and / or search effort, timing of implementation, an assessment of the release location, any habitat enhancement required and monitoring methods.

E. **Threatened and At-Risk plant Management Plan**: to provide details on how any At Risk and Threatened plants within the Project area will be managed to ensure that there is no overall reduction in the size of populations of At Risk and threatened species and occupancy across their natural ranges. The threatened and at-risk plant and vegetation management plan will detail methods for any salvage of canopy tree seedlings for propagation and replanting, including:

a. Salvage of native plant material for propagation and planting within restoration planting areas
b. Salvage of forest litter and surface soils for use in restoration areas
c. Reuse of any mulching / cutting for restoration areas.

F. **Kauri Dieback Management Plan:** to provide details on minimising the spread of kauri dieback disease during works within the quarry footprint. The plan will detail methodology for soil and plant material removal within the management zone, as well as vehicle and equipment cleaning procedures. The plan adheres to the requirements of the Biosecurity (National PA Pest Management Plan) Order 2022.

G. **Edge Effects and Buffer Management plan**: to provide detail on how adverse edge effects on retained and protected indigenous vegetation around the Stage 2 pit edge will be minimised through dense buffer infill planting and pest animal control. The Buffer Planting Management

Plan will provide details on planting schedules, timing of planting, monitoring and maintenance.

H. **Mammalian Pest Control Plan**: to provide detail on how mammalian pest control will be undertaken within both existing forest adjacent to the quarry and within the new plantings.

6.4 Adverse effects that are remediated, where practicable

A total of 22.19 ha of the Project will be remediated sequentially, such that remediation planting will commence from year 1 and be back-filled as fill and pit areas become available throughout the quarry life. This approach will ensure that habitats for fauna and flora are remediated as the quarry progresses, and as such will become available to fauna after 2-20 years of vegetation maturation. Of note, high value lizards are known to occupy rough grass (e.g. copper skinks) and planted kanuka vegetation (geckos) less than 10 years old- where such plantings occur alongside existing established habitats. Similarly, restoration plantings can become suitable for foraging, roosting and nesting for native passerine bird from five years growth. With suitable pest control and maintenance of remediation plantings, habitat loss for fauna is expected to be temporary. Remediation will be guided by a Remediation Planting Management Plan as follows:

A. **Remediation Planting Management Plan**: to provide detail on how restoration of the quarry and fill pits would be restored sequentially, commencing from year 1 and throughout the life of the quarry. This Management Plan is a key feature of the Project design and will demonstrate that edge effects will largely be temporary and limited to localised areas, rather than a continuous 12 ha area of exposed edge at any point in time. The Remediation Planting Management Plan will demonstrate that remediation works will be largely completed across the quarry pit by the end of the quarry life and provide details on planting schedules, timing of planting, monitoring and maintenance.

6.5 Residual adverse effects that are offset

A biodiversity offset, as defined by the NPS-IB is defined as:

"a measurable conservation outcome that meets the requirements in Appendix 3 and results from actions that are intended to:

(a) redress any more than minor residual adverse effects on indigenous biodiversity after all appropriate avoidance, minimisation, and remediation measures have been sequentially applied; and

(b) achieve a net gain in type, amount, and condition of indigenous biodiversity compared to that lost."

We propose to offset the residual adverse effects on the following biodiversity types because they meet the principles for biodiversity offsetting as set out in Appendix 3 of the NPS-IB and detailed in Table 24:

- Effect of the loss of 19.75 ha of VS2 forest;
- Effect of the loss of 8.03 ha of VS5 forest;
- Effect of the loss of 1.19 ha of WF11 forest
- Loss of extent of SEA_T_6454.

6.6 Residual adverse effects that are compensated

Biodiversity compensation, as defined by the NPS-IB is defined as:

> "*a conservation outcome that meets the requirements in Appendix 4 and results from actions that are intended to compensate for any more than minor residual adverse effects on indigenous biodiversity after all appropriate avoidance, minimisation, remediation, and biodiversity offsetting measures have been sequentially applied*."

We provide Biodiversity Compensation Models (BCM) to demonstrate confidence in quantified ~~offsets~~ compensation actions, as well as net gain from a range of enhancement outcomes over various vegetation types and condition within adjacent vegetation and contiguous with the compensation site at Dome Valley (Oldfield Road).

- Effect resulting from the loss of High value Kauri, Podocarp, Broadleaved Forest (WF11).
- High-level effect resulting from the loss of High value regenerating broadleaved species vegetation and habitats relating to avifauna (VS5).
- High-level effect resulting from the loss of High value Kanuka scrub/forest and habitats relating to avifauna (VS2).

Table 24. Summary of adverse effects, values, effects management measures and level of effects before and after avoidance, minimisation and remediation measures.

Adverse Effect	Ecological value	Level of effect before effects avoidance, minimisatin and remediation measures	ffects avoidance, minimisation and remediation measuresLevel of residual effect	esidual effects management		
Loss of 28.97 ha vegetation / habitat	High	High	• Remediation of Pit		Moderate (Temporary: 15-25 years)*	The quantum of offsetting and compensation measures are calculated within the Terrestrial Ecology Residual Effects Analysis Report, and the management actions are described in the Residual Effects Management Plan
Habitat fragmentation / increased edge effect	High	Moderate	• Buffer planting and pest animal control. • Sequential remediation of Pit		Moderate (Temporary: 15-25 years)*	The quantum of offsetting and compensation measures are calculated within the Terrestrial Ecology Residual Effects Analysis Report, and the management actions are described in the Residual Effects Management Plan
Loss of TAR plants and habitats	High	High	• TAR Plant Management Plan, edge effects and buffer management plan and remediation management plans		Low (Temporary: 5-15 years)*	TAR Plant Management Plan, contained within the Ecological Management Plan
Loss of lizard and invertebrates and habitats	High	High	• Lizard Management Plan to capture / relocate lizards and invertebrates • Edge effects and buffer management plan and remediation management plans		Low (Temporary: 5-15 years)*	Lizard Management Plan, contained within the Ecological Management Plan
Loss of birds and habitats	Moderate	Moderate	• Preclearance nesting surveys to minimise mortality to nesting birds as per the Avifauna Management Plan		Low (Temporary: 15-25 years)*	Avifauna Lizard Management Plan, contained within the Ecological Management Plan

Loss of bat and habitats	Very High	Low	• Bat Management Plan to provide for preclearance bat surveys, adoption of tree felling protocols and provision of artificial bat roost boxes in accordance with DOC advice note where a bat roost is discovered. • Edge effects and buffer management plan and remediation management plans	Low (Temporary: 15-25 years)*	Bat Lizard Management Plan, contained within the Ecological Management Plan

Note * = Table 9 of the EIANZ Guidelines describes a 'permanent' effect as one that continues for "an undefined time beyond the span of one human generation (taken as approximately 25 years)" (EIANZ, 2018).

7 FRESHWATER ECOLOGY RECOMMENDATIONS FOR EFFECTS MANAGEMENT

The NPS FM directs in Section 3.24 that the loss of river extent and values is avoided unless there is a functional need for the activity in that location; and the effects are managed by applying the effects management hierarchy. Where adverse effects are managed pursuant to subclause 3, the following is required to be demonstrated:

1. how each step in the effects management hierarchy will be applied to any loss of extent or values of the river (including cumulative effects and loss of potential value), particularly (without limitation) in relation to the values of: ecosystem health, indigenous biodiversity, hydrological functioning, Māori freshwater values, and amenity; and
2. if aquatic offsetting or aquatic compensation is applied, the applicant has complied with principles 1 to 6 in Appendix 6 and 7, and has had regard to the remaining principles in Appendix 6 and 7, as appropriate; and
3. there are methods or measures that will ensure that the offsetting or compensation will be maintained and managed over time to achieve the conservation outcomes.

7.1 Effects Management Hierarchy (NPS FM, 2024)

As described above in Section 6.1, an effects management hierarchy is an approach to managing the adverse effects of an activity. The NPS-FM describes how effects to rivers and natural inland wetlands should be approached by requiring that:

(a) adverse effects are avoided where practicable; then

(b) where adverse effects cannot be avoided, they are minimised where practicable; then

(c) where adverse effects cannot be minimised, they are remedied where practicable; then

(d) where more than minor residual adverse effects cannot be avoided, minimised, or remedied, aquatic offsetting is provided where possible; then

(e) if aquatic offsetting of more than minor residual adverse effects is not possible, aquatic compensation is provided; then

(f) if aquatic compensation is not appropriate, the activity itself is avoided.

7.2 Adverse effects that are avoided, where practicable

Adverse effects to freshwater habitats within the Kings Quarry footprint were not able to be avoided due to the nature of the quarrying project, and the presence of many streams throughout the Kings Quarry Landholdings. However, the quarry footprint does avoid the permanent stream to the south of the proposed project area.

7.3 Adverse effects that are minimised, where practicable

Actual and potential adverse effects on freshwater ecology which are able to be minimised were identified as:

- Death and injury to freshwater fauna; and
- Sedimentation.

7.3.1 Freshwater fauna

The magnitude and level of the potential effect on native fauna is considered to be moderate due to the nature of the activity, extent of habitat loss/alteration, the density and threat status of impacted species, and the ability of fauna to escape the disturbance. Within Stream 1 – Stream 12, the shallow depth would likely restrict sizes of freshwater fauna able to reside within these reaches, with the low stream depth limiting the permanency of aquatic habitat available. Stream 13 would provide a permanent source of high-quality aquatic habitat. The potential loss of freshwater fish is considered a significant adverse effect which must be managed. There is a high potential for injury or mortality of native freshwater fauna during in-filling of streams in the absence of controls.

Potential adverse effects can be minimised through timing of the stream and wetland works, and native fish recovery and relocation immediately prior to streamworks. The Native Freshwater Fish Relocation Plan should include, at a minimum, methods to capture fish, measures to prevent fish re-entering the reach, fishing efforts, relocation sites, storage and transportation to prevent stress and death/predation.

Implementation of native fish recovery protocols will reduce the level of effect to **Low**.

7.3.2 Sedimentation

Works within the Project area could generate sediment, which would negatively impact the freshwater habitats adjacent to the Project area which will not be fully reclaimed, such as the Waitoki Stream. The release of excess fine sediment into streams through changing land use is recognised as a major impact on stream health. Increased fine sediment input to aquatic habitats can reduce visual clarity, clog respiratory structures of animals (such as the gills of fish), degrade benthic habitats and may result in burial and suffocation of aquatic biota (Clapcott *et al.,* 2011).

To minimise the potential for excess fine sediment entering the catchment, an Erosion and Sediment Control Plan (ESCP) has been prepared and will be implemented by an appropriately qualified professional using the industry best practice. The plan details methods on managing sediment in discharges of water as well as dust. No works should occur without the ESCP recommendations being in place. Sediment run off generated by the quarry activities should not enter the Waitoki Stream as appropriate erosion and sediment controls will manage the generation of sediment and prevent this sediment from entering the Waitoki. Maintenance and management of the controls adjacent to the streams should be stringent, and erosion and sediment controls checked prior to and immediately following heavy rain events to minimise the potential for failure or remediate where applicable. Testing of the Waitoki should be carried out regularly to ensure good water quality is maintained during the life of the quarry. Following the implementation of the management measures, the level of effect will be **Low**.

An adaptive management plan which will monitor downstream water quality effects is proposed as a condition of consent for the construction phase. The detailed ESCP and adaptive management plan will be submitted to Council prior to works beginning, and all controls will be maintained. Any adjustments to these controls will be discussed with Council monitoring officer prior to implementation.

7.4 Adverse effects that are remedied, where practicable

Actual and potential adverse effects on freshwater ecology cannot be remedied, therefore residual adverse effects are required to be offset and compensated.

7.5 Residual adverse effects that are offset and compensated

7.5.1 Stream loss

The proposed quarry construction and ancillary works will result in the infilling of 2,439 linear metres of intermittent and permanent stream, ranging from Low to Very High ecological value. No wetlands were recorded.

The magnitude of stream loss is assessed as 'Very high' due to the complete loss of these surface water systems, which is definitive and will have a direct impact. The effects will be permanent and irreversible. Stream reclamation cannot be minimised or remedied, and as the overall level of effect is 'Moderate' to 'Very High' (depending upon the ecological values of the habitats) the effects on streams will need to be offset or compensated.

Under Section E3 Lakes, rivers streams and wetlands of the AUP, E3.2. Objectives [rp] (3) states:
"Significant residual adverse effects on lakes, rivers, streams or wetlands that cannot be avoided, remedied or mitigated are offset where this will promote the purpose of the Resource Management Act 1991."

The loss of the 2,439 m (1,119 m²) of aquatic habitat in the Project area is considered a significant residual adverse effect under the AUP, and a Very High Level of effect under the EcIA guidelines (Roper-Lindsay *et al.,* 2018), and would require aquatic offset or aquatic compensation.

Guidance on, and the principles for, good practice aquatic biodiversity offsetting is provided in the AUP, Ministry for the Environment *et al.* (2014), and in Appendix 6 of the NPS-FM. In summary the offsetting restoration and enhancement documents recommend:

- The site be located as close as possible to the subject site;
- Be 'like-for-like';
- Preferably achieve no net loss;
- Consideration of the use of biodiversity offsetting; and
- The use of Storey *et al*. (2011), Appendix 8 (AUP Operative in part, 2016) and Ministry for the Environment *et al.* (2014) for guidance.

The NPS-FM also sets out eleven principles for aquatic offsetting:

1. Adherence to effects management hierarchy
2. When aquatic offsetting is not appropriate
3. No net loss and preferably a net gain
4. Additionality
5. Leakage
6. Long-term outcomes
7. Landscape context
8. Time lags
9. Science and mātauranga Māori
10. Tangata whenua or stakeholder participation
11. Transparency.

The NPS-FM also sets out eleven principles for aquatic compensation:

- Adherence to effects management hierarchy

- When aquatic compensation is not appropriate
- Scale of aquatic compensation
- Additionality
- Leakage
- Long-term outcomes
- Landscape context
- Time lags
- Trading up
- Finacial contribution
- Science and mātauranga Māori
- Tangata whenua or stakeholder participation
- Transparency.

7.5.1.1 Environmental Compensation Ratio (ECR)

The SEV methodology combined with the calculation of the Environmental Compensation Ratio (ECR) is a transparent, well-recognised methodology for calculating the quantum of offset required for stream loss (Storey *et al.*, 2011). Although the methodology was originally developed in Auckland, it has been reviewed by NIWA for use in Wellington, Hawke's Bay and Southland, and is considered applicable without modification to most stream and river types in those regions. (Storey *et al.*, 2011).

For permanent and intermittent streams, SEV scores can be used to calculate environmental compensation for loss of natural stream habitat by using the Environmental Compensation Ratio (ECR; Storey *et al.*, 2011). The ECR considers the SEV values of both the affected or impacted stream/s and the proposed restoration site stream/s and determines any differential between the scores to provide a ratio for compensation which will result in "no net loss of area weighted stream function" (Storey *et al.*, 2011).

The ECR equation is calculated as follows:

$$ECR = [(SEVi\text{-}P – SEVi\text{-}I) / (SEVm\text{-}P – SEVm\text{-}C)] \times 1.5$$

Where:

- SEVi-P and SEVi-I are the potential SEV value and SEV value after impact, respectively, for the site to be impacted.
- SEVm-C and SEVm-P are the current and potential SEV values, respectively, for the site where the environmental compensation (mitigation) works are to be applied.
- 1.5 is a multiplier that allows for the delay in achieving compensation benefits.

The ECR calculations are, unavoidably, carried out using a number of assumptions. The 'Potential' SEV scores are calculated by altering parameter scores assuming best practice riparian restoration of the stream has taken place and is well established to a level providing at least 70% shade to the stream bed.
As the streams within the Stage 3 expansion area have full riparian cover, no additional 'potential' will be added to the SEV score. Calculation of the 'Potential' score for a restoration site assumed native riparian restoration of a 20 m margin (10 m either side of the watercourse). Calculation of the 'Impact' SEV scores would assume an outcome as proposed, with the full length of the stream being lost.

Following calculation of the ECR, the area of stream impacted (based on length and width of the stream) is multiplied by this value to determine the stream area required for remediation works for the loss of stream values.

The above ECR methodology accounts for the loss of stream values, however the loss of stream extent cannot be feasibly offset considering the extent of stream bed loss. Therefore, compensation of residual adverse effects through the loss of stream extents is required in adherence to the effects management hierarchy.

A detailed Residual Effects Management Plan (REMP), detailing the restoration actions for the offset and compensation reaches, would be prepared by a qualified ecologist to ensure good quality native habitat is created. A minimum of a three-year defects and maintenance contract would be required for the restoration planting to ensure cover is achieved, weed control is maintained and to ensure the proposed compensation is achieved over the medium term.

7.5.1.2 Proposed Aquatic Offset and Compensation Sites

Two sites in close proximity of Kings Quarry are proposed to be used for aquatic offset for stream loss as a result of the Stage 2 expansion of Kings Quarry.

Biodiversity gains for offset would be achieved through the enhancement of the existing habitat to improve its condition; by fencing the area from stock; the removal of structures providing total and partial barriers to fish passage; and ongoing weed control of the restoration plantings.

Biodiversity gains for compensation would be achieved through the enhancement of degraded natural inland wetlands, a rare ecosystem type, with only 10.8% of the historic wetland extent remaining (Dymond *et al*., 2021). At least a 1:2 ratio of stream bed area to wetland bed area restored and the existing habitat to improved; by the replanting of an indigenous wetland type per Singers *et al.* (2017); fencing the area from stock; the restoration of the 40 m (20 m each site) riparian yard and; and ongoing weed control of the restoration plantings.

Combined with these enhancement activities, habitat creation is proposed, involving restoration planting of species that form the early stages in a succession towards a native forest habitat. The restoration planting provides aquatic ecological benefits provided by replacing pasture grass and/or weed species with native shrubs and trees in the riparian zone (providing temperature control and reduction of nuisance growth of aquatic vegetation through shading); woody debris in the stream (increasing habitat and refuges for invertebrates and fish); stabilisation of channel banks and channel shape; and reduction of nutrient and sediment inputs into the streams. In addition, the riparian planting will benefit the restoration wetlands through the buffering and protection from drying winds, temperature fluctuations, and reduction in sediment run-off smothering wetland plants.

7.6 Summary of freshwater ecology recommendations for effects management

The magnitude of effect from the different activity types on streams is summarised in Table 28. This is assigned against the highest ecological value of each stream relevant to the activity to calculate the overall level of effect (as detailed in Table 31 in Appendix A).

The EIANZ Guidelines require effects management to be undertaken where the level of effect is moderate or greater. As the level of effect is 'moderate' or 'high' for the stream loss (which combined comprise 1,119 m^2) effects management is required. Minimisation and remediation of effects can be applied to some of the effects, but as the project will involve the total loss of some of the streams at the site, offsetting is required to manage the effects to those streams.

Table 25. Magnitude of effect and level of effect of the proposed works upon streams identified within Kings Quarry Stage 2 pit expansion area.

Effect/activity	Magnitude	Level of effect before mitigation	Recommended management	Recommended management of residual adverse effects	Level of residual effect after mitigation
Stream reclamation and loss of stream values	Very High	Very High	Effects cannot be minimised or remediated. Effects required to be offset	Offset	Very High. Cannot be avoided, minimised or remediated. Residual adverse effects must be offset and compensated.
Stream reclamation and loss of stream extent	Very High	Very High	Effects cannot be minimised, remediated or offset. Effects required to be compensated	Compensation	Very High. Cannot be avoided, minimised, remediated or offset. Residual adverse effects must be compensated.
Fish injury or mortality	High	High – Very High	Implementation of a Native Freshwater Fish Relocation Plan n immediately prior to streamworks	Minimise	Low
Sedimentation	High	High	Implantation of Erosion and Sediment Control Plan	Minimise	Low

8 CONCLUSION

Kings Quarry Limited is proposing Stage 2 of Kings Quarry at Wainui, North Auckland, and Bioresearches has been engaged to provide an Ecological Impact Assessment to inform the application for resource consents.

The Project will involve completion of bulk earthworks and quarrying activities across the entirety of the Project area, which will result in the permanent, complete loss of all existing freshwater and terrestrial habitat within the Project area boundaries. This includes the loss of approximately 28.97 ha of indigenous vegetation and associated fauna habitats; and loss of 2,439 linear meters of stream habitat, corresponding to 1,119 m^2 of aquatic habitat when multiplied by the stream widths.

The levels of effect of various aspects of the Project upon the ecological features, prior to ecological management, range from low to high.

Potential adverse effects upon terrestrial and freshwater fauna and flora as a result of this proposal will be managed through the implementation of management plans, which have been compiled into one Ecological Management Plan. However, there are residual effects that cannot be addressed through management, such as the loss of terrestrial, freshwater and fauna habitat within the Project area. To address this, and ensure the Project achieves no-net loss, separate terrestrial and freshwater residual effects reports and a Residual Effects Management Plan have been prepared by Bioresearches to address this.

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APPLICABILITY AND LIMITATIONS

Restrictions of Intended Purpose

This report has been prepared solely for the benefit of Kings Quarry Limited as our client with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such party's sole risk.

Legal Interpretation

Opinions and judgements expressed herein are based on our understanding and interpretation of current regulatory standards and should not be construed as legal opinions. Where opinions or judgements are to be relied on, they should be independently verified with appropriate legal advice.

Maps and Images

All maps, plans, and figures included in this report are indicative only and are not to be used or interpreted as engineering drafts. Do not scale any of the maps, plans or figures in this report. Any information shown here on maps, plans and figures should be independently verified on site before taking any action. Sources for map and plan compositions include LINZ Data and Map Services and local council GIS services. For further details regarding any maps, plans or figures in this report, please contact Bioresearches.

Appendix A Ecological Impact Assessment Methodology

The ecological assessments undertaken for the proposed expansion of Kings Quarry generally follow Ecological Impact Assessment guidelines for use in New Zealand (EcIAG) published by EIANZ (Roper-Lindsay et al. 2018). The EcIAGs provide a standardised matrix framework that allows ecological effects assessments to be clear, transparent and consistent. The EcIAG framework is generally used in impact assessments in New Zealand as good practice.

The EcIAGs provide a three-step process for undertaking terrestrial and freshwater assessments as follows:

Step 1: Assess the value of the area (terrestrial and/or freshwater), taking into consideration species (Table 23) and other attributes of importance for fauna, vegetation or habitats (Table 23, Table 24 and Table 25) to assign an overall ecological value (Table 26).

Step 2: Determine the magnitude of effect (Table 27). This step also includes consideration of the timescale and permanence of the effect, whereby temporary (< 25 years) and long-term (substantial improvement after 25 years) effects are distinguished from permanent (beyond the span of a human generation) effects.

Step 3: Evaluate the overall severity or level of effect using a matrix (Table 28) of the ecological value and magnitude of effect.

That analysis then leads to an effects management regime comparable to the level of adverse ecological effect using the management hierarchy to end with an overall outcome for ecological values that demonstrably results in no greater than minor, or preferably, a net improvement (Net Environmental Gain).

Fauna considered in this report include all those that are protected by the Wildlife Act 1953, including lizards, birds and long-tailed bats. Particular consideration was given where species with a conservation status of nationally 'At Risk' or higher have the potential to be present.

Table 26. Factors to be considered in assigning value to species (Roper-Lindsay et al., 2018).

Determining factors	Value
Nationally threatened species, found in the ZOI either permanently or seasonally	Very High
Species listed as 'At Risk' – declining, found in the ZOI, either permanently or seasonally	High
Species listed as any other category of 'At Risk' found in the ZOI (Zone of Interest) either permanently or seasonally	Moderate
Locally (ED) uncommon or distinctive species	Moderate
Nationally and locally common indigenous species	Low
Exotic species, including pests, species having recreational value	Negligible

Table 27. Attributes to be considered when assigning ecological value or importance to a site or area of terrestrial vegetation / habitat / community (as per Table 4 of Roper-Lindsay et al. 2018).

Matters	Attributes to be considered

Representativeness	Criteria for representative vegetation: • Typical structure and composition • Indigenous species dominate • Expected species and tiers are present • Criteria for representative vegetation: • Species assemblages that are typical of the habitat • Indigenous species that occur in most of the guilds expected for the habitat type
Rarity/Distinctiveness	Criteria for rare/distinctive vegetation and habitats: • Naturally uncommon or induced scarcity • Amount of habitat or vegetation remaining • Distinctive ecological features • National Priority for Protection • Criteria for rare/distinctive species of species assemblages: • Habitat supporting nationally threatened or At-Risk species, or locally uncommon species • Regional or national distribution limits of species or communities • Unusual species or assemblages • Endemism
Diversity and pattern	• Level of natural diversity, abundance and distribution • Biodiversity reflecting underlying diversity • Biogeographical considerations- pattern, complexity • Temporal considerations, considerations of lifecycles, daily or seasonal cycles of habitat availability and utilisation
Ecological context	• Site history and local environment conditions which have influenced the development of habitats and communities • The essential characteristics that determine an ecosystems integrity, form, functioning and resilience (from 'intrinsic value' as defined in RMA) • Size, shape and buffering • Condition and sensitivity to change • Contribution of the site to ecological networks, linkages, pathways and the protection and exchange of genetic material • Species role in ecosystem functioning - high level, key species identification, habitat as proxy

Table 28. Matters that may be considered when assigning ecological value to a freshwater site or area (as per Table 7 of Roper-Lindsay et al. 2018).

Matters	Attributes to be considered
Representa-tiveness	• Extent to which site/catchment is typical or characteristic • Stream order • Permanent, intermittent or ephemeral waterway • Catchment size • Standing water characteristics
Rarity/ Distinctive-ness	• Supporting nationally or locally Threatened, At Risk or uncommon species • National distribution limits • Endemism • Distinctive ecological features • Type of lake/pond/wetland/spring

Diversity and pattern	• Level of natural diversity • Diversity metrics • Complexity of community • Biogeographical considerations - pattern, complexity, size, shape
Ecological context	• Stream order • Instream habitat • Riparian habitat • Local environmental conditions and influences, site history and development • Intactness, health and resilience of populations and communities • Contribution to ecological networks, linkages, pathways • Role in ecosystem functioning – high level, proxies

Table 29. Assigning ecological value (Roper-Lindsay et al. 2018).

Value	Description
Very High	Area rates High for 3 or all of the four assessment matters listed in Table 24 or Table 25. Likely to be nationally important and recognised as such.
High	Area rates High for 2 of the assessment matters, Moderate and Low for the remainder, or Area rates High for 1 of the assessment maters, Moderate for the remainder. Likely to be regionally important and recognised as such.
Moderate	Area rates High for one matter, Moderate and Low for the remainder, or Area rates Moderate for 2 or more assessment matters Low or Very Low for the remainder Likely to be important at the level of the Ecological District.
Low	Area rates Low or Very Low for majority of assessment matters and Moderate for one. Limited ecological value other than as local habitat for tolerant native species.
Negligible	Area rates Very Low for 3 matters and Moderate, Low or Very Low for remainder.

Table 30. Criteria matrix for describing magnitude of effects (Roper-Lindsay et al. 2018).

Magnitude	Description
Very High	Total loss of, or very major alteration, to key elements/ features of the baseline conditions such that the post development character/ composition/ attributes will be fundamentally changed and may be lost from the site altogether; AND/OR Loss of a very high proportion of the known population or range of the element / feature.
High	Major loss or major alteration to key elements/ features of the existing baseline conditions such that the post-development character, composition and/or attributes will be fundamentally changed; AND/OR Loss of a high proportion of the known population or range of the element / feature.
Moderate	Loss or alteration to one or more key elements/features of the existing baseline conditions, such that post-development character, composition and/or attributes will be partially changed; AND/OR Loss of a moderate proportion of the known population or range of the element / feature.
Low	Minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances/patterns; AND/OR Having a minor effect on the known population or range of the element / feature.

Negligible	Very slight change from existing baseline condition. Change barely distinguishable, approximating to the "no change" situation; AND/OR Having a negligible effect on the known population or range of the element / feature.

Table 31. Criteria matrix for describing level of effects (Roper-Lindsay et al. 2018).

Ecological value → Magnitude ↓	Very high	High	Moderate	Low	Negligible
Very High	Very High	Very High	High	Moderate	Low
High	Very High	Very High	Moderate	Low	Very Low
Moderate	High	High	Moderate	Low	Very Low
Low	Moderate	Low	Low	Very Low	Very Low
Negligible	Low	Very Low	Very Low	Very Low	Very Low
Positive	Net gain	Net gain	Net gain	Net gain	Net gain

Appendix B Wildlife Authority

Department of Conservation
Te Papa Atawbai

Wildlife Act Authority for wildlife on non-public conservation land

Authorisation Number: 37604-FAU

THIS AUTHORITY is made this 10th day of August 2018

PARTIES:

The Director-General of Conservation and where required the Minister of Conservation (the Grantor)
AND

Bioresearches Group Limited (the Authority Holder)

BACKGROUND:

A. The Director-General of Conservation is empowered to issue authorisations under the Wildlife Act 1953.

B. The Authority Holder wishes to exercise the authorisation issued under the Wildlife Act 1953 subject to the terms and conditions of this Authority.

OPERATIVE PARTS

In exercise of the Grantor's powers the Grantor:

AUTHORISES the Authority Holder under Section 53, and 56 of the Wildlife Act 1953, section 5 of the National Parks Act 1980, section 38 of the Conservation Act 1987, and 49 of the Reserves Act 1977, subject to the terms and conditions contained in this Authority and its Schedules.

SIGNED on behalf of the Grantor by David Speirs, Operations Director, Hauraki-Waikato-Taranaki acting under delegated authority

in the presence of:

Witness Signature

Witness Name: Amy Loomb

Witness Occupation: Personal Assistant

Witness Address: 73 Rostrevor St, Hamilton

A copy of the Instrument of Delegation may be inspected at the Director-General's office at 18-32 Manners Street, Wellington.

1

Appendix C Recce plot results

Table 32. Results from Recce plot 13

Species Name	Common name	Vegetation tier							BioStatus
		>25 m	12 - 25m	5 - 12m	2 - 5 m	30cm - 2m	<30cm	Epiphytic	
Alsophila tricolor	ponga			5	2		1		Indigenous Endemic
Asplenium flaccidum	drooping spleenwort							1	Indigenous Non-Endemic
Asplenium lamprophyllum	-						1		Indigenous Endemic
Asplenium oblongifolium	huruhuruwhenua / shining spleenwort						1	1	Indigenous Endemic
Asplenium polyodon	sickle spleenwort						1		Indigenous Non-Endemic
Astelia hastata	tank lily							1	Indigenous Endemic
***Astelia* sp.**	-							1	Indigenous Non-Endemic
Austroblechnum membranaceum	-						1		Indigenous Endemic
Beilschmiedia tarairi	taraire						1		Indigenous Endemic
Carex solandri	forest sedge						1		Indigenous Endemic
Carex uncinata	kamu / bastard grass / hook sedge						1		Indigenous Non-Endemic
Carpodetus serratus	putaputawētā / marble leaf			1					Indigenous Endemic
Coprosma rhamnoides	twiggy coprosma					1			Indigenous Endemic
Coprosma spathulata	-					1	1		Indigenous Endemic
Corybas trilobus	spider orchid								Indigenous Endemic
Dacrycarpus dacrydioides	kahikatea		2			1	1		Indigenous Endemic
Doodia australis	rasp fern							1	Indigenous Non-Endemic
Earina mucronata	peka-a-waka / bamboo orchid							1	Indigenous Endemic
Freycinetia banksii	kiekie					2			Indigenous Endemic
Gahnia pauciflora	cutting sedge					1			Indigenous Endemic
Geniostoma ligustrifolium* var. *ligustrifolium	hangehange					1	1		Indigenous Endemic

Hedycarya arborea	porokaiwhiri / pigeonwood			1	1	1	1		Indigenous Endemic
Icarus filiformis	thread fern						1		Indigenous Endemic
Knightia excelsa	rewarewa		3	2		1	1		Indigenous Endemic
Kunzea robusta	kānuka		2						Indigenous Endemic
Melicytus ramiflorus	māhoe					1			Indigenous Non-Endemic
Metrosideros diffusa	white rātā							1	Indigenous Endemic
Metrosideros perforata	akatea							1	Indigenous Endemic
Myrsine australis	māpou / red matipo			1	1		1		Indigenous Endemic
Nestegis lanceolata	white maire						1		Indigenous Endemic
Oplismenus hirtellus* subsp. *imbecillis	basket grass						1		Indigenous Non-Endemic
Phyllocladus trichomanoides	tanekaha		2	2	1	1	1		Indigenous Endemic
Podocarpus totara	tōtara					1			Indigenous Endemic
Pseudopanax crassifolius	lancewood			2					Indigenous Endemic
Rhabdothamnus solandri	taurepo					1			Indigenous Endemic
Rhopalostylis sapida	nīkau			2	1	3	1		Indigenous Endemic
Ripogonum scandens	supplejack							1	Indigenous Endemic
Zealandia pustulata* subsp. *pustulata	kōwaowao / hounds tongue fern						1	1	Indigenous Non-Endemic
Total cover in each vegetation tier		**0**	**6**	**5**	**2**	**2**	**2**	**0**	

Table 33. Results from Recce plot 23

Species Name	Common name	Vegetation tier							BioStatus
		>25 m	12 - 25m	5 - 12m	2 - 5 m	30cm - 2m	<30cm	Epiphytic	
Alsophila tricolor	ponga			4	4		1		Indigenous Endemic
Carex solandri	forest sedge			4			1		Indigenous Endemic
Carex uncinata	kamu / bastard grass / hook sedge			4			1		Indigenous Endemic

Coprosma lucida	karamū			3			1		Indigenous Endemic
Corynocarpus laevigatus	karaka			2			1		Indigenous Non-Endemic
Dacrycarpus dacrydioides	kahikatea				3	4	1		Indigenous Endemic
Geniostoma ligustrifolium* var. *ligustrifolium	hangehange				1	1	1		Indigenous Endemic
Hedycarya arborea	porokaiwhiri / pigeonwood			2					Indigenous Endemic
Knightia excelsa	rewarewa			2	1				Indigenous Endemic
Kunzea robusta	kānuka					1	1		Indigenous Endemic
Melicytus micranthus	swamp māhoe						1		Indigenous Endemic
Melicytus ramiflorus	māhoe						1		Indigenous Endemic
Metrosideros perforata	akatea					1	1		Indigenous Endemic
Myrsine australis	māpou / red matipo					1			Indigenous Endemic
Oplismenus hirtellus* subsp. *imbecillis	basket grass						1		Indigenous Non-Endemic
Phyllocladus trichomanoides	tanekaha						1		Indigenous Endemic
Podocarpus totara	tōtara						1		Indigenous Endemic
Pseudopanax crassifolius	lancewood						2	1	Indigenous Endemic
Rhabdothamnus solandri	taurepo						1		Indigenous Non-Endemic
Rhopalostylis sapida	nīkau						1		Indigenous Endemic
Total cover in each vegetation tier		**0**	**0**	**5**	**3**	**4**	**2**	**1**	

Table 34. Results from Recce plot C

Species Name	Common name	Vegetation tier							BioStatus
		>25 m	12 - 25m	5 - 12m	2 - 5 m	30cm - 2m	<30cm	Epiphytic	
Alsophila tricolor	ponga		2			1			Indigenous Endemic
Brachyglottis repanda	rangiora		2	2		1	1		Indigenous Endemic
Carex uncinata	kamu / bastard grass / hook sedge			1	1	1	1		Indigenous Endemic

Carpodetus serratus	putaputawētā / marble leaf			2	1	1	1		Indigenous Endemic
Coprosma rhamnoides	twiggy coprosma			2	1	1	1		Indigenous Endemic
Coprosma robusta	karamū			1	1		1		Indigenous Non-Endemic
Coprosma spathulata	-			1	1				Indigenous Endemic
Cordyline australis	tī kōuka / cabbage tree				4	1			Indigenous Endemic
Dianella nigra	tūrutu, New Zealand Blueberry				1	1	1		Indigenous Endemic
Geniostoma ligustrifolium* var. *ligustrifolium	hangehange				1				Indigenous Endemic
Hedycarya arborea	porokaiwhiri / pigeonwood				1				Indigenous Endemic
Knightia excelsa	rewarewa				1		1		Indigenous Endemic
Kunzea robusta	kānuka				1	1		1	Indigenous Non-Endemic
Leucopogon fasciculatus	soft mingimingi				1				Indigenous Endemic
Melicytus macrophyllus	large-leaved māhoe					1	1		Indigenous Endemic
Melicytus ramiflorus	māhoe					1			Indigenous Endemic
Myrsine australis	māpou / red matipo					1			Indigenous Endemic
Parablechnum novae-zelandiae	kiokio					1	1		Indigenous Endemic
Phormium tenax	harakeke / flax					1	1		Indigenous Endemic
Phyllocladus trichomanoides	tanekaha					1	1		Indigenous Endemic
Podocarpus totara	tōtara					1			Indigenous Endemic
Pseudopanax crassifolius	lancewood						1		Indigenous Endemic
Rhopalostylis sapida	nīkau						1		Indigenous Endemic
Rubus cissoides	bush lawyer						1		Indigenous Endemic
Tmesipteris elongata	fork fern						1		Indigenous Endemic
Total cover in each vegetation tier		**0**	**2**	**3**	**4**	**2**	**2**	**1**	

Table 35. Results from Recce plot D

Species Name	Common name	Vegetation tier							BioStatus
		>25 m	12 - 25m	5 - 12m	2 - 5 m	30cm - 2m	<30cm	Epiphytic	
Alsophila tricolor	ponga				3	1	1		Indigenous Endemic
Carex uncinata	kamu / bastard grass / hook sedge						2		Indigenous Endemic
Carpodetus serratus	putaputawētā / marble leaf				1				Indigenous Endemic
Clematis paniculata	puawānanga / white clematis			1					Indigenous Endemic
Coprosma rhamnoides	twiggy coprosma						1		Indigenous Endemic
Cordyline australis	tī kōuka / cabbage tree			2					Indigenous Endemic
Dianella nigra	tūrutu, New Zealand Blueberry						1		Indigenous Endemic
Geniostoma ligustrifolium* var. *ligustrifolium	hangehange				1		1		Indigenous Endemic
Knightia excelsa	rewarewa						1		Indigenous Endemic
Kunzea robusta	kānuka		1						Indigenous Endemic
Leucopogon fasciculatus	soft mingimingi						1		Indigenous Endemic
Melicytus ramiflorus	māhoe			1					Indigenous Non-Endemic
Metrosideros perforata	akatea				1	1	1		Indigenous Endemic
Myrsine australis	māpou / red matipo			2	1				Indigenous Endemic
Phyllocladus trichomanoides	tanekaha		2	3			1		Indigenous Endemic
Podocarpus totara	tōtara		1	2		1	1		Indigenous Endemic
Pseudopanax crassifolius	lancewood			1		1	1		Indigenous Endemic
Rhopalostylis sapida	nīkau						1		Indigenous Endemic
Zealandia pustulata* subsp. *pustulata	kowaowao / hounds tongue fern					1			Indigenous Non-Endemic
Total cover in each vegetation tier		**0**	**2**	**4**	**3**	**2**	**2**	**0**	

Appendix D Plant species lists

Table 36. Native plants recorded within the proposed project area

Botanical name	Common name	Regional threat classification	National threat classification
Conifers			
Agathis australis	**Kauri**	**At Risk - Declining**	**At Risk - Declining**
Dacrydium cupressinum	Rimu	Not threatened	Not Threatened
Dacrycarpus dacrydioides	Kahikatea	Not threatened	Not Threatened
Phyllocladus trichomanoides	Tanekaha	Not threatened	Not Threatened
Podocarpus totara var. *totara*	Tōtara	Not threatened	Not Threatened
Dicot herbs			
Acaena anserinifolia	Piripiri	Not threatened	Not Threatened
Centella uniflora	Centella	Not threatened	Not Threatened
Drosera auriculata	Sundew plant	Not threatened	Not Threatened
Euchiton audax		**At Risk - Declining**	**Not Threatened**
Euchiton japonicus		Not threatened	Not Threatened
Euchiton sphaericus		Not threatened	Not Threatened
Gonocarpus micranthus subsp. *micranthus*		Not threatened	Not Threatened
Lobelia anceps	Lobelia	Not threatened	Not Threatened
Nertera depressa	Nertera	Not threatened	Not Threatened
Nertera dichondrifolia	Nertera	Not threatened	Not Threatened
Persicaria decipiens	Willow weed	Not threatened	Not Threatened
Pseudognaphalium luteoalbum		Not threatened	Not threatened
Senecio hispidulus	Fire weed	Not threatened	Not Threatened
Veronica plebeia		Not threatened	Not Threatened
Dicot trees and shrubs			
Alectryon excelsus subsp. *excelsus*	Titoki	Not threatened	Not Threatened
Beilschmiedia tarairi	Taraire	Not threatened	Not Threatened
Brachyglottis repanda	Rangiora	Not threatened	Not Threatened
Carpodetus serratus	Putaputaweta/ marble leaf	Not threatened	Not Threatened
Clematis paniculata	Puawanaga	Not threatened	Not Threatened
Coprosma areolata	Thin leaved coprosma	Not threatened	Not Threatened
Coprosma autumnalis	kanono	Not threatened	Not Threatened
Coprosma lucida	Shining karamū	Not threatened	Not Threatened
Coprosma rhamnoides	Twiggy coprosma	Not threatened	Not Threatened
Coprosma robusta	Karamū	Not threatened	Not Threatened
Coprosma spathulata subsp. *spathulata.*	-	Not threatened	Not Threatened
Coriaria arborea var. *arborea*	Tutu	Not threatened	Not Threatened

Corynocarpus laevigatus	Karaka	Not threatened	Not Threatened
Elaeocarpus dentatus var. *dentatus*	Hinau	Not threatened	Not Threatened
Geniostoma ligustrifolium var. *ligustrifolium*	Hangehange	Not threatened	Not Threatened
Hedycarya arborea	Porokaiwiri / pigeonwood	Not threatened	Not Threatened
Knightia excelsa	Rewarewa	Not threatened	Not Threatened
Kunzea robusta	**Kānuka**	**At Risk - Declining**	**Not Threatened**
Leptospermum scoparium var. scoparium	**Mānuka**	**Threatened - Regionally Vulnerable**	**Not Threatened**
Leucopogon fasciculatus	Mingimingi	Not threatened	Not Threatened
Melicytus macrophyllus	**Large leaved māhoe**	**At Risk - Naturally Uncommon**	**Not Threatened**
Melicytus micranthus	**Swamp māhoe**	**Threatened - Regionally Vulnerable**	**Not Threatened**
Melicytus ramiflorus subsp. *ramiflorus*	Māhoe	Not threatened	Not Threatened
Metrosideros perforata	**Small white rata**	**At Risk - Declining**	**Not Threatened**
Myrsine australis	Māpou/ matipo	Not threatened	Not Threatened
Olearia rani var. *rani*	Heketara	Not threatened	Not Threatened
Parsonsia heterophylla	New Zealand jasmine	Not threatened	Not Threatened
Pennantia corymbosa	Kaikōmako	Threatened - Regionally Endangered	Not Threatened
Piper excelsum subsp. *excelsum*	Kawakawa	Not threatened	Not Threatened
Pomaderris kumeraho	Kūmarahou	At Risk - Declining	Not Threatened
Pseudopanax crassifolius	Lancewood	Not threatened	Not Threatened
Rhabdothamnus solandri	Taurepo / New Zealand gloxinia	Not threatened	Not Threatened
Rubus cissoides	Bush lawyer	Not threatened	Not Threatened
Schefflera digitata	Pate	Not threatened	Not Threatened
Vitex lucens	Pūriri	Not threatened	Not Threatened
Ferns & Fern allies			
Adiantum hispidulum	Rosy maidenhair fern	Not threatened	Not Threatened
Alsophila tricolor	Ponga / silver fern	Not threatened	Not Threatened
Asplenium flaccidum	Hanging spleenwort	Not threatened	Not Threatened
Asplenium oblongifolium	Shining spleenwort	Not threatened	Not Threatened
Asplenium polyodon	Sickle spleenwort	Not threatened	Not Threatened
Dicksonia squarrosa	Whekī ponga	Not threatened	Not Threatened
Diploblechnum fraseri		Not threatened	Not Threatened
Doodia australis	Rasp fern	Not threatened	Not Threatened
Gleichenia microphylla	**Tangle fern**	**At Risk - Declining**	**Not Threatened**
Icarus filiformis	Thread fern/ nini	Not threatened	Not Threatened
Lecanopteris pustulata subsp. *pustulata*	Kowaowao / hounds tongue fern	Not threatened	Not Threatened
Lycopodium volubile	Climbing clubmoss	Not threatened	Not Threatened

Paesia scaberula	Ring fern	Not threatened	Not Threatened
Pakau pennigera	Gully fern	Not threatened	Not Threatened
Parablechnum novae-zelandiae	Kiokio	Not threatened	Not Threatened
Pteridium esculentum	Bracken	Not threatened	Not Threatened
Sphaeopteris medullaris	Mamaku	Not threatened	Not Threatened
Tmesipteris elongata	Fork fern	Not threatened	Not Threatened
Tmesipteris lanceolata	Fork fern	Not threatened	Not Threatened
Monocots			
Astelia trinervia	Kauri grass	Not threatened	Not Threatened
Austroderia aff. *fulvida*	**Toetoe**	**Threatened - Regionally Endangered**	**Not Threatened**
Carex uncinata	Hook sedge	Not threatened	Not Threatened
Carex banksiana	Fine leaved hook sedge	Not threatened	Not Threatened
Carex dissita	Forest sedge	Not threatened	Not Threatened
Carex lessoniana	-	Not threatened	Not Threatened
Carex ochrosaccus	Forest sedge	At Risk - Declining	Not Threatened
Carex solandri	forest sedge	Not threatened	Not Threatened
Carex uncinata	kamu / bastard grass / hook sedge	Not threatened	Not Threatened
Carex virgata	-	Not threatened	Not Threatened
Cordyline australis	Tī kōuka / cabbage tree	Not threatened	Not Threatened
Cordyline banksii	Te ngahere	Not threatened	Not Threatened
Dianella nigra	Turutu, New Zealand blueberry	Not threatened	Not Threatened
Eleocharis acuta	Sharp spike sedge	Not threatened	Not Threatened
Freycinetia banksii	Kiekie	Not threatened	Not Threatened
Gahnia lacera	Cutty grass	Not threatened	Not Threatened
Gahnia setifolia	Razor sedge	Not threatened	Not Threatened
Juncus planifolius	Grass-leaved rush	Not threatened	Not Threatened
Microlaena stipoides	Slender rice grass	Not threatened	Not Threatened
Oplismenus hirtellus subsp. imbecillis	Basket grass	Not threatened	Not Threatened
Pentapogon crinitus	Long hair plume grass	Not Threatened	Not Threatened
Pentapogon inaequiglumis	**Short hair plume grass**	**Threatened - Regionally Vulnerable**	**At Risk – Declining**
Phormium tenax	Harakeke/ flax	Not threatened	Not Threatened
Pterostylis banksii	Greenhood orchid	Not threatened	Not Threatened
Rhopalostylis sapida	Nīkau palm	Not threatened	Not Threatened
Ripogonum scandens	Supplejack	Not threatened	Not Threatened
Schoenus tendo	Kauri grass	Not threatened	Not Threatened

Table 37. Weedy exotic plants recorded within the project area

Botanical name	Common name
Carex longebrachiata	Australian sedge
Cortaderia selloana	Pampas
Crocosmia x crocosmiiflora	Montbretia
Digitalis purpurea	Foxglove
Phytolacca octandra	Inkweed
Pinus radiata	Monterey pine
Rubus fruticosus	Blackberry
Selaginella kraussiana	Selaginella
Solanum mauritianum	Woolly nightshade
Ulex europaeus	Gorse

Appendix E Invertebrate Desktop Study Results

Full results for the desktop study iNaturalist database search for invertebrates are presented in Table 35.

Where threat classifications for a species have been assigned, these are included in Table 35. Where they are not available, the biostatus (e.g., endemic, native or exotic) as been included, along with any relevant information on the species threat status.

Table 38. Invertebrate desktop records within 5 km of the project area

Common Name	Latin Name	Biostatus and/or Threat classification
Aenetus virescens	Pūriri moth	Endemic
Amarygmus watti	Darkling beetle	Exotic
Amphipsalta zelandica	Chorus cicada	Endemic
Anthidium manicatum	European woolcarder bee	Exotic
Apis melifera	Western honey bee	Exotic
Arhopalus ferus	Burnt pine longhorn	Exotic
Austrolestes colensonis	Blue damselfly	Endemic
Badumna insignis	Black house spider	Introduced and Naturalised
Balta bicolor	Wood cockroach	Exotic
Calliphora sp.	Bluebottle fly	-
Capua intractana	-	Native
Clitarchus hookeri	Smooth stick insect	Not Threatened
Conocephalus semivittatus	Blackish meadow katydid	Not Threatened
Conoderus exsul	Pasture wireworm	Native
Cryptamorpha desjardinsi	Desjardins's flat beetle	Exotic
Culex pervigilans	Vigilant mosquito	Exotic
Cycloctenus sp.	Cyclotenid spider	-
Danaus plexippus	Monarch butterfly	Native
Deinacrida heteracantha	Wētāpunga*	Threatened – Nationally Increasing
Dicranosterna semipunctata	Leaf beetle	Exotic
Dolomedes minor	Nurseryweb spider	Not Threatened
Dysdera crocata	Slater spider	Not Threatened
Eristalis tenax	Common drone fly	Exotic
Eudonia minualis	Little orange-spot scoparia moth	Endemic
Helastia cinerearia	Carpet moth	Endemic
Hemideina thoracica	Auckland tree wētā	Not Threatened
Hermetia illucens	Black soldier fly	Exotic
Hypodrassodes maoricus	-	Not Threatened
Liarea turriculata ssp. *turriculata**	-	Not Threatened
Micromus tasmaniae	Tasmanian lacewing	Exotic
Miomantis caffra	South african mantis	Exotic
Mycetophilidae sp.	Fungus gnats	-
Opogona omoscopa	Dusky scuttler	Exotic
Orthodera novaezealandiae	New Zealand mantis	Endemic
Oxysarcodexia varia	Flesh fly	Exotic

Paryphanta busbyi	Kauri snail	At Risk - Declining
Pholcidae sp.	Cellar spider	-
Pieris rapae	Cabbage butterfly	Exotic
Schrankia costaestrigalis	Pinion-streaked Snout	Native
Sidymella sp.	Square-ended crab spiders	-
Siphanta acuta	Torpedo bug	Exotic
Socca pustulosa	Knobbled orbweaver	Not Threatened
Steatoda capensis	False katipo	Introduced and Naturalised
Steatoda grossa	False black widow	Introduced and Naturalised
Tipulidae sp.	Crane fly	-
Trite planiceps	Black-headed jumping spider	Not Threatened
Uliodon sp.	Vagrant spider	-
Wiseana signata	Sand porina	Endemic
Xyridacma ustaria	Tarata looper	Endemic
Zizina otis ssp. *labradus*	Common blue	Exotic

Appendix F Stream search effort and habitat suitability for native frogs at Kings Quarry

Table 39. Stream search effort and habitat suitability for native frogs at Kings Quarry

Stream	Habitat Assessment	Representative images	Search effort
1	**Not suitable:** soft bottomed, incised channels. Storm / slit damaged.	Photo 8	Not searched
2	**Not suitable:** soft bottomed, incised channels. Storm / silt damaged	Photo 9	Not searched
3	**Not suitable**		Not searched
4	**Localised habitat** (cobbles and waterfall)	Photos 11 & 12	2 hours targeted searches of cobbles and large waterfall (cracks and overhanging vegetation)
5	**Not suitable** Storm damaged, slips and silt covered	Photo 10	Not searched
6	**Marginal** Some rock (not bedrock), but largely owing to historic modifications associated with existing pit infrastructure. Remainder is soft bottomed and channelised	Photo 14, 18	Road side edges searched- rock substrate installed. Upper parts unsuitable.
7	**Suitable** Bedrock, cobbles and boulders, particularly within short length of consented Stage 1 (previously searched as well)	Photos 15, 19, 20, 22, 23, 26, 27	4 search hours: Nov 2023 (Visited twice). Also searched during consented Stage 1 investigations (Bioresearches 2021)
8	**Suitable** Few small localised bedrock waterfalls	Photos 4a and 4b	2 search hours Nov 2023 (Visited twice). Also searched during consented Stage 1 investigations (Bioresearches 2021).
9	**Marginal- localised** Some localised areas of rock but largely imbedded and silt-laden	Photo 21	1 search hour Dec 2024
10	**Not suitable** The dominant substrate throughout consisted of soft sediments with occasional imbedded gravels	Photos 28-31	Not searched
11	**Not suitable** Soft sediment, no bedrock		Not searched
12	**Not suitable** Soft sediment, no bedrock		Not searched
13	**Marginal- localised** Few waterfalls, localised cobble areas but mostly silt-laden and often deeply incised.	Photos 32-37	1 search hour Dec 2024

Appendix G eDNA analysis results

Table 40. eDNA analysis results

ScientificName	Rank	TaxID	CommonName	Group	535597	535590	535595	535594	535596	535591	535592	535593	535589
Gobiomorphus cotidianus	species	226931	Common bully; tīpokopoko; toitoi	Fish	9024	0	17192	0	12242	0	0	0	0
Echyridella menziesii	species	981778	Freshwater mussel; kākahi; kāeo; torewai	Molluscs	859	0	1325	0	287	0	0	0	0
Acanthocyclops robustus	species	415614	Copepod	Crustaceans	1948	0	0	0	66	0	0	0	0
Gobiomorphus huttoni	species	587584	Redfin bully	Fish	58	0	1107	0	607	0	0	0	0
Anguilla dieffenbachii	species	61127	Longfin eel; tuna; kūwharuwharu; reherehe; kirirua	Fish	392	252	512	0	451	0	0	1292	0
Bos taurus	species	9913	Cattle; kau	Mammals	170	0	323	0	692	0	0	0	0
Chaetogaster diastrophus	species	74727	Oligochaete worm	Worms	92	0	370	50	224	0	0	0	0
Trichosurus vulpecula	species	9337	Common brushtail possum; paihamu; paihama	Mammals	202	0	268	0	66	0	0	0	0
Capra hircus	species	9925	Goat; nanenane	Mammals	0	0	411	0	0	0	0	0	0
Rattus rattus	species	10117	Black Rat; hinamoki; inamoki	Mammals	45	0	0	340	0	0	0	0	0
Oxyethira albiceps	species	697957	Micro caddisfly	Insects	98	77	10	0	151	0	0	0	0
Galaxias fasciatus	species	89555	Banded kokopu; kokōpu	Fish	0	0	279	0	54	0	0	0	0
Gambusia affinis	species	33528	Mosquitofish	Fish	0	0	309	0	0	0	0	0	0
Amynthas corticis	species	351238	Snake worm	Worms	22	0	51	20	167	0	0	0	0
Psilochorema mimicum	species	697960	NZ caddisfly	Insects	6	59	10	18	113	27	0	0	0
Potamothrix bavaricus	species	745771	Aquatic oligochaete worm	Worms	79	0	131	0	13	0	0	0	0
Cochliopodium kieliense	species	1512276	Amoeba	Amoebae	11	19	0	123	44	23	0	0	0
Octolasion lacteum	species	334871	Worm	Worms	28	0	116	0	49	0	0	0	0
Anas platyrhynchos	species	8839	Mallard duck; rakiraki	Birds	0	0	0	0	174	0	0	0	0
Nothophytophthora sp. *'liri'*	species	2796156		Oomycetes	0	0	0	153	0	21	0	0	0
Lumbriculus variegatus	species	61662	Blackworm	Worms	34	0	119	0	19	0	0	0	0
Austrosimulium australense	species	10000005	Sandfly	Insects	170	0	0	0	0	0	0	0	0
Anguilla australis	species	7940	Shortfin eel; tuna; hao; aopori; hikumutu	Fish	0	0	0	0	140	0	0	0	0
Hydrobiosis gollanis	species	697987	NZ Caddisfly	Insects	23	21	19	0	66	0	0	0	0
Limnodrilus hoffmeisteri	species	76587	Redworm	Worms	0	0	72	0	56	0	0	0	0
Potamopyrgus antipodarum	species	145637	Mud Snail	Molluscs	29	22	0	26	42	0	0	0	0
uncultured *Pythium*	species	205931		Oomycetes	34	8	0	0	59	0	0	0	0
Aulodrilus pluriseta	species	76585	Aquatic oligochaete worm	Worms	0	0	70	0	25	0	0	0	0
Triplectides obsoletus	species	697963	NZ caddisfly	Insects	55	0	25	0	15	0	0	0	0

Aporrectodea caliginosa	species	302032	Worm	Worms	0	0	5	0	82	0	0	0	0
Psychodidae sp. BOLD:AAU4648	species	2660484		Insects	22	12	0	21	17	12	0	0	0
Eiseniella tetraedra	species	1302610	Squaretail worm	Worms	10	0	10	0	63	0	0	0	0
Paratanytarsus grimmii	species	288873	Chironomid	Insects	52	0	9	0	21	0	0	0	0
Chaetogaster diaphanus	species	212246	Oligochaete worm	Worms	10	0	64	0	7	0	0	0	0
Isotomurus palustris	species	36144	Marsh springtail	Springtails	0	30	0	44	0	0	0	0	0
Orthonychiurus folsomi	species	2581074	Springtail	Springtails	21	0	0	0	52	0	0	0	0
Phasianus colchicus	species	9054	Pheasant	Birds	0	0	69	0	0	0	0	0	0
Nocturama antipodites	species	123749	Freshwater red alga	Red algae	8	0	0	0	57	0	0	0	0
Ophyiulus pilosus	species	118470	Millipede	Other	0	0	0	45	14	0	0	0	0
Chydorus brevilabris	species	362310	Water flea	Crustaceans	56	0	0	0	0	0	0	0	0
Chrysophyceae sp.	species	1955566		Heterokont algae	0	17	0	0	0	39	0	0	0
Orthopsyche thomasi	species	486978	Caddisfly	Insects	0	0	0	50	0	0	0	24	0
Polyplectropus aurifuscus	species	1875897	Caddisfly	Insects	0	15	0	10	0	22	0	18	0
Sheathia transpacifica	species	2781386	Red alga	Red algae	13	0	0	0	32	0	0	0	0
Compsopogon caeruleus	species	31354	Freshwater red alga	Red algae	24	0	0	0	15	0	0	0	0
Declana floccosa	species	344251	Forest semilooper	Insects	38	0	0	0	0	0	0	0	0
Tanytarsus sp. EJD-2015	species	1763607	Non-biting midge	Insects	15	0	0	0	23	0	0	0	0
Eukerria saltensis	species	169929	Worm	Worms	0	0	0	0	35	0	0	0	0
Prostoma graecense	species	324887	Freshwater nemertean	Ribbon worms	17	7	0	0	0	11	65	0	0
Nothocladus ater	species	69142	Red algae	Red algae	0	28	0	0	0	0	0	0	0
Cheimarrichthys fosteri	species	206139	Torrentfish; panoko; pānokonoko; pānonoko	Fish	0	0	28	0	0	0	0	0	0
Dama dama	species	30532	Fallow deer	Mammals	0	0	23	0	0	0	0	0	0
Orthopsyche fimbriata	species	329710	Hydropsychid caddisfly	Insects	11	0	0	9	0	0	0	0	0
Lepidoptera sp. NZAC 03012277	species	1597328		Insects	0	20	0	0	0	0	0	0	0
Spumella sp.	species	1955568	Golden-brown alga	Heterokont algae	0	0	0	19	0	0	0	0	0
Nais communis	species	188228	Sludgeworm	Worms	0	17	0	0	0	0	0	0	0
Onychiuridae sp. DPCOL101273	species	676432	Springtail	Springtails	0	0	0	17	0	0	0	0	0
Hydroptilidae sp. 12KH6B	species	1877717	Purse-case caddisfly	Insects	0	0	0	0	17	0	0	0	0
Psilota tristis	species	2714830	Hoverfly	Insects	0	0	0	17	0	0	0	0	0
Globisporangium cystogenes	species	295491	Parasitic oomycete	Oomycetes	0	0	0	16	0	0	0	0	0

Clubiona peculiaris	species	1212509	Sac spider	Spiders	16	0	0	0	0	0	0	0	0
Phytophthora chlamydospora	species	1692154	Water mould	Oomycetes	0	0	0	16	0	0	0	0	0
Corynoneura scutellata	species	611450	Non-biting midge	Insects	15	0	0	0	0	0	0	0	0
Oxyethira ahipara	species	1968965	Microcaddisfly	Insects	0	15	0	0	0	0	0	0	0
Hirundo neoxena	species	317132	Welcome swallow; warou	Birds	0	0	14	0	0	0	0	0	0
Trichoptera sp. BOLD:AAK1684	species	977119		Insects	0	14	0	0	0	0	0	0	0
Hydra vulgaris	species	6087	Hydra	Cnidarians	0	0	5	0	7	0	0	0	0
Lumbricus rubellus	species	35632	Red earthworm	Worms	0	0	12	0	0	0	0	0	0
Ablabesmyia sp. NZ08.Motel	species	1981520		Insects	12	0	0	0	0	0	0	0	0
Cornu aspersum	species	6535	Garden snail	Molluscs	0	0	0	0	11	0	0	0	0
Nitzschia palea	species	303400	Diatom	Diatoms	0	0	0	5	0	6	0	0	0
Rhododrilus n. sp. 7 TRB-2010	species	925722	Worm	Worms	0	0	0	0	11	0	0	0	0
Neotoxoptera formosana	species	1425443	Onion aphid	Insects	0	11	0	0	0	0	0	0	0
Austroclima sepia	species	1968917	Mayfly	Insects	0	0	0	0	11	0	0	0	0
Craspedacusta sowerbii	species	128124	Freshwater jellyfish	Cnidarians	10	0	0	0	0	0	0	0	0
Deroceras reticulatum	species	145610	Grey field slug; Grey garden slug	Molluscs	10	0	0	0	0	0	0	0	0
Paraphysomonas sp.	species	1955561	Golden-brown alga	Heterokont algae	0	0	0	0	10	0	0	0	0
Paracyclops fimbriatus	species	1606834	Copepod	Crustaceans	0	9	0	0	0	0	0	0	0
Diptera sp. NZAC 03009279	species	1596738		Insects	0	0	0	0	0	8	30	23	0
Mallomonas sp.	species	2003107		Heterokont algae	8	0	0	0	0	0	0	0	0
Paracalliope fluviatilis	species	359163	Amphipod crustacean	Crustaceans	0	0	0	0	6	0	0	0	0
Takecallis taiwana	species	1425415		Insects	0	0	0	0	6	0	0	0	0
Chydorus sphaericus complex sp. A1	species	1939838		Crustaceans	6	0	0	0	0	0	0	0	0
Pemphigus populitransversus	species	220090	Poplar petiole gall aphid	Insects	5	0	0	0	0	0	0	0	0
Neelidae sp. DPCOL67088	species	676489	Springtail	Springtails	0	0	0	5	0	0	0	0	0
Megascolex laingii	species	914218	Worm	Worms	0	0	5	0	0	0	0	0	0
Daphnia pulex or *pulicaria*	species	10000156	Water flea	Crustaceans	0	0	0	0	0	5	0	0	0
Gobiomorphus	genus	86236	Bullies	Fish	2924	0	5574	0	1349	0	0	0	0
Nais	genus	74730	Sludgeworm	Worms	163	157	744	0	686	0	0	0	0
Dero	genus	66487	Worm	Worms	0	0	402	0	0	0	0	0	0
Nitzschia	genus	2857	Pennate diatom	Diatoms	0	33	0	28	0	114	0	0	0

Amynthas	genus	195544	Worm	Worms	12	0	0	112	40	0	0	0	0
Hydrobiosis	genus	697982	NZ Caddisfly	Insects	17	27	23	0	65	0	0	0	0
Cochliopodium	genus	313557	Amoeba	Amoebae	0	8	0	29	19	0	0	0	0
Rhopalosiphum	genus	40931	Aphid	Insects	30	0	6	0	15	0	0	0	0
Rattus	genus	10114	Rat	Mammals	0	0	0	45	0	0	0	0	0
Arcitalitrus	genus	1238132	Sandhopper	Crustaceans	12	24	0	0	0	5	0	0	0
Spumella	genus	89043	Golden-brown alga	Heterokont algae	0	0	0	0	24	12	0	0	0
Calliphora	genus	7372		Insects	6	0	0	0	25	0	0	0	0
Gonium	genus	33096	Green alga	Green algae	10	0	0	0	10	0	0	0	0
Orthopsyche	genus	329709	Hydropsychid caddisfly	Insects	0	20	0	0	0	0	0	0	0
Potamopyrgus	genus	145636	Mud snails	Molluscs	0	11	6	0	0	0	0	0	0
Philodina	genus	44581	Rotifer	Rotifers	13	0	0	0	0	0	0	0	0
Phytophthora	genus	4783	Water mold	Oomycetes	0	0	0	0	12	0	0	0	0
Simocephalus	genus	77650		Crustaceans	11	0	0	0	0	0	0	0	0
Tubifex	genus	6385	Worm	Worms	0	10	0	0	0	0	0	0	0
Ctenopseustis	genus	65023	Brownheaded leafroller moth	Insects	0	0	5	0	0	0	0	0	0
Chironomidae	family	7149	Nonbiting midges	Insects	112	125	0	0	67	6	0	0	0
Cecidomyiidae	family	33406	Gall midges	Insects	33	23	6	162	0	0	0	0	0
Hyriidae	family	96925		Molluscs	26	0	0	0	49	0	0	0	0
Isotomidae	family	36141	Smooth springtails	Springtails	0	59	0	0	0	0	0	0	0
Sciaridae	family	7184	Black fungus gnats	Insects	0	0	0	0	20	0	0	0	0
Lumbricidae	family	6392		Worms	0	8	0	0	7	0	0	0	0
Chrysomelidae	family	27439	Leaf beetles	Insects	0	0	0	0	5	0	0	0	0
Charopidae	family	69587		Molluscs	0	5	0	0	0	0	0	0	0
root	no rank	1	Unidentified	Other	5059	4552	770	7092	6913	8321	0	0	0
Metazoa	kingdom	33208	Metazoans	Other	518	937	350	1353	1367	849	590	375	8
Insecta	class	50557	Insects	Other	776	1332	409	56	2247	172	793	96	0
Arthropoda	phylum	6656	Arthropods	Other	568	2235	273	501	671	122	142	78	0
Diptera	order	7147	Flies	Insects	9	839	32	98	51	19	0	20	0
Crustacea	subphylum	6657	Crustaceans	Other	0	0	339	0	0	0	0	0	0
Annelida	phylum	6340	Annelid worms	Other	0	0	0	0	113	0	0	0	0
Clitellata	class	42113		Worms	44	0	9	0	55	0	0	0	0
Coleoptera	order	7041	Beetles	Insects	47	0	13	0	32	0	0	0	0
Lepidoptera	order	7088	Butterflies and moths	Insects	0	0	0	0	57	0	0	0	0
unclassified Paraphysomonas	no rank	2617784		Heterokont algae	0	0	0	45	0	0	0	0	0
Trichoptera	order	30263	Caddisflies	Insects	0	0	0	0	43	0	0	0	0
Oomycota	phylum	4762		Heterokont algae	20	0	0	0	22	0	0	0	0

unclassified Diptera	no rank	265461		Insects	0	42	0	0	0	0	0	0	0
Eurotatoria	class	2816136		Rotifers	0	6	0	21	0	0	0	0	0
Viridiplantae	kingdom	33090	Green plants	Other	26	0	0	0	0	0	0	0	0
Araneae	order	6893	Spiders	Other	0	0	0	24	0	0	0	0	0
Branchiopoda	class	6658		Crustaceans	0	0	0	22	0	0	0	0	0
Mammalia	class	40674	Mammals	Other	22	0	0	0	0	0	0	0	0
Fungi	kingdom	4751		Other	0	6	0	0	15	0	0	0	0
unclassified Chaetogaster	no rank	2664999		Worms	0	0	0	0	20	0	0	0	0
Actinopteri	class	186623		Other	0	0	0	0	19	0	0	0	0
Tubulinea	phylum	555369		Amoebae	0	0	0	19	0	0	0	0	0
Arachnida	class	6854	Arachnids	Other	0	0	0	12	0	0	0	0	0
Poduromorpha	order	730331		Springtails	12	0	0	0	0	0	0	0	0
unclassified Segregatospumella	no rank	2622448		Heterokont algae	0	0	0	12	0	0	0	0	0
Chordata	phylum	7711	Chordates	Other	6	0	0	0	5	0	0	0	0
unclassified Andracalles	no rank	2877279		Insects	0	0	0	11	0	0	0	0	0
Polydesmida	order	71419		Other	0	0	0	10	0	0	0	0	0
unclassified Forcipomyiinae	no rank	1474665		Insects	0	0	0	0	9	0	0	0	0
Arcellinida	order	318493		Amoebae	0	0	0	0	7	0	0	0	0
Sarcoptiformes	order	83137		Mites and ticks	6	0	0	0	0	0	0	0	0
Octolasion cyaneum	species	302033	Worm	Worms	0	0	0	0	0	0	0	344	0
Pseudoeconesus bistirpis	species	698000	Caddisfly	Insects	0	0	0	0	0	0	0	29	0
Hydropsychinae	subfamily	147297	Caddisflies	Insects	0	0	0	0	0	0	8	0	0
Chironomini	tribe	72530		Insects	0	0	0	0	0	0	0	5869	0
root	no rank	1	Unidentified	Other	0	0	0	0	0	0	3123	1290	89
Mollusca	phylum	6447	Molluscs	Other	0	0	0	0	0	0	41	0	0
Opiliones	order	43271	Daddy longlegs	Other	0	0	0	0	0	0	0	5	0

Appendix H Full avifauna desktop study results

Table 41. Full Avifauna desktop search results

Threat Classification (Robertson *et al.*, 2021)	Common Name	Scientific Name
Threatened – Nationally Critical	Australasian Bittern, Matuku Hūrepo	*Botaurus poiciloptilus*
Threatened – Nationally Vulnerable	Caspian Tern, Taranui	*Hydroprogne caspia*
	Grey Duck, Pārera	*Anas superciliosa*
	South Island (SI) Takahe, Takahē	*Porphyrio hochstetteri*
Threatened – Nationally Increasing	New Zealand (NZ) Dabchick, Weweia	*Poliocephalus rufopectus*
At Risk – Declining	Banded Rail, Moho Pererū	*Gallirallus philippensis assimilis*
	New Zealand (NZ) Pipit, Pīhoihoi	*Anthus novaeseelandiae novaeseelandiae*
	North Island (NI) Fernbird, Mātātā	*Poodytes punctatus vealeae*
	Red-Billed Gull, Tarāpunga	*Chroicocephalus novaehollandiae scopulinus*
	South Island Pied Oystercatcher (SIPO), Tōrea	*Haematopus finschi*
	Spotless Crake, Pūweto	*Zapornia tabuensis tabuensis*
At Risk – Recovering	North Island (NI) Kaka, Kākā	*Nestor meridionalis septentrionalis*
	Northern New Zealand (NZ) Dotterel, Tūturiwhatu	*Charadrius obscurus aquilonius*
	Pāteke, Brown Teal (North Island)	*Anas chlorotis (North Island)*
	Pied Shag, Kāruhiruhi	*Phalacrocorax varius varius*
	Variable Oystercatcher (VOC), Tōrea	*Haematopus unicolor*
At Risk – Relict	Black Shag, Kawau Tuawhenua	*Phalacrocorax carbo novaehollandiae*
	Cook's Petrel, Tītī	*Pterodroma cookii*
	New Zealand (NZ) Red-Crowned Parakeet, Kākāriki	*Cyanoramphus novaezelandiae novaezelandiae*
At Risk – Naturally Uncommon	Little Black Shag, Kawau Tūī	*Phalacrocorax sulcirostris*
	Royal Spoonbill, Kōtuku Ngutupapa	*Platalea regia*
Not Threatened	Australasian Gannet, Tākapu	*Morus serrator*
	Australasian Harrier, Kāhu	*Circus approximans*
	Australasian Shoveler, Kuruwhengu	*Spatula rhynchotis*
	Black Swan, Wāna	*Cygnus atratus*
	Grey Teal, Tētē Moroiti	*Anas gracilis*
	Grey Warbler, Riroriro	*Gerygone igata*
	Kererū, New Zealand (NZ) Pigeon, Kūkupa, Kūkū	*Hemiphaga novaeseelandiae*
	Morepork, Ruru	*Ninox novaeseelandiae novaeseelandiae*
	New Zealand (NZ) Kingfisher, Kōtare	*Todiramphus sanctus vagans*
	New Zealand (NZ) Scaup, Pāpango	*Aythya novaeseelandiae*
	North Island (NI) Fantail, Pīwakawaka	*Rhipidura fuliginosa placabilis*
	North Island (NI) Tomtit, Pied Tit	*Petroica macrocephala toitoi*

	Paradise Shelduck, Parrie, Pūtangitangi	*Tadorna variegata*
	Pied Stilt, Poaka	*Himantopus himantopus leucocephalus*
	Pūkeko	*Porphyrio melanotus melanotus*
	Silvereye, Tauhou	*Zosterops lateralis*
	Southern Black-Backed Gull, Karoro	*Larus dominicanus*
	Spur-Winged Plover	*Vanellus miles novaehollandiae*
	Tui, Tūī	*Prosthemadera novaeseelandiae novaeseelandiae*
	Welcome Swallow, Warou	*Hirundo neoxena neoxena*
	White-Faced Heron	*Egretta novaehollandiae novaehollandiae*
Non-resident - Vagrant	Little Pied Shag	*Microcarbo melanoleucos melanoleucos*
	Long-Tailed Cuckoo, Koekoeā	*Eudynamys taitensis*
	Shining Cuckoo, Pīpīwharauroa	*Chrysococcyx lucidus lucidus*
Introduced and Naturalised	Australian Magpie	*Gymnorhina tibicen*
	Barbary Dove	*Streptopelia risoria*
	Blackbird	*Turdus merula*
	Brown Quail	*Synoicus ypsilophorus*
	California Quail, Koera	*Callipepla californica*
	Canada Goose, Kuihi	*Branta canadensis*
	Chaffinch	*Fringilla coelebs*
	Common Starling	*Sturnus vulgaris*
	Dunnock	*Prunella modularis*
	Eastern Rosella	*Platycercus eximius*
	Eurasian Skylark	*Alauda arvensis*
	Goldfinch	*European goldfinch*
	Greenfinch	*Chloris chloris*
	Greylag Goose	*Anser anser*
	House Sparrow	*Passer domesticus*
	Indian Myna	*Acridotheres tristis*
	Indian Peafowl, Pīkake	*Pavo cristatus*
	Laughing Kookaburra	*Dacelo novaeguineae*
	Malay Spotted Dove	*Streptopelia chinensis*
	Mallard Duck, Rakiraki	*Anas platyrhynchos*
	Pheasant, Peihana	*Phasianus colchicus*
	Rock Pigeon	*Columba livia*
	Song Thrush	*Turdus philomelos*
	Turkey, Korukoru	*Meleagris gallopavo*
	Yellowhammer	*Emberiza citrinella*

Appendix I Five-minute bird count data

Table 42.. Full five minute bird count results

Species	Native/Introduced	WF11 (outside pit)	VS5 (Within pit)	VS2 (within pit)	VS2 (outside pit)
Fantail, Nth Is	Native	2.00 ± 1.06	2.00 ± 0.00	2.00 ± 0.71	2.00 ± 0.84
Harrier, Australasian	Native	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Kingfisher, NZ	Native	0.00 ± 0.00	1.50 ± 1.50	0.00 ± 0.00	0.00 ± 0.00
Pigeon, NZ/Kereru/Kupapa	Native	2.00 ± 0.58	0.50 ± 0.50	3.50 ± 1.19	2.60 ± 1.08
Plover, Spur-winged	Native	0.00 ± 0.00	0.00 ± 0.00	0.50 ± 0.29	0.00 ± 0.00
Pūkeko	Native	0.00 ± 0.00	0.50 ± 0.50	0.50 ± 0.29	0.00 ± 0.00
Shelduck, Paradise	Native	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Silvereye	Native	4.17 ± 0.60	4.00 ± 1.00	6.75 ± 0.75	6.40 ± 1.03
Swallow, Welcome	Native	0.00 ± 0.00	0.00 ± 0.00	0.50 ± 0.50	0.00 ± 0.00
Tomtit, Nth Is	Native	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Tui	Native	3.83 ± 0.31	1.00 ± 0.00	2.00 ± 0.71	2.60 ± 0.87
Warbler, Grey	Native	2.33 ± 0.33	2.00 ± 2.00	1.75 ± 0.48	3.20 ± 0.37
Whitehead	Native	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Blackbird	Introduced	1.67 ± 0.42	0.00 ± 0.00	0.00 ± 0.00	0.80 ± 0.37
Chaffinch	Introduced	0.50 ± 0.34	1.50 ± 1.50	1.00 ± 0.41	0.00 ± 0.00
Dove, Barbary	Introduced	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Goose, Canada	Introduced	0.00 ± 0.00	1.00 ± 1.00	0.00 ± 0.00	0.00 ± 0.00
Magpie, Australian	Introduced	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.20 ± 0.20
Myna, Indian	Introduced	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Pheasant	Introduced	0.00 ± 0.00	0.50 ± 0.50	0.25 ± 0.25	0.40 ± 0.40
Pigeon, Feral	Introduced	0.00 ± 0.00	0.00 ± 0.00	1.50 ± 1.50	0.00 ± 0.00
Quail, California	Introduced	0.33 ± 0.21	2.00 ± 2.00	0.00 ± 0.00	0.00 ± 0.00
Rosella, Eastern	Introduced	0.00 ± 0.00	2.00 ± 1.00	0.25 ± 0.25	0.00 ± 0.00
Skylark	Introduced	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Sparrow, House	Introduced	0.00 ± 0.00	0.00 ± 0.00	1.75 ± 1.03	0.00 ± 0.00
Native species dominance (% individuals/native species)		85.15	62.16	78.65	92.31
No. native species recorded		5	7	8	5

Appendix J Weather Data During Bat Surveys

Table 43. Weather Data During Bat Surveys, 2020, 2022-23 and 2023 surveys

Survey Period	Date	Minimum overnight temperature (°C)*	Precipitation in two hours after sunset (mm)	Suitable night?
Spring 2020	17/11/2020	10.2	0	
	18/11/2020	13.3	0	
	19/11/2020	10.4	0	
	20/11/2020	**8.8**	0	No
	21/11/2020	**9.2**	0	No
	22/11/2020	11.4	0	
	23/11/2020	**8.2**	0	No
	24/11/2020	**9.9**	**3.4**	No
	25/11/2020	13.7	0	
	26/11/2020	14.8	0	
	27/11/2020	13.6	0	
	28/11/2020	**9.2**	0	No
	29/11/2020	**8.9**	0	No
	30/11/2020	10.8	1.2	
	1/12/2020	13.8	0	
	2/12/2020	**8.6**	0	No
	3/12/2020	11.9	0	
	4/12/2020	**9.8**	0	No
	5/12/2020	12.1	0	
	6/12/2020	12.6	0	
	7/12/2020	14.1	0	
	8/12/2020	18	0	
	9/12/2020	15.6	1.5	
	10/12/2020	16.2	0	
	11/12/2020	11.9	0	
Summer 2022 - 2023	16/12/2022	16.1	0	
	17/12/2022	14.2	1.2	
	18/12/2022	13.5	0	
	19/12/2022	12.2	0	
	20/12/2022	12.2	0	
	21/12/2022	13.3	0	
	22/12/2022	13.6	0	
	23/12/2022	14.2	0	
	24/12/2022	13.7	0	
	25/12/2022	13.3	0	
	26/12/2022	13	0	
	27/12/2022	14.1	0	
	28/12/2022	14.9	0	
	29/12/2022	14	0	
	30/12/2022	14.2	0	
	31/12/2022	13.7	0	

	1/1/2023	13.8	0	
	2/1/2023	14.5	0	
	3/1/2023	13.3	2	
	4/1/2023	14	**7**	No
	5/1/2023	15.3	1.6	
	6/1/2023	15.7	**3.2**	No
	7/1/2023	16.3	0	
	8/1/2023	15.2	0	
	9/1/2023	15.3	0	
	10/1/2023	12.1	0.6	
	11/1/2023	12.5	0	
	12/1/2023	12.9	**6.8**	No
	13/1/2023	13.5	0	
	14/1/2023	13.3	0	
	15/1/2023	13.3	0	
	16/1/2023	13.1	0	
	17/1/2023	13.5	0	
	18/1/2023	12.2	0	
	19/1/2023	14	0	
	20/1/2023	13.1	0.4	
	21/1/2023	14.6	0	
	22/1/2023	14	0	
	23/1/2023	13	0	
	24/1/2023	13.8	0	
	25/1/2023	11.6	0	
	26/1/2023	11.3	1.2	
	27/1/2023	16.5	**16.2**	No
	28/1/2023	16.9	0	
	29/1/2023	16.7	**8**	No
	30/1/2023	15.3	0.4	
	31/1/2023	16.1	**11.2**	No
	1/2/2023	16.2	0	
	2/2/2023	16.5	**4.2**	No
	3/2/2023	17.5	0	
	4/2/2023	16.2	0	
	5/2/2023	14.9	**3.4**	No
	6/2/2023	14.3	0	
	7/2/2023	13.1	0	
	8/2/2023	13.7	0	
	9/2/2023	12.9	0	
	10/2/2023	11.7	0	
	11/2/2023	14.1	**3.2**	No
	12/2/2023	14	0	
	13/2/2023	13.1	**29.8**	No
	14/2/2023	13	0	

	15/2/2023	14.7	0	
	16/2/2023	13.3	0	
	17/2/2023	12.2	0	
	18/2/2023	12.6	0	
	19/2/2023	13.7	0	
	20/2/2023	13.2	0	
	21/2/2023	13.5	0	
	22/2/2023	13.8	0	
	23/2/2023	14.1	0	
	24/2/2023	11.3	**56**	No
	25/2/2023	11	0	
	26/2/2023	12.6	0	
	27/2/2023	13.1	0	
	28/2/2023	12.9	0	
	1/3/2023	13.1	0	
	2/3/2023	12.9	0	
	3/3/2023	12.6	0	
	4/3/2023	13.8	0	
	5/3/2023	12.9	0	
	6/3/2023	12.2	0	
	7/3/2023	13.1	0	
	8/3/2023	12.6	0	
	9/3/2023	13.2	0	
	10/3/2023	14.1	0.2	
	11/3/2023	13.2	0	
	12/3/2023	12.7	0	
	13/3/2023	12.7	0	
	14/3/2023	10.8	0	
	15/3/2023	11.7	0	
	16/3/2023	12.6	0	
	17/3/2023	18.5	**3.4**	No
Spring 2023	3/10/2023	**6**	0	No
	4/10/2023	**5**	0	No
	5/10/2023	**6.7**	0	No
	6/10/2023	**9.7**	0	No
	7/10/2023	**8.2**	0	No
	8/10/2023	**8.3**	0	No
	9/10/2023	**8.2**	0	No
	10/10/2023	**8.7**	0.4	No
	11/10/2023	**8.8**	0	No
	12/10/2023	**8.7**	0	No
	13/10/2023	**9.4**	0	No
	14/10/2023	**9.9**	0	No
	15/10/2023	11	0	
	16/10/2023	10.9	0	

	17/10/2023	11.4	0.2	
	18/10/2023	11.9	0	
	19/10/2023	11.9	0	

Table 44. Weather Data During Bat Surveys, 2025 survey

Date	Official sunset time	Official sunrise time	Minimum temperature first four hours after sunset (Degrees C)	Rainfall 2 hr after sunset	Rainfall 4 hr after sunset	Wind speed (km/h)	Valid weather night
31/12/2024	20:43:00	06:05:00	15.3	0	0	2.089583	Yes
1/01/2025	20:43:00	06:05:00	16.3	0	0	3.1375	Yes
2/01/2025	20:43:00	06:05:00	15.1	0	0	1.258333	Yes
3/01/2025	20:43:00	06:06:00	13.5	1.27	2.28	7.495833	Yes
4/01/2025	20:43:00	06:07:00	14.6	0	0	1.516667	Yes
5/01/2025	20:43:00	06:08:00	9.6	0	0	0.295833	Yes
6/01/2025	20:43:00	06:09:00	13.2	0	0	1.34375	Yes
7/01/2025	20:43:00	06:10:00	14.5	0	0	1.195833	Yes
8/01/2025	20:43:00	06:11:00	16.7	0	0	3.847917	Yes
9/01/2025	20:43:00	06:12:00	15.7	0	0	0.439583	Yes
10/01/2025	20:43:00	06:13:00	11	0	0	0.208333	Yes
11/01/2025	20:43:00	06:14:00	14.9	0	0	0.966667	Yes
12/01/2025	20:42:00	06:14:00	9	0	0	0.147917	Yes
13/01/2025	20:42:00	06:15:00	13.3	0	0	0.875	Yes
14/01/2025	20:42:00	06:16:00	11.3	0	0	0.247917	Yes
15/01/2025	20:42:00	06:17:00	11.8	0	0	0.166667	Yes
16/01/2025	20:41:00	06:19:00	13.7	0	0	0.2125	Yes
17/01/2025	20:41:00	06:20:00	17.3	0	0	2.977083	Yes
18/01/2025	20:40:00	06:21:00	18.3	0	0	4.872917	Yes
19/01/2025	20:40:00	06:22:00	19.2	0	0	11.2125	Yes
20/01/2025	20:40:00	06:23:00	16.3	1.27	1.27	6.795833	Yes
21/01/2025	20:39:00	06:24:00	18.6	0	0	4.204082	Yes
22/01/2025	20:39:00	06:25:00	18.3	0	0	0.587755	Yes
23/01/2025	20:38:00	06:26:00	15.6	0	0	1.478723	Yes
24/01/2025	20:37:00	06:27:00	14.8	0	0	0.189583	Yes
25/01/2025	20:37:00	06:28:00	19.8	0	0	5.3625	Yes
26/01/2025	20:36:00	06:29:00	19.3	0	0.5	10.02708	Yes
27/01/2025	20:35:00	06:30:00	11.8	0	0	0.879167	Yes
28/01/2025	20:35:00	06:31:00	16.1	0.25	0.25	0.041667	Yes
29/01/2025	20:34:00	06:33:00	14.1	0	0	0.085714	Yes
30/01/2025	20:33:00	06:34:00	18.4	0	0	0.247917	Yes
31/01/2025	20:32:00	06:35:00	15.2	0	0	0.091667	Yes

1/02/2025	20:31:00	06:36:00	15.7	0	0	0.633333	Yes
2/02/2025	20:31:00	06:37:00	16.3	0	0	0.34375	Yes
3/02/2025	20:30:00	06:38:00	14.3	0	0	0.195833	Yes
4/02/2025	20:29:00	06:39:00	12.6	0	0	0.132653	Yes
5/02/2025	20:28:00	06:40:00	11.8	0	0	0.185417	Yes
6/02/2025	20:27:00	06:41:00	13.7	0	0	0.141667	Yes
7/02/2025	20:26:00	06:43:00	16.2	0	0	1.464583	Yes
8/02/2025	20:25:00	06:44:00	13.3	0	0	0.016667	Yes
9/02/2025	20:24:00	06:45:00	14.9	0	0	0.085714	Yes
10/02/2025	20:23:00	06:46:00	14.9	0	0	0.0625	Yes
11/02/2025	20:22:00	06:47:00	15.9	0	0	0.15625	Yes
12/02/2025	20:21:00	06:48:00	13.6	0	0	0.2125	Yes
13/02/2025	20:20:00	06:49:00	13.9	0	0	0.13125	Yes
14/02/2025	20:18:00	06:50:00	18.5	0	0	2.964583	Yes
15/02/2025	20:17:00	06:51:00	18.8	0.25	0.25	6.808333	Yes
16/02/2025	20:16:00	06:52:00	18.4	1.02	1.27	6.335417	Yes
17/02/2025	20:15:00	06:53:00	20.1	0	2.29	0.28125	Yes
18/02/2025	20:14:00	06:54:00	14.8	0	0	0.263265	Yes
19/02/2025	20:13:00	06:55:00	19.6	0	0	2.029167	Yes
20/02/2025	20:11:00	06:56:00	19.9	0	0	1.014583	Yes
21/02/2025	20:10:00	06:57:00	12.2	0	0	0.614583	Yes
22/02/2025	20:00:00	06:58:00	13.3	0	0	0.55	Yes
23/02/2025	20:07:00	06:59:00	12.1	0	0	0.014583	Yes
24/02/2025	20:06:00	07:00:00	13.4	0	0	0.329167	Yes
25/02/2025	20:05:00	07:01:00	14	0	0	0.239583	Yes
26/02/2025	20:04:00	07:02:00	11.8	0	0	0.079592	Yes
27/02/2025	20:02:00	07:03:00	12.3	0	0	0.047917	Yes
28/02/2025	20:01:00	07:04:00	14.7	0	0	0.410417	Yes
1/03/2025	19:59:00	07:05:00	14.2	0	0	0.044898	Yes
2/03/2025	19:58:00	07:06:00	12.7	0	0	0.061224	Yes
3/03/2025	19:05:00	07:07:00	13.2	0	0	0.1225	Yes
4/03/2025	19:55:00	07:08:00	17.2	0	2.54	3.834043	Yes
5/03/2025	19:54:00	07:09:00	13.8	0	0	0.84375	Yes
6/03/2025	19:53:00	07:10:00	7.8	0	0	0.09375	Yes

Appendix K Macroinvertebrate Community Data Results

						S13	S10	S7	S4
						HB	SB	HB	HB
PHYLUM	CLASS: Order	Family	Taxa	Taxa MCI hb	Taxa MCI sb	Site 1	Site 2	Site 3	Site 4
MOLLUSCA	GASTROPODA	Hydrobiidae	*Potamopyrgus antipodarum*	4	2.1				1
ARTHROPODA	CRUSTACEA: Amphipoda		*Paraleptamphopus subterraneus*	5	5.5	1	55		138
			Paracalliope fluviatilis	5	5.5	6			
	INSECTA: Odonata	Anisoptera	*Antipodochlora braueri*	6	6.3	1			
	Ephemeroptera	Oligoneuriidae	*Coloburiscus humeralis*	9	8.1	88			
		Leptophlebiidae	*Deleatidium 'lilli' group*	8	5.6	1	4		
			Arachnocolus phillipsi	8	8.1		1		
			Zephlebia spp	7	8.8	57	19		113
			Neozephlebia scita	7	7.6	3			4
	Trichoptera	Hydropsychidae	*Aoteapsyche colonica*	4	6			4	1
			Orthopsyche fimbriata	9	7.5	17			
		Hydroptilidae	*Oxyethira albiceps*	2	1.2			2	
		Hydrobiosidae	*Hydrobiosis parumbripennis*	7	7.4	1			
			Psilochorema sp.	8	7.8	1			2
			Neurochorema confusum	6	6	1			
		Polycentropodidae	*Polyplectropus puerilis*	8	8.1	5	16	4	6
	Coleoptera	Ptilodactylidae	Ptilodactylidae	8	7.1	2			
		Scirtidae	Scirtidae	8	6.4		5		
	Diptera	Hexatomini	*Paralimnophila skusei*	6	7.4	1	2	1	
			Eriopterini	9	7.5	3		4	
		Chironomidae	*Chironomus*	1	3.4		52		3
			Polypedilum	3	8	1	1		2
			Orthocladiinae	2	3.2			27	
			Tanypodinae	5	6.5		18		
		Dixidae	*Paradixa sp.*	4	8.5		10	1	4
	Collembola	Collembola .	Collembola	6	5.3			3	
		TOTALS:	NO. TAXA			16	11	8	10
			NO. EPT TAXA			9	4	3	5
			NO. INDIVIDUALS			189	183	46	274

Appendix L Wetland delineation plot data

The four tables below detail the vegetation plot data collected at Points 1 to 4.

Table 45. Wetland vegetation delineation plot results for Point 1

Stratum	Scientific Name	Common Name	Classification	Cover %	Dominant
Herb	*Carex solandri*	Forest Sedge	FAC	25	Yes
	Blechnum novae-zelandiae	Kiokio	FAC	10	Yes
	Dianella nigra	Turutu	UPL	1	No
Sapling/shrub	*Rhopalostylis sapida*	Nīkau	FACU	10	Yes
	Coprosma robusta	Karamū	FACU	3	No
	Coprosma spathulate	-	UPL	2	No
Tree	*Cyathea dealbata*	Pōnga	UPL	17	Yes
	Kunzea robusta	Kāunka	FACU	4	No
	Podocarpus totara	Tōtara	FACU	2	No
Percent dominant which are OBL, FACW or FAC					25%
Prevalence index					4.13

Table 46. Wetland vegetation delineation plot results for Point 2

Stratum	Scientific Name	Common Name	Classification	Cover %	Dominant
Herb	*Carex dissita*	Forest Sedge	FAC	60	Yes
	Blechnum novae-zelandiae	Kiokio	FAC	5	No
	Oplismenus hirtellus	Basket grass	FACU	10	No
Sapling/shrub	*Phyllocladus trichomanoides*	Tanekaha	FACU	2	No
	Coprosma spathulata		UPL	5	Yes
	Pittosporum tenuifolium	Kohuhu	FACU	1	No
	Dicksonia fibrosa	Whekī	UPL	4	Yes
	Melicytus ramiflorus	Māhoe	FACU	2	No
Tree	*Dicksonia fibrosa*	Whekī	UPL	15	Yes
	Kunzea robusta	Kānuka	FACU	5	No
	Rhopalostylis sapida	Nīkau	FACU	2	No
Percent dominant which are OBL, FACW or FAC					25
Prevalence index					3.64

Table 47. Wetland vegetation delineation plot results for Point 3

Stratum	Scientific Name	Common Name	Classification	Cover %	Dominant
Herb	*Carex dissita*	Forest Sedge	FAC	15	Yes
	Blechnum novae-zelandiae	Kiokio	FAC	3	No
	Oplismenus hirtellus	Basket grass	FACU	10	Yes
	Carex solandri	Forest Sedge	FAC	5	No
Sapling/shrub	*Melicytus ramiflorus*	Māhoe	FACU	4	Yes
	Coprosma spathulata		UPL	3	Yes
	Rhopalostylis sapida	Nīkau	FACU	4	Yes
	Rubus cissoides	Tātarāmoa	FACU	1	No
	Phyllocladus trichomanoides	Tanekaha	FACU	2	No

Tree	*Rhopalostylis sapida*	Nīkau	FACU	2	No
	Dicksonia fibrosa	Whekī	UPL	20	Yes
	Melicytus ramiflorus	Māhoe	FACU	5	No
Percent dominant which are OBL, FACW or FAC					33
Prevalence index					3.9

Table 48. Wetland vegetation delineation plot results for Point 4

Stratum	Scientific Name	Common Name	Classification	Cover%	Dominant
Herb	*Carex uncinata*	Hook sedge	FACU	45	Yes
	Blechnum novae-zelandiae	Kiokio	FAC	2	No
Sapling/shrub	*Rubus cissoides*	Tātarāmoa	FACU	5	Yes
	Phyllocladus trichomanoides	Tanekaha	FACU	2	No
	Rhopalostylis sapida	Nīkau	FACU	15	Yes
	Pseudopanax arboreus	Whauwhaupaku	UPL	2	No
	Coprosma robusta	Karamū	FACU	3	No
Tree	*Dicksonia fibrosa*	Whekī	UPL	10	Yes
	Cyathea dealbata	Ponga	UPL	5	No
	Kunzea robusta	Kānuka	FACU	8	Yes
Percent dominant which are OBL, FACW or FAC					0
Prevalence index					4.07