REPORT

APPENDIX K

Tonkin+Taylor

Preliminary Assessment of Ecological Effects

Peacocke Structure Plan Area

Prepared for
Hamilton City Council
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Executive summary

The need to protect, enhance and restore Hamilton City's biodiversity values is reflected in a range of provisions in policies, plans and non-statutory documents. This includes the consideration and application of biodiversity offsets to address residual adverse effects that cannot be avoided, remedied or mitigated[1].

The Peacocke Structure Plan Area (PSPA), comprises approximately 750 ha of rural land on the southern fringe of Hamilton. This area is the city's primary growth area and when fully developed, is likely to accommodate around 7,500 homes. The PSPA includes a proposed development footprint of around 500 ha. The remainder includes the Southern Links road footprint, and the balance including conservation areas that are to be protected.

The Peacocke Structure Plan (PSP) was developed in 2007 to provide a framework for guiding development within the PSPA, while recognising the importance of the natural environment and the presence of significant biodiversity values (e.g. the gully network and the presence of Nationally 'Threatened' long-tailed bat). The PSP is currently being reviewed to address changes in the legal and policy framework that have occurred since 2007, along with changes in infrastructure.

To assist the plan change process, this report provides a preliminary assessment of ecological effects associated with the proposed land use change from rural and semirural to intensive residential and commercial uses in the PSPA. In this regard, this assessment:

- Describes the known or likely biodiversity values within the PSPA and immediate surrounds;
- Provides a preliminary assessment of effects associated with the proposed land use change; and
- Assesses the type and quantum of habitat restoration and enhancement measures that would likely be required to address residual adverse effects to a No Net Loss (NNL) or Net Gain (NG) standard after consideration of measures to avoid, remedy or mitigate for adverse effects.

The overarching purpose of this preliminary assessment is to inform future plan change or consenting processes, and ultimately improve ecological outcomes across the PSPA.

The assessment was desktop-based and was undertaken following the Ecological Impact Assessment Guidelines (EcIAG) produced by the Environment Institute of Australia and New Zealand (Roper-Lindsay et al, 2018). This was followed by the application of a Qualitative Biodiversity Model (QBM) to better understand the type and quantum of habitat restoration and enhancement that may be required to address residual adverse effects.

The PSPA supports a number of significant biodiversity values, including the ecologically significant Waikato River margin, the Mangakōtukutuku gully network, indigenous forest remnants and includes habitats of the nationally 'Threatened' (nationally critical) long-tailed bat as well as nationally 'Threatened' or 'At Risk' birds, lizards, fish and plants.

Of key importance, the change from rural to residential landuse within the PSPA will likely result in a 'Very High' level of residual effects on bats after measures to avoid, remedy or mitigate for adverse effects are implemented. This is attributed primarily to the large-scale loss (ca 500 ha) of low- and moderate-value bat habitats in the form of pasture, and exotic vegetation of higher stature as well as the loss of 3.09 ha of habitat assessed as having high value for bats.

[1] Biodiversity offsetting is based on widely accepted principles. The commonly applied definition of biodiversity offsets[1] is: *A measurable conservation outcome resulting from actions designed to compensate for residual, adverse biodiversity effects arising from activities after appropriate avoidance, remediation, and mitigation measures have been applied. The goal of a biodiversity offset is to achieve no-net-loss, and preferably a net-gain, of indigenous biodiversity values.*

We consider this loss of 3.09 ha of high value bat habitat to constitute a 'Very High' level of effects that cannot be adequately or appropriately addressed, and we recommend efforts to protect these areas.

However, while the level of residual effects on low- and moderate-value bat habitat within the PSPA is also 'Very High', it is our view that these effects can be appropriately addressed through habitat restoration and enhancement, with a focus on native revegetation and the control of introduced predatory mammals within suitable protected areas.

Application of the QBM indicates that habitat restoration or enhancement activities within all the available 185 ha in the PSPA, but outside of the development footprint, will go a considerable way towards addressing residual effects on long-tailed bats (and it is assumed all other indigenous biodiversity values). This includes approximately 65 ha of revegetation and 120 ha of pest control within existing high value bat habitat. However, the quantum of effort is unlikely to achieve NNL/NG outcomes for long-tailed bats. To achieve NNL/NG outcomes for long-tailed bats would likely require:

- A reduction in the development footprint coupled with an increase in the quantum of habitat restoration and enhancement measures; and/or
- Additional habitat restoration and enhancement measures in areas outside of the PSPA.

On the latter point, the QBM indicates that in addition to restoration and habitat enhancement efforts within available areas within the PSPA (and outside the development footprint), to achieve NNL/NG outcomes with a reasonable degree of confidence would likely require the following restoration and habitat enhancement measures outside the PSPA:

- A further 140 ha of native revegetation; OR
- A further 800 ha of intensive mammalian pest control (in perpetuity); OR
- A lesser quantum of both within habitat outside the PSPA that has high existing or potential bat habitat values.

We have further assessed the relative proportion of revegetation and pest control and assessed that this would require in the order of 60 hectares of native revegetation and 180 hectares of pest control within river or gully margins in the surrounding landscape.

The limitations and constraints associated with the high-level nature of this report and the lack of quantitative data are acknowledged. We expect that further information provided during future policy development or by resource consent applicants will influence — to varying degrees — the location, scale and type of measures considered necessary to demonstrably achieve No Net Loss or preferably Net Gain outcomes for indigenous biodiversity values within the PSPA.

1 Introduction

1.1 Background

The Peacocke Structure Plan Area (PSPA), comprises approximately 750 ha of rural land on the southern fringe of Hamilton City (Appendix C, Figure 1) with a proposed development footprint of around 500 ha. The remainder includes the Southern Links road footprint and mitigation areas (ca 132 ha) and the balance of 119 ha includes conservation areas that are to be protected.

The PSPA is the city's primary growth area and when fully developed, is likely to accommodate around 7,500 homes.

The Peacocke Structure Plan (PSP) was developed in 2007 to provide a framework for guiding development within the PSPA. The PSP recognises the importance of the natural environment and the presence of significant biodiversity values within the PSPA, which include the ecologically significant Waikato River margin, Mangakōtukutuku gully network, indigenous forest remnants and the nationally 'Threatened' (nationally critical) long-tailed bat.

The PSP is currently being reviewed to address changes in the legal and policy framework that have occurred since 2007, along with changes in infrastructure. These changes include the Southern Links, a future state highway and local arterial road network for which designation was approved in 2016.

Within the wider Hamilton Ecological District, less than two percent of indigenous habitat cover remains. The need to protect and enhance remaining biodiversity values in the area is expressly recognised in statutory documents including:

- A 10% indigenous habitat target2, identified in the Operative Hamilton City District Plan as a key policy direction;
- Working towards no net loss (NNL) or preferably a net gain (NG) in biodiversity as directed by Policy 11.1 of the Waikato Regional Policy Statement (WRPS); and
- Consideration and application of biodiversity offsets to address residual adverse effects that cannot be avoided, remedied or mitigated as directed by Policy 11.1 of the WRPS.

1.2 Report purpose and scope

To assist the plan change process, this report provides a preliminary assessment of ecological effects associated with the proposed land use change from rural and semirural to intensive residential and commercial uses in the PSPA. To this end, this assessment:

- Describes the known or likely biodiversity values within the PSPA and immediate surrounds;
- Provides a preliminary assessment of effects associated with the proposed land use change; following the Ecological Impact Assessment Guidelines (EcIAG) produced by the Environment Institute of Australia and New Zealand (Roper-Lindsay et al, 2018)[1]. This will largely be based on:
  - the potential level of effects of land use change within the PSPA development area on biodiversity values after measures to avoid, remedy or mitigate for effects are implemented, and
  - potential benefits within areas that are protected for biodiversity management.
- Assesses the type and quantum of habitat restoration and enhancement measures that would likely be required to address residual effects to a No Net loss or Net Gain standard using a Qualitative Biodiversity Model (QBM) as a decision support tool. In this regard, we have focused exclusively on offsetting or compensating for long-tailed bat habitat because:
  - Long-tailed bat is a nationally 'Threatened' species (Nationally Critical);

- There is a reasonable amount of available information on bats within the PSPA and immediate surrounds; and
- Achieving an NNL/NG objective for bat values is expected to result in an NNL or NG outcome for most biodiversity values affected by the development since bats are known to use most, if not all, habitat types within the PSPA.

The overarching purpose of this preliminary assessment is to inform future plan change or consenting processes and ultimately improve outcomes for indigenous biodiversity across the PSPA.

This assessment is informed by a desktop review and in particular by the PSPA Ecological Significance Assessment Report (Kessels and Baber, 2021) and the PSPA Bat Report (Mueller et al. 2021)[2]. The limitations and constraints associated with the high-level nature of this report and the lack of quantitative data are acknowledged. We expect that further information provided during future policy development or by resource consent applicants will influence — to varying degrees — the location, scale and type of measures considered necessary to demonstrably achieve No Net Loss or preferably Net Gain outcomes for indigenous biodiversity values within the PSPA.

[2] This document is referred to as the PSPA Biodiversity Management Framework in Baber and Kessels (2021) and Mueller et al. (2021) however the title has subsequently changed to the PSPA Preliminary Assessment of Ecological Effects Report.

2 Methodology

2.1 Desktop review

The reports and information referenced in Section 7 was used to inform the methodology and approach to assessing effects. In summary, this included a review of relevant databases and literature including the following:

- New Zealand Herpetological Database (Department of Conservation – Bioweb Database);
- New Zealand Plant Conservation Network plant distribution database information (New Zealand Plant Conservation Network, 2017) drawn from the National Vegetation Survey Database (NVS);
- Summaries of Hamilton City biennial bird counts (Fitzgerald and Innes, 2013) and Ornithological Society of New Zealand census summaries (Cornes et al., 2012a);
- Ecological expert evidence statements related to the NZTA Waikato Expressway and Southern Links roading projects;
- The ecologically based objectives and policies in the PSP (2007);
- Hamilton City Council District Plan Section 20.2 Objectives and Policies: Natural Environments;
- Waikato Regional Policy Statement (WRPS) policy directions set out in Part B 11;
- The local Indigenous Biodiversity Strategy Hamilton City Pilot Project September 2018;
- HCC Biodiversity Strategy (2019);
- WRC's RPS criteria (Section 11A – Table 11-1) for assessing sites of significant indigenous biodiversity (Waikato Regional Council, 2016);
- Boffa Miskell vegetation mapping and associated reporting for the Amberfield subdivision;
- Significant Natural Areas layer for HCC;
- Standard NZ aerial imagery (2012); and
- Knowledge of experienced local experts (Gerry Kessels).

2.2 Assessment of effects on biodiversity

We undertook a high-level assessment of effects on biodiversity values within the PSPA broadly following the Ecological Impact Assessment Guidelines (EcIAG) produced by the Environment Institute of Australia and New Zealand (EIANZ) (Roper-Lindsay et al. 2018). The purpose of the assessment of effects was to:

- Broadly characterise the biodiversity values present within the PSPA based on a desktop review of available information and data;
- Assess the likely level of residual effects associated with urbanisation on those values after efforts to avoid, remedy or mitigate for effects. We have assumed that standard effects management practices are adopted; and
- Determine the type and quantum of habitat restoration and enhancement activities that are likely required to achieve Net Gain outcomes for biodiversity.

Using a standard framework and matrix approach, such as the EcIAG guidelines, provides a consistent and transparent assessment of effects and is considered good practice. The use of these guidelines (or an updated edition) is recommended for all assessment of ecological effects that are required within the PSPA. The EcIAG approach is described the following sections.

2.2.1 Step one: Biodiversity values assessment

Biodiversity values known or likely to be present within the PSPA are assigned on a scale of 'Low' to 'Very High' based on species, communities, and habitats, using criteria in the EcIAG (see Appendix D Table 1 – 3).

2.2.2 Step two: Magnitude of effects assessment

Magnitude of effect is assessed after efforts to avoid, remedy or mitigate for effects have been considered. The magnitude of effect is a measure of the extent or scale of the effect of the landuse change within the PSPA on the biodiversity values, and the degree of change that it will cause. This is scored on a scale of 'Negligible' to 'Very High' (Appendix D Table 4 – 5) and is assessed in terms of:

- Level of confidence in understanding the expected effect;
- Spatial scale of the effect;
- Duration and timescale of the effect;
- The relative permanence of the effect; and
- Timing of the effect in respect of key ecological factors.

2.2.3 Step three: Assessment of the level of effects

An overall level of effect associated with the landuse change in the PSPA is identified for each biodiversity value (habitat/species type) using a matrix approach. Each biodiversity value (described in Section 2.2.1) is combined with the magnitude of residual effects on that value (Section 2.2.2) resulting from the activity after efforts to avoid, remedy or mitigate for effects have been considered (Appendix D Table 6).

The matrix describes an expected overall level of effect associated with landuse change in the PSPA for each biodiversity value on a scale of 'Very Low' to 'Very High'. The level of effect is then used to guide the need for residual effects management in the form of habitat restoration or enhancement.

2.2.4 Assessment limitations and constraints

The key limitations and constraints associated with this high-level assessment of ecological effects are as follows:

- The assessment was based on a desktop review of available information, and subjective knowledge of the site. No specific site-based fieldwork was conducted to inform the assessment;
- Any changes to the PSPA layout may change the scenario as presented;
- Habitat condition assessment was based on the standard NZ aerial imagery as part of an ArcGIS licence dated 2012; and
- The assessment assumes the accuracy of assumptions in the PSP regarding the security, management and funding of the potential conservation area into perpetuity.

The following assumptions underpin the assessment:

- The PSPA, as provided as an ArcMap shapefile by HCC, is divided between potential development areas and conservation areas, and is accurate in extent;
- The potential conservation area is currently all private land not under existing private management for biodiversity gain, and therefore can be considered a potential gain to future conservation estate;
- The entire conservation area (excluding the 16 ha lost to Southern Links) is available to compensate for potential impacts on biodiversity within the development area; and

- The entirety of the potential impact is confined to the development area as provided by HCC in the PSPA, i.e., any potential edge effects or indirect impacts are contained within the development area and accounted as full loss, though in reality these would only be partial loss.

2.3 Residual Effects Management

Where the level of residual effects on biodiversity values within the PSPA is assessed as 'moderate' or higher, measures to address residual effects to an expected NNL/NG standard are considered warranted.

2.3.1 Residual effects management overview

Qualitative Biodiversity Models (QBMs) have been used in this assessment as a decision support tool to provide guidance on the type and amount of compensation required to achieve expected NNL/NG outcomes for biodiversity in the PSPA (Baber et al 2021; Tonkin & Taylor 2021). The models:

- Provide guidance on addressing residual adverse effects within the PSPA for which impacts or gains cannot feasibly be measured or quantified with adequate precision, i.e. cannot be demonstrably offset;
- Serve as a decision support tool that provides additional transparency, process and rigour to the process of addressing residual adverse effects through compensation measures at proposed habitat restoration/enhancement site(s);
- Provide guidance on whether NNL/NG outcomes are expected to be achieved. Expected Net Gain outcomes are sought, rather than No Net Loss (NNL) outcomes, to provide more confidence that NNL is actually achieved;
- Operate at the 'as close to offset as possible' end of the compensation continuum. This is termed 'biodiversity compensation' in the Proposed National Policy Statement for Indigenous Biodiversity (NPSIB); and
- Are intended for use under the auspices of biodiversity offsetting or compensation principles[3] and importantly, only once adherence to the effects management hierarchy and limits to offsetting principles have been demonstrated (Baber et al 2021).

In broad terms, the QBMs are based on:

- Available information and expert assessment of the amount and quality of habitat that will be adversely affected at the impact sites;
- Available information and expert assessment of the amount and quality of habitat that will be subject to compensation actions (i.e. habitat restoration and enhancement) at the compensation sites; and
- Assessment of the potential biodiversity benefits associated with potential habitat restoration and enhancement measures.

[3] We prefer the biodiversity offsetting and compensation principles as set out in the Draft National Policy Statement for Indigenous Biodiversity (NPSIB)

3 Biodiversity characteristics and values

3.1 Context

The site is within the Hamilton Ecological District. Indigenous vegetation in the Hamilton Ecological District (ED) has been severely depleted with less than 2% of all indigenous ecosystems remaining (Leathwick et al, 1995). Since human settlement, the original, indigenous-dominated forest ecosystem cover has been largely replaced by ecosystems dominated by exotic species and/or urban development, particularly in the flatter to rolling country of the Hamilton basin floor.

3.2 Site description

The 750 ha site is situated in southern Hamilton on a low terrace adjacent to the Waikato River. Within this flat to gentle rolling hill landscape, low mounds or ridges of alluvial plains emerge by moderately to well-drained alluvium from the Hinuera formation which predominantly supported mixed conifer-broadleaf forest. In shallow depressions or swales, the alluvium has more silt and clay and the poorer drainage in these soils created boggy areas that were dominated by kahikatea semi-swamp forests. In lower terraces beside the Waikato River, the alluvium has more sand and gravel and is better drained. These well drained areas suited totara-matai-kowhai forest types (Clarkson *et al.,* 2007). Very few peat areas are situated in the PSPA, but areas of poorly drained gley-soils, as well as the small areas of peat historically hosted a range of vegetation types including submerged vegetation, swamp forest, sedgelands, shrublands and restiad bogs (Clarkson *et al*., 2007).

As Cornes et al (2012) states:

> "*Hamilton City, at 11,080 ha, makes up 7.0% of the 159,375 ha of Hamilton Ecological District (ED). Hamilton ED is confined to the Hamilton Basin with some of the surrounding hills and foothills included (McEwen, 1987). Leathwick et al. (1995) found less than 2% of natural vegetation that once existed in the ecological district pre 1840s still remains. Wetlands and conifer forests were the dominant ecosystems of Hamilton ED before human settlement (Harding, 1997). These two ecosystems also suffered the highest percentage reduction through anthropogenic activities. All past vegetation types are less than 2% cover within the district*."

The PSPA is dominated by two large physical features: the Waikato River and the Mangakōtukutuku Gully. The Waikato River runs along the eastern side of the PSPA with stepped terraces giving way to steep banks to the river. On the opposite side of the site is the Mangaonua Gully and Hammond Park (Appendix C, Figure 1, 2 and 3). In the south, a minor gully separates an island of river terrace. The surface geology consists of alluvial loose sedimentary and weak igneous rocks. The landscape is undulating with the southern portion substantially elevated, being about 65 metres above the level of the Waikato River.

The PSPA is currently a mixture of large farms with some 'lifestyle block' development, and remains predominantly in rural land use. The farming activities in the area have been in place for over a hundred years and the dominant vegetation includes exotic trees and shelterbelts. Historic clearance has removed almost all of the original indigenous vegetation. Prior to human settlement low terraces adjacent to the Waikato River, and river terrace and gully scarps were once characterised by totara-matai-kowhai forest. Gully floors were likely to have been dominated by kahikatea pukatea-swamp maire forest (Clarkson, Clarkson et al. 2007). Very little remnant or regenerating indigenous vegetation now exists and is primarily located as small, fragmented patches within the Waikato River corridor and the Mangakōtukutuku Gully.

3.3 Habitat types

A wide range of vegetation or habitats for indigenous fauna have been identified as being ecologically significant within the PSPA based on WRPS significance criteria (Section 11A WRPS) (Kessels and Baber, 2021). These significant ecological areas have been assigned into ecological significance categories based on the ecological values they provide.

Table 3.1: Key ecological features within the PSPA, their ecological significance, location relative to the development footprint and areal extent[4] (refer to section 2.6 for definitions of significance categories).

Key Ecological Features and their aerial extent	General location	Description	Ecological characteristics and values	Key WRPS Ecological Significance Criteria Triggered
Ecologically significant areas of indigenous biodiversity				
Significant indigenous terrestrial and freshwater fauna habitat: Riparian margins and associated waterways (**58.74 ha**)	Mostly outside the current development footprint	This includes mostly exotic forest and shrubland vegetation present along the Waikato River, Mangakōtukutuku Gully and associated tributaries in the PSPA. There are areas of wetland and stream habitats interspersed throughout. Most of this vegetation is exotic though small areas of habitat is dominated by indigenous vegetation in places and exotic dominated vegetation typically also includes native species.	These habitat types provide significant habitat for indigenous vegetation and fauna present on site, and are particularly important as roost, foraging and flyway habitat for the 'Threatened' (nationally critical) long-tailed bat, and important for At Risk bird species including kākā, pied shag, little shag, little black shag, black shag and New Zealand dabchick. The waterways in this habitat complex also provide habitat for several 'At Risk' fish species, while the riparian margins enhance or protect the waterway habitat. It may also provide habitat for indigenous lizard species.	Criterion 3: Long-tailed bats and 'At Risk' fish species have been confirmed to use these habitats. Criterion 4, criterion 6, criterion 8: Under-represented stream and riparian margin habitat is utilised by a range of aquatic species. Criterion 11: Parts of this habitat provide an ecological buffer, linkage and corridors which are necessary to protect significant habitat from external adverse effects.
Significant indigenous terrestrial fauna habitat: non-riparian linear features (ecological corridors) (**20.49 ha**)	Mostly Inside the current development footprint	This includes shelterbelts that provide connectivity across the landscape. The vegetation is largely exotic.	This is important foraging and flyway habitat for long-tailed bats and indigenous bird species.	Criterion 3: Long-tailed bats have been confirmed to use, or likely to use, these habitats. Criterion 11: This habitat provides an ecological buffer, linkage and corridors necessary to protect significant habitat from external adverse effects.

[4] A considerable amount of this habitat will be permanently lost due to Southern Links

Key Ecological Features and their aerial extent	General location	Description	Ecological characteristics and values	Key WRPS Ecological Significance Criteria Triggered
Significant indigenous bat habitat: non-riparian habitat ecological buffers (**56.59 ha**)	Mostly Inside the current development footprint	This includes any vegetation, including pasture, within 20 m of significant riparian margins and associated waterways, and significant non-riparian linear features	This is foraging and flyway habitat for long-tailed bat.	Criterion 3: Long-tailed bats have been confirmed to use, or likely to use, these habitats for foraging and as flyways. Criterion 11: This habitat provides an ecological buffer, linkage and corridors necessary to protect significant habitat from external adverse effects.
Significant Indigenous vegetation remnants (**4.5 ha***)	Mostly outside development footprint	This includes small fragments, groups or individual mature indigenous trees along the margins of the Waikato River and associated tributaries in the PSPA.	This vegetation is important due to its rarity in the landscape. It provides important habitat for native flora and fauna as well as native vegetation, and fauna present on site. This is potentially important as roosting, foraging and flyway habitat for the 'Threatened' (nationally critical) long-tailed bat.	Criterion 4: These small indigenous remnants are under-represented within the Hamilton Ecological District. Criterion 3: Long-tailed bats have been confirmed to use, or likely to use, these habitats
Ecologically Significant wetlands and wetlands where significance is Likely or Indeterminate				
Wetlands (**7.3 ha**) including Riverine & Palustrine wetlands (**5.6 ha***) and Ephemeral Seep or Spring wetlands (**1.7 ha**).	Mostly outside the development footprint, but some wetlands are within pasture areas within the development footprint	The wetland areas comprise a mixture of exotic and native rushes and sedges, sometimes with a canopy of exotic deciduous trees, and native tree ferns.	Wetlands are threatened ecosystem types and may include wetland associated 'Threatened' or 'At Risk' species. They are potentially important as roosting, foraging and flyway habitat for 'Threatened' (nationally critical) long tailed bat.	Significant. Some wetland areas are Likely or Indeterminate until further site-specific surveys are undertaken. Criterion 4, criterion 6, criterion 8: Under-represented wetlands and wetland habitat which is utilised by a range of aquatic and terrestrial indigenous species.

3.4 Long tailed bats

The New Zealand long-tailed bat (*Chalinolobus tuberculatus*) is considered vulnerable to extinction and is ranked as nationally 'Threatened' (Nationally Critical), which is the highest threat ranking in the Department of Conservation's threat classification system. It meets this threat ranking because it is undergoing a "very high ongoing or predicted decline (> 70%)." (O'Donnell et al 2018).

There have been numerous intensive surveys and monitoring studies of long-tailed bats in and around the PSPA (see Mueller et al. 2021). These surveys include acoustic monitoring, thermal imaging, and capture and radio-tracking of individual bats.

Long-tailed bats use a variety of habitats within the PSPA for roosting, commuting, and foraging. These habitats are all likely to be important for long-tailed bats in this locality. The variety of inter-connected habitats in this southern part of Hamilton means this is the most valuable and significant locality for long-tailed bats within Hamilton City.

Previous bat monitoring undertaken across Hamilton City clearly demonstrates that the rural urban fringe to the south of city, within which the PSPA is located, is core habitat for the Hamilton long-tailed bat population (Mueller et al. 2021). The studies reviewed produced similar results, confirming that the large, vegetated gullies containing tributaries of the Waikato River are key landscape features, providing connectivity for bats to move through a comparatively modified landscape.

Habitat connectivity, or distance to the Waikato River/major gullies, emerged as the single most significant explanatory variable the statistical model employed in these city-wide surveys, highlighting the importance between habitat type and distance to the river/gullies for bats. Overall, bat activity significantly increased with:

- Decreasing distances from well-connected habitats and linear landscape features (gullies and river); and
- Increasing distances from the city centre and levels of human activity. Pass rates were consistently highest at habitats where houses, roads and street lights were lowest. Even slight increases in the number of roads and street lights resulted in decreases in pass rates.

Riparian margins, with dense indigenous and exotic trees and shrubs associated with riverine and gully landscapes, appeared to be critical habitat, as bats depend on access to key resources associated with these environments. In particular, these habitats provide:

- Mature exotic and indigenous vegetation for roosting purposes;
- Emergent aquatic insect prey (e.g. mosquitoes) for foraging (which can include foraging over areas of open pasture);
- Freshwater for drinking; and
- Linear landscape corridors for movement and navigation.

Surveys undertaken in the Mangaonua and Mangakōtukutuku gullies, located to the east and west of the PSPA respectively, also recorded regular bat activity. Recent radio tracking surveys have also demonstrated that long-tailed bats are not limited to the gully network in Hamilton South, but are also commuting overland in areas where anthropogenic disturbance is limited. A number of bat roosts have been found within and adjacent to the PSPA (Mueller et al. 2021). In addition, home ranges and indicative commuting routes have also been determined by recent studies showing that many of these bats reside within, or are directly adjacent to, the PSPA (Davidson-Watts I, 2019; Mueller et al. 2021).

3.5 Birds

The PSPA has a diverse bird assemblage, which includes both terrestrial species, and species associated with wetland/water habitats (Tonkin & Taylor, 2021). This reflects its location directly adjacent to the Waikato River. In terms of abundance, the avifauna assemblage is dominated by naturalised introduced species, which are common in the agricultural landscape surrounding Hamilton (Cornes et al., 2012a; Fitzgerald and Innes, 2013). Nationally 'Threatened' or 'At Risk' species that have been detected, or potentially present in the wider Hamilton City area, include the North Island kākā, kārearea (*Falco novaeseelandiae ferox)*, and the pied shag, all classified as 'At Risk – recovering'; and the New Zealand dabchick, little black shag and black shag, all 'At Risk – Naturally Uncommon'). The riparian margin vegetation along the river may be utilised by the shag species for roosting and/or nesting, but there is no suitable habitat for New Zealand dabchick onsite. Like other rural and urban parts of the Hamilton area, kākā may visit the site when dispersing during winter, or as a short visit, but are unlikely to inhabit the area for long periods (Fitzgerald and Innes, 2013).

3.6 Lizards

Three lizard species have been recorded in the locality (DOC BioWeb database). The most common of these species is the copper skink, (*Cyclodina aenea*), which is widespread in the Waikato and not threatened, and is known to be present within the PSPA. Faecal material attributed to forest gecko (*Hoplodactylus granulatus*) has been reported in the Hakarimata Ranges, some 30 km to the north. DOC also has a record of the threatened Auckland green gecko (*Naultinus elegans elegans*) from Hakarimata (BioWeb database).

Other species which could be present include ornate skink *(C. ornata),* Pacific gecko *(H. pacificus)* and the introduced plague skink which is known to be present within the PSPA (Tonkin & Taylor, 2021).

3.7 Invertebrates

Nationally 'Threatened' or 'At Risk' terrestrial invertebrates are unlikely to be present but as no focussed surveys are known to have been undertaken in the PSPA, the presence of threatened terrestrial invertebrate species cannot be ruled out.

3.8 Freshwater fauna

There are numerous records for fish within the PSPA, including in the Waikato River and Mangakōtukutuku Gully, as well as in smaller gullies near the PSPA. Longfin eel (*Anguilla diefenbachii*) have been recorded in this locality, as havelamprey (*Geotria australis*), inanga (*Galaxias maculatus*), giant kōkopu (*Galaxias argenteus*), shortjaw kōkopu (*Galaxias postvectis*), torrentfish (*Cheimarrichthys fosteri*), redfin bully (*Gobiomorphus huttoni*), koaro (*Galaxias brevipinnis*) and black mudfish (*Neochanna diverus*). All of these species are classified as 'At Risk' or 'Threatened'. Freshwater invertebrates recorded near the PSPA include the 'At Risk – Declining' freshwater mussel, kākahi *(Echyridella menziesii)*, and the freshwater snail (*Austropeplea tomentosa)*.

3.9 Vegetation

Several plant species are now classified as 'Threatened' due to the threat posed by Myrtle rust. Of these kanuka and manuka are present and naturally occurring within the PSPA.

The only other threatened plant species is poroporo (*Solanum aviculare var*. *aviculare*) which is 'Threatened – Nationally Vulnerable' (de Lange et al., 2018). It is unclear if this species is found within the PSPA.

4 Assessment of effects on biodiversity

The previous section described the biodiversity values present within the PSPA to provide context. This section focuses on assessing the potential biodiversity impacts of urbanisation associated with structure plan. The assessment is based on the EcIAG produced by EIANZ (Roper-Lindsay et al. 2018) and adapted to determine the overall 'level of effect' of the development on biodiversity values. It is an indicative assessment only, and each specific development proposal would need to be evaluated in detail at the time of lodging a consent application to Council.

4.1 Biodiversity value assessment (Step 1)

It is important to note that undertaking an assessment of biodiversity values for the PSPA does not preclude the statutory requirement to undertake an assessment of ecological significance applying the criteria in Section11A of the WRPS, and hence section 6(c) of the RMA. There are scheduled significant natural areas (SNAs) in the District Plan which are located within PSPA (refer to section 3.3). However, these SNAs relate to an assessment of indigenous vegetation values only. Hamilton City Council has not undertaken an assessment of significant habitats for indigenous fauna as part of the Hamilton District Plan but see Baber and Kessels (2021).

The biodiversity values associated with each habitat type and for nationally 'Threatened' or 'At Risk species are assessed in Table 4.1 below.

Table 4.1: Biodiversity values within the PSPA[5] based on tables in Appendix D, Tables 1 – 3)

Key biodiversity features	Biodiversity characteristics and values	Biodiversity Value
Habitats		
Significant indigenous terrestrial and freshwater fauna habitat: Riparian margins and associated waterways (**58.74 ha**)	• Moderate value for representativeness. • High value for rarity and distinctiveness. Indigenous vegetation < 2% in Ecological District. Important roosting, foraging and flyway habitats for the Nationally 'Threatened' long tailed bat. Likely presence of nationally 'Threatened' kanuka and manuka (threatened due to threats from myrtle rust) • Moderate value for diversity and pattern. • High value for ecological context, particularly ecological connectivity in the landscape and ecological buffering of waterways. Two high and two moderate values equates to an overall value assessment of High.	High
Significant indigenous terrestrial and freshwater fauna habitat: non-riparian linear features (ecological corridors) (**20.49 ha**)	• Low value for representativeness. • High value for rarity and distinctiveness (important foraging and flyway habitats for the Nationally 'Threatened' long tailed bat). • Low value for diversity and pattern. • High value for ecological context, particularly ecological connectivity in the landscape and ecological buffering of waterways). Two high and two Low values equates to an overall value assessment of High.	High

[5] Many of these values for fauna species have been recorded outside the PSPA, but they are considered likely to be present.

Key biodiversity features	Biodiversity characteristics and values	Biodiversity Value
Significant indigenous bat habitat: non-riparian habitat ecological buffers (**56.59 ha**)	• Moderate value for representativeness. • High value for rarity and distinctiveness (Roosting and/or foraging and flyway habitats for the Nationally 'Threatened' long tailed bat). • Moderate value for diversity and pattern. • Moderate value for ecological context, particularly connectivity in the landscape for bats. One high and three moderate values equates to an overall value assessment of 'High'.	High
Significant Indigenous vegetation remnants (**4.5 ha**)	• Moderate value for representativeness. • High value for rarity and distinctiveness. Indigenous vegetation < 2% in Ecological District. Roosting and/or foraging and flyway habitats for the Nationally 'Threatened' long tailed bat. Likely presence of nationally 'Threatened' kanuka and manuka (threatened due to threats from myrtle rust). • Moderate value for diversity and pattern. • Moderate value for ecological context, particularly connectivity in the landscape for bats. One high and three moderate values equates to an overall value assessment of 'High'.	High
Wetlands (**7.3 ha**) including Riverine & Palustrine wetlands (**5.6 ha***) and Ephemeral Seep or Spring wetlands (**1.7 ha**).	*There is insufficient information to assess the ecological value of wetlands within the PSPA as this will first require an assessment of presence and extent based on field investigations and assessment using the Wetland Delineation Protocol (MfE 2020). It is also key to note that the areal extent of wetlands provided in column one is likely to be an underestimate as this only includes wetlands that can be readily detected through analysis of aerial imagery.*	Likely to range from Moderate to Very High
Non-significant exotic vegetation (excluding pasture) (**47.58 ha**)	• Very Low value for representativeness. • High value for rarity and distinctiveness as this habitat does provide low value foraging and flyway habitat for the Nationally 'Threatened' long tailed bat. • Low value for diversity and pattern. • Moderate value for ecological context, does provide connectivity in the landscape for bats so not scored as Very Low. One high, one moderate, one low and one very low equates to an overall value assessment of 'Moderate'	Moderate
Non-significant exotic vegetation (pasture) (**500.33 ha**)	• Very low value for representativeness. • High value for rarity and distinctiveness as this habitat does provide foraging and flyway habitat for the Nationally 'Threatened' long tailed bat. • Very low value for diversity and pattern. • Moderate value for ecological context, particularly connectivity in the landscape for bats. One high, one moderate and two very low values equates to an overall value assessment of 'Moderate'.	Moderate

Key biodiversity features	Biodiversity characteristics and values	Biodiversity Value
Flora species		
Kānukā[1]	Threatened – Nationally Vulnerable	Very High
Mānuka[1]	Threatened – Nationally Vulnerable	Very High
Poroporo	Threatened – Nationally Vulnerable	Very high
Fauna species		
Long-tailed bats	Nationally threatened species (Nationally Critical) with the PSPA constituting a hot spot for roost sites, foraging habitat and flyways (Table 4.3)	Very High
Forest gecko, moko-piri-ra ̄kau	At Risk (declining) possibly present but not in development area	High
Auckland green gecko, elegant gecko, kākāriki	At Risk (declining) possibly present but not in development area	High
Ornate skink	At Risk (declining) possibly present but not in development area	High
Pacific gecko	At Risk (relict) possibly present but not in development area	Moderate
Grey duck, pārera	Threatened – Nationally Critical	Very High
New Zealand pipit, pīhoihoi	At Risk – Declining	High
White heron, kōtuku	Threatened – Nationally Critical	Very high
Australasian bittern, matuku hūrepo	Threatened – Nationally Critical	Very high
North Island fernbird, mātātā	At Risk – Declining	High
Long-tailed cuckoo, koekoea	At Risk – Naturally Uncommon	Moderate
Bush falcon, karearea	At Risk – Recovering	Moderate
Banded rail, moho pererū	At Risk – Declining	High
New Zealand pied oystercatcher, tōrea	At Risk – Declining	High
Black billed gull, tarāpuka	Threatened – Nationally Critical	Very high
Red billed gull, tarāpunga	At Risk – Declining	High
North Island kākā, kākā	At Risk – Recovering	Moderate
Black shag, kawau	At Risk – Naturally Uncommon	Moderate
Little black shag, kawau tūi	At Risk – Naturally Uncommon	Moderate
Pied shag, karuhiruhi	At Risk – Recovering	Moderate
Royal spoonbill, kōtuku ngutupapa	At Risk – Naturally Uncommon	Moderate
New Zealand dabchick, waiwea	At Risk – Recovering	Moderate

Key biodiversity features	Biodiversity characteristics and values	Biodiversity Value
Marsh crake, koitareke	At Risk – Declining	High
Spotless crake, pūweto	At Risk – Declining	High
Longfin eel, tuna	At Risk – Declining; may be present in river and gully waterways	High
Torrentfish, piripiripohatu	At Risk – Declining; may be present in river and gully waterways	High
Giant kōkopu, taiwharu	At Risk – Declining; may be present in river and gully waterways	High
Koaro	At Risk – Declining; may be present in river and gully waterways	High
Īnanga, inaka	At Risk – Declining; may be present in river and gully waterways	High
Shortjaw kōkopu	Threatened – Nationally Vulnerable; may be present in river and gully waterways	Very high
Lamprey, kanakana	Threatened – Nationally Vulnerable; may be present in river and gully waterways	Very high
Redfin bully	At Risk – Declining; may be present in river and gully waterways	High
Black mudfish	At Risk – Declining; may be present in river and gully waterways	High
Freshwater mussel, kākahi	At Risk – Declining	High
Freshwater snail	Data Deficient	Moderate

Notes: [1] Level of threat status for myrtaceae species is primarily associated with a precautionary approach due to disease risk.

4.2 Magnitude of effects assessment (Step 2)

4.2.1 Overview of potential adverse effects associated with the proposed landuse change

In general terms, habitat loss associated with housing development and associated infrastructure has the potential to create a range of adverse effects on biodiversity values, during enabling works construction (resulting from direct physical disturbance), seasonal construction, and on an ongoing basis. Potential adverse effects on biodiversity values during and after construction may include:

- Vegetation and habitat loss through vegetation clearance and earthworks;
- The creation of habitat edge effects, altering the composition and health of adjacent vegetation (i.e., habitat degradation), which may affect habitat suitability for flora and fauna;
- Direct mortality or injury to species, for example all plants and most of the smaller less mobile species (e.g. lizards and invertebrates) may be harmed during vegetation clearance or earthworks activities. Likewise, roosting bats could potentially harmed during vegetation clearance activities. Outside of bird breeding season, bird mortality would be low, however, during breeding season vegetation removal has the potential to result in the destruction of nests, eggs and fledglings;
- Habitat fragmentation and isolation, due to the loss and reduction of available habitat types, and by reducing the ability for plants and animals to disperse across the landscape for food, shelter, and breeding purposes, i.e. severing or partially severing access to habitats that would otherwise be suitable;

- Construction and operations related noise and vibrations or dust effects; and
- Sediment runoff to wetlands and watercourses that may affect the quality of aquatic habitats.

Potential long-term ongoing adverse effects may include:

- Ongoing habitat degradation associated with habitat loss, edge effects and fragmentation, which permanently affect movement of some species, with possible effects on meta-population dynamics and increased vulnerability to local extinction;
- Ongoing disturbance effects, particularly on habitat margins/edges, through noise, dust and lighting associated with infrastructure and housing;
- Mortality or injury on roads through strike or road kill for some species;
- The increased presence of people and introduced species in previously less accessible areas;
- Lost opportunities for creating wildlife corridors; and
- Ongoing degradation of aquatic habitat quality through:
  - Contaminated stormwater runoff (sediment, heavy metals and elevated temperature) from road surface to wetlands; and
  - Increased risk of spills of potential toxins (for example, oil or chemicals) from cartage vehicles.

4.2.2 Overview of likely measures to avoid, remedy or mitigate for potential adverse effects

Potential adverse effects on terrestrial and wetland values associated with construction and operation should be avoided, remedied or mitigated to the extent possible, through:

- Further refinement of the development footprint to ensure that the vegetation clearance and earthworks footprint is kept to a minimum.
- Seasonal constraints on vegetation clearance. Vegetation clearance is expected to be affected by specific timing restrictions to avoid or minimise effects on fauna that are legally protected under the Wildlife Act (1953). This should include avoidance of vegetation clearance:
  - Outside of earthworks season (i.e., should not be undertaken from 1 May – 1 October) due to the need for erosion and sediment controls to be in place in accordance with the relevant management plan;
  - During colder months when bats are less active and when roosting bats are less likely to be detected through standard bat tree felling protocol methods;
  - During peak bird breeding season to reduce harm to eggs or chicks (August to December inclusive); and
  - In accordance with seasonal constraints for salvaging and relocating lizards and invertebrates.
- Vegetation clearance protocols should include:
  - Physical delineation of vegetation to be cleared to avoid inadvertent clearance and to minimise potential damage to branches and roots; and
  - Directional felling to prevent damage to vegetation immediately adjacent to the footprint.
- Sediment control measures should be undertaken to avoid or minimise effects on the wider aquatic receiving environment, i.e., wetlands, streams and the Waikato River.
- Vegetation/habitat clearance salvage and relocation operations for nationally 'Threatened', 'At Risk', Regionally uncommon or legally protected species present or potentially present

onsite. This should include:

  - Best practice bat tree felling protocol to reduce the risk of harming roosting bats;
  - Lizard salvage and relocation; and
  - Redeployment of dead standing wood or fallen logs into native revegetation sites, to mitigate for potential effects on regionally uncommon invertebrates that may be present, e.g., tree weta and peripatus.
- Controls on domestic cats; and
- Mitigation plantings to buffer against light, noise, dust or general disturbance of ecologically significant habitats. These plantings are ideally undertaken before the construction starts, to reduce the time lag needed for planted habitat to become ecologically functional.

These measures to avoid, remedy or mitigate potential adverse effects should be detailed in the respective ecological management plans, as mandated through proposed consent conditions set out in the AEE.

4.2.3 Expected magnitude of effects after measures to avoid, remedy or mitigate adverse effects

Table 4.2: Magnitude of effects assessment after measures to avoid, remedy or mitigate for effects (Appendix D, Tables 4 – 5)

Biodiversity value	Direct and indirect effects within the PSPA development footprint	Magnitude of effects after mitigation (Appendix D)
Habitat complexes		
Significant indigenous terrestrial and freshwater fauna habitat: Riparian margins and associated waterways (**58.74 ha**)	It is assumed that there will be no permanent loss of riparian margins and associated waterways within PSPA. It is assumed that there will be potential effects on these habitat types due to light, noise or general disturbance associated with housing developments or degradation of the associated waterways through stormwater pollutants and potential sedimentation. It is expected that these effects will be appropriately mitigated for, though residual effects are expected.	Moderate
Significant indigenous terrestrial fauna habitat: non-riparian linear features (ecological corridors) (**20.49 ha**)	Permanent loss of 3.09 ha of non-riparian linear features (shelterbelts), which equates to 15 % of the 20.49 ha of available habitat within the PSPA, and a small proportion of what is available in the landscape. It is assumed that there will be potential effects on these habitat types due to light, noise or general disturbance associated with housing developments. It is expected that these effects will be appropriately mitigated for though residual effects are expected.	High
Significant indigenous bat habitat: non-riparian habitat ecological buffers (**56.59 ha**)	It is assumed that there will be no permanent loss of this habitat type. It is assumed that there will be potential effects on these habitat types due to light, noise or general disturbance associated with housing developments, and that these effects will be appropriately mitigated for, though residual effects are expected.	Low
Significant indigenous	It is assumed that there will be no permanent loss of this habitat type. It is assumed that there will be potential effects on these	Low

Biodiversity value	Direct and indirect effects within the PSPA development footprint	Magnitude of effects after mitigation (Appendix D)
vegetation remnants (**4.5 ha***)	habitat types due to light, noise or general disturbance associated with housing developments, and that these effects will be appropriately mitigated for, though residual effects are possible.	
Wetlands (**7.3 ha**) including Riverine & Palustrine wetlands (**5.6 ha***) and Ephemeral Seep or Spring wetlands (**1.7 ha**).	It is assumed that there would be no permanent loss of natural freshwater wetlands due to activity status rules for natural freshwater wetlands set out in the NES-F but some constructed wetlands (ponds) may be lost. Potential effects on these habitat types will result from light, noise or general disturbance associated with housing developments (terrestrial) or degradation of water quality through stormwater pollutants and potential sedimentation. It is expected that these effects will be appropriately mitigated for, though residual effects are expected.	Moderate
Non-significant exotic vegetation (excluding pasture) (**47.58 ha**)	Permanent loss of 34.36 ha which equates to 72.2% of the available habitat within the PSPA, and which constitutes a moderate proportion of the habitat available in the surrounding landscape.	High
Non-significant exotic vegetation (pasture) (**535.73 ha**)	Permanent loss of 462.88 ha which equates to 86.4% of the available habitat within the PSPA, and which constitutes a moderate proportion of the habitat available in the surrounding landscape.	High
Species		
Nationally Threatened Long tailed bat	Permanent loss of 3.09 ha of high-quality bat habitat, 34.36 ha of moderate quality bat habitat and 500.33 ha of low quality bat habitat, which equates to 78.7% of what remains available in the PSPA (excluding the Southern Links footprint), and a large proportion of the habitat available to the local bat population (albeit only a small proportion of this is high quality bat habitat). In addition to direct effects, landscape and habitat ecological connectivity may be severed or partially severed. It is assumed that there will be potential effects on these habitat types due to light, noise or general disturbance associated with housing developments. It is expected that these effects will be appropriately mitigated for, though residual effects are expected.	High
Nationally Threatened Kānuka and Mānuka	Permanent loss of all kānuka and mānuka within the development footprint, which is expected to be negligible	Negligible
Nationally threatened poroporo	It is assumed that no Poroporo are present within the development footprint	Negligible
Nationally threatened or 'At Risk' forest and wetland birds	It is assumed that there would be no permanent loss of natural freshwater wetlands due to activity status rules for natural freshwater wetlands set out in the NES-F but some constructed wetlands (ponds) may be lost. Potential effects on these species may occur through light, noise or general disturbance associated with housing developments (terrestrial) or through degradation of water quality through stormwater pollutants and potential	Likely Moderate

Biodiversity value	Direct and indirect effects within the PSPA development footprint	Magnitude of effects after mitigation (Appendix D)
	sedimentation. It is expected that these effects will be appropriately mitigated for, though residual effects are expected.	
'At Risk' fish and freshwater invertebrate species	It is assumed there will be no permanent loss of natural streams. Potential indirect effects on fish and freshwater invertebrates may occur through degradation in water quality associated with stormwater runoff, however there will be corresponding potential positive effects through a reduction in sedimentation and nutrient enrichment associated with farming activities (particularly the presence of livestock in riparian margins).	Low

4.3 Levels of effect (Step 3)

Table 4.3 below sets out the potential 'Level of Effects' for habitat complexes based on the assumption that all biodiversity values within the development footprint will be lost, with the exception of wetlands.

Of key importance, even with application of remediation and mitigation measures, urbanisation within the PSPA development footprint, as currently proposed, will likely result in a 'Very High' level of residual adverse effects on bats. This in effect means that the initial design of specific urban subdivisions and infrastructure is critical, and will form the most important part of avoiding significant effects on critical habitats within the PSPA. In practical terms, this means that known roosts should be retained, as should riparian margins, buffers and ecological corridors.

Efforts to address potential adverse effects are considered necessary for all habitats or species that have the potential for a 'Level of Effects' of 'Moderate' or higher. Recommendations for addressing these effects are provided in Section 5 below.

Table 4.3: Level of residual effects on biodiversity values after mitigation (Appendix D Table 6)

Biodiversity value	Biodiversity value category	Magnitude of effects category after mitigation	Level of effects category (after mitigation)
Habitat/vegetation type			
Significant indigenous terrestrial and freshwater fauna habitat: Riparian margins and associated waterways (**58.74 ha**)	High	Moderate	High
Significant indigenous terrestrial fauna habitat: non-riparian linear features (ecological corridors) (**20.49 ha**)	High	High	Very High
Significant indigenous bat habitat: non-riparian habitat ecological buffers (**56.59 ha**)	High	Low	Low
Significant indigenous vegetation remnants (**4.5 ha***)	High	Low	Low

Biodiversity value	**Biodiversity value category**	**Magnitude of effects category after mitigation**	**Level of effects category (after mitigation)**
Wetlands (**7.3 ha**) including Riverine & Palustrine wetlands (**5.6 ha***) and Ephemeral Seep or Spring wetlands (**1.7 ha**).	*Moderate to High*	*Likely Moderate*	*Potentially high*[6]
Non-significant exotic vegetation (excluding pasture) (47.58 ha)	Moderate	High	Moderate
Non-significant exotic vegetation (pasture) (**535.73 ha**)	Moderate	High	Moderate
Nationally Threatened or 'At Risk' Flora Species			
Nationally threatened (vulnerable) kānuka	Very high	Negligible	Low
Nationally threatened (vulnerable) mānuka	Very high	Negligible	Low
Nationally threatened (vulnerable) poroporo	Very high	Negligible	Low
Nationally Threatened or 'At Risk' Fauna Species			
Nationally threatened (critical) Long-tailed bat	Very high	High	Very high
At Risk (declining) Forest gecko, moko-piri-ra ̄kau	High	Low	Low
At Risk (declining) Auckland green gecko, elegant gecko, kākāriki	High	Low	Low
At Risk (declining) Ornate skink	High	Low	Low
At Risk (naturally uncommon) Pacific gecko	Moderate	Low	Low
Nationally threatened (critical) Grey duck, pārera	Very high	Low	Moderate
At Risk (declining) New Zealand pipit, pīhoihoi	Moderate	Moderate	Moderate
Nationally threatened (critical) White heron, kōtuku	Very high	Negligible	Low
Nationally threatened (critical) Australasian bittern, matuku hūrepo	Very high	Low	Moderate
At Risk (declining) North Island fernbird, mātātā	Moderate	Low	Low
At Risk (naturally uncommon) Long-tailed cuckoo, koekoea	Moderate	Low	Low
At Risk (recovering) Bush falcon, karearea	Moderate	Low	Low
At Risk (declining) Banded rail, moho pererū	High	Negligible	Low
At Risk (declining) New Zealand pied oystercatcher, tōrea	High	Negligible	Low
Nationally threatened (critical) Black billed gull, tarāpuka	Very high	Negligible	Low
At Risk (declining) Red billed gull, tarāpunga	High	Negligible	Low
At Risk (recovering) North Island kākā	Moderate	Low	Low
At Risk (naturally uncommon) Black shag, kawau	Moderate	Low	Low
At Risk (naturally uncommon) Little black shag, kawau tūi	Moderate	Low	Low

[6] It is key to note that prohibited activity status applies to a number of activities that may affect natural freshwater wetlands as defined by the National Policy Statement – Freshwater Management 2020 and as set out in National Environmental Standards for Freshwater 2020. Furthermore determining the presence and extent of natural wetlands typically requires field investigations and an assessment against the Wetland Delineation Protocol (MfE, 2020). Correspondingly it is difficult to determine the potential level of effects on wetlands.

Biodiversity value	Biodiversity value category	Magnitude of effects category after mitigation	Level of effects category (after mitigation)
At Risk (recovering) Pied shag, karuhiruhi	Moderate	Low	Low
At Risk (naturally uncommon) Royal spoonbill, kōtuku ngutupapa	Moderate	Low	Low
At Risk (recovering) New Zealand dabchick, waiwea	Moderate	Low	Low
At Risk (declining) Marsh crake, koitareke	High	Negligible	Low
At Risk (declining) Spotless crake, pūweto	High	Low	Low
At Risk (declining) Longfin eel, tuna	High	Low	Low
At Risk (declining) Torrentfish, piripiripohatu	High	Low	Low
At Risk (declining) Giant kōkopu, taiwharu	High	Low	Low
At Risk (declining) Koaro	High	Low	Low
At Risk (declining) Īnanga, inaka	High	Low	Low
Nationally threatened (vulnerable) Shortjaw kōkopu	High	Low	Low
Nationally threatened (vulnerable) Lamprey, kanakana	High	Low	Low
At Risk (declining) Redfin bully	High	Low	Low
At Risk (declining) Black mudfish	High	Low	Low
At Risk (declining) Freshwater mussel, kākahi	High	Low	Low
Freshwater snail (Data deficient)	Moderate	Low	Low

5 Residual effects management

5.1 Residual effects

As set out in Table 5.1, a number of residual adverse effects are expected as a result of the proposed landuse change in the PSPA.

Of key importance, the change from rural to residential landuse within the PSPA will likely result in a 'Very High' level of residual effects on bats after measures to avoid, remedy or mitigate for adverse effects are implemented. This is attributed primarily to the large-scale loss (ca 500 ha) of low- and moderate-value bat habitats in the form of pasture, and exotic vegetation of higher stature as well as the loss of 3.09 ha of habitat assessed as having high value for bats.

We consider this loss of 3.09 ha of high value bat habitat to constitute a 'Very High' level of effects that cannot be adequately or appropriately addressed, and we recommend efforts to protect these areas.

However, while the level of residual effects on low- and moderate-value bat habitat within the PSPA is also 'Very High', it is our view that these effects can be appropriately addressed through habitat restoration and enhancement, with a focus on native revegetation and the control of introduced predatory mammals within suitable protected areas.

Table 5.1: Biodiversity values for which the level of residual effects has been assessed as moderate or higher.

Biodiversity value	Level of effects category (after mitigation)
Significant indigenous terrestrial and freshwater fauna habitat: Riparian margins and associated waterways (**58.74 ha**)	High
Significant indigenous terrestrial fauna habitat: non-riparian linear features (ecological corridors) (**20.49 ha**)	Very High
Wetlands (**7.3 ha**) including Riverine & Palustrine wetlands (**5.6 ha***) and Ephemeral Seep or Spring wetlands (**1.7 ha**).	*Potentially high*[7]
Non-significant exotic vegetation (excluding pasture) (47.58 ha)	Moderate
Non-significant exotic vegetation (pasture) (**535.73 ha**)	Moderate
Nationally threatened (critical) Long-tailed bat	Very high
Nationally threatened (critical) Grey duck, pārera	Moderate
At Risk (declining) New Zealand pipit, pīhoihoi	Moderate
Nationally threatened (critical) Australasian bittern, matuku hūrepo	Moderate
At Risk (declining) Spotless crake, pūweto	Moderate

[7] It is key to note that prohibited activity status applies to a number of activities that may affect .natural freshwater wetlands as defined by the National Policy Statement – Freshwater Management and as set out in the National Environmental Standards – Freshwater. Furthermore to determine the presence and extent of natural wetlands typically requires field investigations and an assessment against the Wetland Delineation Protocol (MfE, 2020). Correspondingly it is difficult to determine the potential level of effects on wetlands.

5.2 Residual effects management approach

To address residual effects, we recommend a focus on native revegetation (in addition to mitigation plantings), the control of introduced predatory mammals within suitable protected areas, and that these measures follow best practice guidelines to optimise ecological outcomes.

In this instance, the recommended measures to address residual effects are considered to be forms of compensation rather than offsetting. The proposed measures do not meet the definition of offsetting because:

- The loss of degraded exotic-dominated habitat does not include the re-creation of an exotic-dominated wetland with similar ecological characteristics and function. Rather, it is proposed to exchange the permanent loss of exotic dominated habitat with the restoration and enhancement of indigenous biodiversity values in a large, degraded wetland. Importantly, this approach is expected to generate better outcomes for wetland biodiversity than a strict offset approach.
- This preliminary assessment was based on desktop information rather than quantitative data and therefore impacts cannot be demonstrably offset, noting that for most large-scale projects it is not feasible to demonstrably offset biodiversity values with the necessary degree of precision (Baber et al. 2021).

Although biodiversity compensation does not involve the same numerical rigour as offsetting, it is generally recognised that ecological outcomes are improved where offset principles are applied as a guideline when designing compensation packages (Maseyk et al. 2018).

The QBM focused exclusively on bat habitat because bats are a nationally 'Threatened' ('Nationally Critical) species, because they are wide-ranging and use all habitat types currently present, and are expected to be adversely affected by the proposed landuse changes within the PSPA. As such, working towards NNL/NG outcomes for bats is expected to benefit the full suite of biodiversity values found within the PSPA.

5.3 Determining the quantum of residual effects management

The type and magnitude of proposed compensation measures for this project will be guided by the application of a Qualitative Biodiversity Model (QBM) (Baber et al., 2021; Tonkin & Taylor 2021) as set out below.

Overall, it is key to recognise that QBMs have limitations, and should therefore be used simply as decision support tools (see Tonkin & Taylor, 2021). As such, their role is to help us understand the rationale and justification for determining compensation measures that are expected to result in tangible NNL/NG outcomes for affected biodiversity values. They do not provide certainty that NNL/NG outcomes will be achieved. Certainty of outcome will not eventuate until *after* habitat restoration/enhancement activities have commenced, and providing that a robust biodiversity monitoring programme has been implemented, and the biodiversity impacts and gains can indeed be quantified with a high degree of accuracy (Baber et al, 2021).

The proposed residual effects management approach seeks to achieve NG outcomes within 25 years for residual effects on PSPA biodiversity values. As necessitated by the project (and effects management) cycle, application of this model will be a staged process. As such, confirmation of NNL/NG biodiversity outcomes is dependent on application of a BOAM and further surveys to be undertaken during, for example, resource consent application stages for developments in the PSPA, and through the development and implementation of relevant management plans in accordance with consent conditions.

5.4 Qualitative Biodiversity Model results

As mentioned previously, the PSPA QBM focuses on bats on the basis that the type and quantum of habitat restoration and enhancement measures that are likely required to achieve NNL/NG outcomes for bats, will likely also address residual effects on most, if not all, biodiversity values.

The QBM is based on:

- Available information and expert assessment of the amount and quality of habitat that will be adversely affected at the impact sites;
- Available information and expert assessment of the amount and quality of habitat that will be subject to compensation actions (i.e. habitat restoration and enhancement) at the compensation sites; and
- Assessment of the potential benefits to bats associated with potential habitat restoration and enhancement measures.

In summary, the QBM outputs indicate that habitat restoration, or enhancement activities within all available habitat (185 ha), that is within the PSPA but outside of the development footprint, will go a considerable way towards addressing residual effects.

However, it is unlikely to achieve a Net Gain outcome for long-tailed bats. As described in Section 5.3, further bat habitat restoration and enhancement measures in areas outside of the PSPA are therefore likely required to generate a Net Gain outcome for long-tailed bats.

Table 5.2 below sets out the data inputs into the QBM along with explanations where required. Table 5.3 sets out the impact and compensation gain output scores along with the overall Net Gain outcome.

Table 5.2: PSPA bat habitat model inputs

General model descriptor inputs	
Model inputs	**Explanation**
Biodiversity type	Long-tailed bats
Technical expert input(s)	Gerry Kessels (primary) and Matt Baber (peer review)
Benchmark	**Data input**: 5 **Explanation**: The benchmark is set at 5 to align with EcIAG habitat categories. The benchmark constitutes a hypothetical but realistic future state, i.e., a large population of long-tailed bats that are located within high value, mature native forest dominated landscape that is subject to long-term pest control and is at carrying capacity.
Net Gain target	**Data input**: 20% **Explanation**: The Net Gain target was set at 20%. In general terms, the greater the assigned Net Gain outcome target, the greater the likelihood that No Net Loss or preferably Net Gain outcomes will be achieved. For compensation we consider a Net Gain outcome target of 20% to be generally appropriate, which equates to a 20% overshoot of No Net Loss, i.e. the Compensation Score is 20% Higher than the Impact Score.

Impact model inputs and descriptions	
Habitat/site impacted	**Low value bat habitat within the development footprint (pasture)**
Impact contingency (Value)	**Data input**: Very High value (the calculated impact score is multiplied by 1.15, i.e. 15%). **Explanation**: The impact contingency (value) relates to the modelled biodiversity value and addresses the need to take a more precautionary approach when impacting on habitats or species that are assessed as being of higher ecological value through the EcIAG ecological value assessment. Long tailed bats are considered to be of 'Very High' value based on the EcIAG. For biodiversity values assessed as 'Very High' the calculated impact score is multiplied by 1.15, i.e. 15%).
Impact contingency (uncertainty)	**Data input:** High uncertainty (the calculated impact score is multiplied by 1.15 (+15%) **Explanation**: The impact contingency (uncertainty) addresses the inherent uncertainties in some habitat or species values. This provides for a more precautionary approach when impacting on more complex habitats, or on species for which there is less information regarding species-specific impacts associated with an effect. The impact contingency (uncertainty) in relation to the effects on bats associated with the loss of low value bat habitat was deemed to be 'high'. For impacts assessed as having 'high' uncertainty the calculated impact score is multiplied by 1.15, i.e., + 15%).
Areal extent of impact (ha)	**Data input**: 462.88 ha
Value score prior to Impact	Data input: 0.25 Explanation: Pasture within the PSPA development area has been assigned a score of 0.25 relative to the benchmark of 5, e.g., considered to equate to 5 % the value of benchmark habitats.This assessment is based on the expert opinion of Gerry Kessels, based on desktop and field investigations and using professional judgement. It is key to note that the EcIAG (2018) does not include criteria for determining habitat suitability for a given species. Since habitat suitability is a key component of a magnitude of effects assessment, this will ideally be addressed in subsequent versions of the EcIAG. In the interim, we set out proposed criteria below that applied to all impact and compensation scores in this model: 0 = Habitat not suitable < 1 = Marginal habitat that may be used but is not important for any part of the species or species assemblage life-cycle (s) 1 - <2 = Relatively low value habitat that provides some but not all of a species or species assemblages life-history requirements, and/or the habitat is of low quality, and the relative abundance within the habitat is low compared to other habitat types 2 - <3 = Relatively moderate value habitat that provides for most if not all of a species or species assemblages life-history requirements and/or the habitat quality is of moderate quality and the relative abundance within the habitat is moderate compared to other habitat types 3 - <4 = Relatively high value habitat that would typically provide for all species or species assemblage life-history requirements and/or provides a critical resource or resource(s) for life-history requirements. The habitat quality is high and the relative

	abundance within the habitat is, or is likely to be, high compared to other habitat types. 4 - <5 = Relatively very high value habitat that provides for all species or species assemblage life-history requirements and/or provides a critical resource or resource(s) needed for life-history requirements. The habitat quality is very high and the relative abundance within the habitat is or is likely to be very high compared to other habitat types. Likely to be a local hotspot for that species 5 = Highest quality habitat and/or relative abundance for a given species or species assemblage, likely to be a regional hotspot or benchmark site with the species or species assemblage at carrying capacity. In instances where population densities or relative abundance appears higher in seemingly less suitable habitats than in more suitable habitats, this will need to be addressed and reflected in the relative value scores.
Value score after Impact	Data input: 0 Explanation: A value of 0 has been assigned because it is conservatively assumed that all habitat within the PSPA development footprint will be lost and/or no longer used by bats.
Habitat/site impacted	Moderate value habitat for bats within the development footprint (e.g. non-pasture vegetation that was not assessed as having high value for bats (Kessels and Baber, 2021)
Impact contingency (Value)	Data input: Very High value (the calculated impact score is multiplied by 1.15, i.e. 15%). Explanation: See above
Impact contingency (uncertainty)	Data input: High uncertainty (the calculated impact score is multiplied by 1.15 (+15%) Explanation: See above
Areal extent of impact (ha)	Data input: 34.36 ha
Value score <u>prior to</u> Impact	Data input: 2 Explanation: Moderate value habitats within the PSPA development area have been assigned a score of 2 relative to the benchmark of 5, e.g., they are considered to equate to 40 % of the value of benchmark habitats. This assessment is based on the expert opinion of Gerry Kessels based on desktop and field investigations and using professional judgement
Value score <u>after</u> Impact	Data input: 0 Explanation: A value of 0 as it is conservatively assumed that all habitat within the PSPA development footprint will be lost either directly or indirectly (loss of connectivity)
Habitat/site impacted	Vegetation within the development footprint that was assessed as being of High value for bats, e.g. select non-riparian linear shelterbelts and groups of trees (Baber and Kessels, 2021).

Impact contingency (Value)	**Data input**: Very High value (the calculated impact score is multiplied by 1.15, i.e. 15%). **Explanation**: See above
Impact contingency (uncertainty)	**Data input:** high uncertainty (the calculated impact score is multiplied by 1.15 (+15%) **Explanation**: See above
Areal extent of impact (ha)	**Data input**: 3.09 ha
Value score prior to Impact	**Data input**: 3.5 **Explanation**: Bat habitat within the PSPA development footprint assessed as having high value for bats has been assigned a score of 3.5 relative to the benchmark of 5, e.g., these habitats are considered to equate to 70 % the value of benchmark habitats. This assessment is based on the expert opinion of Gerry Kessels, based on desktop and field investigations and using professional judgement.
Value score after Impact	**Data input**: 0 **Explanation**: A value of 0 as it is conservatively assumed that all such habitat within the PSPA development footprint will be lost either directly or indirectly (loss of connectivity)
Compensation model inputs	
Compensation type 1	Indigenous revegetation of pasture habitat within river and gully margins, buffer habitat and ecologically corridors considered to be significant or likely significant (Kessels and Baber, 2021). It is assumed that native revegetation will be optimised for bat values through the deployment of artificial roost boxes as well as the planting of small numbers of fast-growing cavity forming exotic trees for roosting.
Discount rate	**Data input**: 3% **Explanation**: A discount rate of 3 % has been applied to account for the inherent risk in the temporal-lag between the impact occurring (due to the development) and the biodiversity gains being generated (due to the offset actions) has been used. The worked examples provided in the model User Manual apply a discount rate of 3 %, as informed by research conducted as part of the Department of Conservation's research project on biodiversity offsetting in New Zealand.
Finite end-point	**Data input**: 25 years. **Explanation**: The finite end-point of 25 years represents the time period over which to calculate Net Present Biodiversity value. This equates to the time between the commencement of a revegetation and an assessment of the associated benefits for the modelled biodiversity value.
Compensation contingency (confidence)	**Data input**: 'Moderate Confidence' (Calculated compensation gain is multiplied by 0.825).

	Explanation: Compensation contingency relates to the level of confidence in the likely success of the proposed habitat restoration/enhancement measures and methodology (see above). This reflects that even well-established management methods sometimes fail to achieve targets for a multitude of reasons. The model does not consider confidence in the implementer of the proposed habitat restoration/enhancement activity. Nor does it consider likelihood of abandonment of the project post-impact but prior to the implementation of habitat restoration or enhancement measures. 'Moderate Confidence' equates to a well-known measure that is often implemented, and which has been proven to succeed greater than 75% of the time. However, complicating factors and/or expert opinion precludes greater confidence in this compensation measure. Likelihood of success is greater than 75% but less than 90%. Calculated compensation gain is multiplied by 0.825. NB: The approach used to assign contingency aligns with that used in Maseyk et al. (2015) except that the term 'offset' has been changed to 'compensation'.
Areal extent (ha) of compensation type	**Data input**: 65.27 ha **Explanation**: This equates to the available area of pasture outside the development footprint, which includes 13.74 ha in river and gully margins, 36.85 ha in bat habitat buffer areas and 15.9 ha within bat corridor areas (Kessels and Baber, 2021).
Value score <u>prior to</u> compensation measure (relative to benchmark)	**Data input**: 0.25 **Explanation**: Pasture within these areas have been assigned a score of 0.25 relative to the benchmark of 5, e.g., they are considered to equate to 5 % the value of benchmark habitats. This assessment is based on the expert opinion of Gerry Kessels, based on desktop and field investigations and using professional judgement.
Value score <u>after</u> compensation measure (relative to benchmark)	**Data input**: 3 **Explanation**: When the revegetation and associated habitat enhancement is 25 years old, it is assigned a value score of 3 against the Benchmark of 5. This assessment is based on the expert opinion of Gerry Kessels, based on desktop and field investigations and using professional judgement.
Compensation type 2	Mammalian pest control in perpetuity
Discount rate	**Data input**: 3% **Explanation**: See above
Finite end-point	**Data input**: 1 year **Explanation**: The finite end-point of 1 years represents the time period over which to calculate Net Present Biodiversity value. This is based on the expectation that pest control will reduce predation risk on roosting bats almost immediately after commencement of pest control operations. It is assumed that the pest control programme will follow best practice methods for reducing predation risk to bats.

Compensation contingency (confidence)	**Data input**: 'Moderate Confidence' (Calculated compensation gain is multiplied by 0.825). **Explanation**: See above
Areal extent (ha) of compensation type	**Data input**: 119.99 ha **Explanation**: This equates to all bat habitat (51.833 ha, bat habitat buffer (48.01 ha) and bat corridors (20.15ha), which are deemed to be or likely be ecologically significant (Kessels and Baber, 2021))
Value score prior to compensation measure (relative to benchmark)	**Data input**:3.5 **Explanation**: The existing vegetation within the compensation areas has been assigned a score of 3.5 relative to the benchmark of 5, e.g., they are considered to equate to 70 % the value of benchmark habitats. This assessment is based on the expert opinion of Gerry Kessels, based on desktop and field investigations and using professional judgement
Value score after compensation measure (relative to benchmark)	**Data input**:3.75 **Explanation:** The existing tall stature habitat within the compensation areas has been assigned a score of 3.75, relative to the benchmark of 5 once under a pest control regime, i.e. relative to the benchmark a 5% gain in ecological value or the difference in the percentage of bats that are predated on by introduced predatory mammals). This assessment is based on the expert opinion of Gerry Kessels, based on desktop and field investigations and using professional judgement.

Table 5.3: PSPA bat habitat model outputs

Impact model outputs	Totals	Low value bat habitat	Moderate value bat habitat	High value bat habitat
Impact Score	-32.42	-31.026	-1.375	-0.019
Compensation model outputs	**Totals**	**Revegetation**	**Pest Control**	
Compensation Score	18.95	14.15	4.81	
Net gain outcome	-41.55 %			

5.4.1 Compensation options outside the PSPA

The compensation model outputs above indicate that the proposed 65.27 ha of revegetation and 119.99 ha of pest control within available habitat in the PSPA will be unlikely to achieve NNL/NG outcomes.

Through model iterations, it was determined that the following would be required in suitable bat habitat outside the PSPA to achieve NNL/NG outcomes with a reasonable degree of certainty[8] a Net Gain target of 20 % within 25 years:

- A further 140 ha of native revegetation; or
- 800 ha of intensive mammalian pest control (in perpetuity); or
- A lesser quantum of both would be required outside the PSPA within values that have high bat values.

We have further assessed the relative proportion of revegetation and pest control, and determined that this would require in the order of 60 hectares of native revegetation and 180 hectares of pest control within river or gully margins in the surrounding landscape.

[8] Based on the arbitrary setting of a 20% Net Gain target.

6 Applicability

This report has been prepared for the exclusive use of our client Hamilton City Council, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

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.....	.....
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Ecologist	Project Director

Report prepared by:	Technical review by:
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Appendix A: Waikato Regional Policy Statement – policies regarding biodiversity offset

The Waikato Regional Policy Statement (Waikato Regional Council, 2016) contains the following policies and methods which specifically address biodiversity offsetting and the achievement of no net loss of indigenous biodiversity:

Policy 11.1 Maintain or enhance indigenous biodiversity

Promote positive indigenous biodiversity outcomes to maintain the full range of ecosystem types and maintain or enhance their spatial extent as necessary to achieve healthy ecological functioning of ecosystems, with a particular focus on:

a. working towards achieving no net loss of indigenous biodiversity at a regional scale;…

…j. the consideration and application of biodiversity offsets.

Implementation Method 11.1.3 Avoidance, remediation, mitigation and offsetting (for indigenous biodiversity that is not significant)

Regional and district plans:

a. for non-significant indigenous vegetation and non-significant habitats of indigenous fauna (excluding activities pursuant to 11.1.4):...

ii. should promote biodiversity offsets as a means to achieve no net loss of indigenous biodiversity where significant residual adverse effects are unable to be avoided, remedied or mitigated.

Policy 11.2 Protect significant indigenous vegetation and significant habitats of indigenous fauna

Implementation Method 11.2.2 Protect areas of significant indigenous vegetation and significant habitats of indigenous fauna

Regional and district plans shall (excluding activities pursuant to 11.1.4):…

d. where any adverse effects are unable to be avoided, remedied or mitigated in accordance with (b) and (c), more than minor residual adverse effects shall be offset to achieve no net loss; and…

f. recognise that remediation, mitigation and offsetting may not be appropriate where the indigenous biodiversity is rare, at risk, threatened or irreplaceable; …

Appendix B: Offsetting overview

The definition of biodiversity offsets that has been adapted for and is most closely aligned with the Resource Management Act (RMA) (Maseyk et al. 2018) is:

A measurable conservation outcome resulting from actions designed to compensate for residual, adverse biodiversity effects arising from activities after appropriate avoidance, remediation, and mitigation measures have been applied. The goal of a biodiversity offset is to achieve no-net-loss, and preferably a net-gain, of indigenous biodiversity values. (Maseyk et al. 2018)

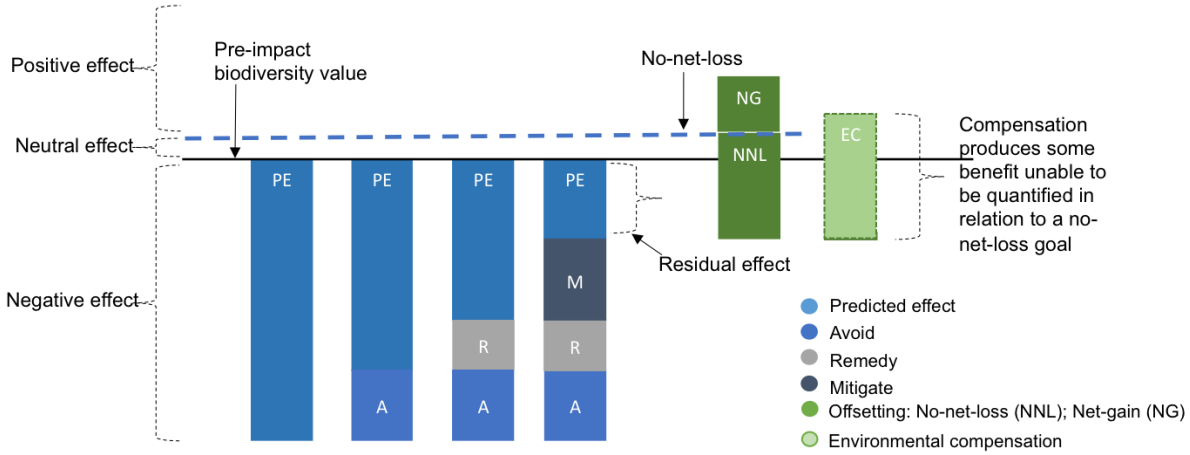


Figure Appendix B.1: Taken from Maseyk et al. 2018. Conceptual illustration of the effects management hierarchy progressing from avoidance (least risk and most certainty) to environmental compensation (greatest risk and least certainty) and showing the difference between a neutral 'no-net-loss' and positive 'net gain' outcome. The no-net-loss line is above the pre-impact biodiversity value as more gains than losses are required to achieve no-net-loss when accounting for uncertainty and time-lags.

Biodiversity offsetting is based on widely accepted principles, the most frequently-cited guiding principles for biodiversity offsetting are those developed by Business for Biodiversity Offsets Programme (BBOP) which includes principles on science, social, culture and policy matters (BBOP 2012). The BBOP principles are:

1 Adherence to the mitigation hierarchy: A biodiversity offset is a commitment to compensate for significant residual adverse impacts on biodiversity identified after appropriate avoidance, minimisation and on-site rehabilitation measures have been taken according to the mitigation hierarchy.

2 Limits to what can be offset: There are situations where residual impacts cannot be fully compensated for by a biodiversity offset because of the irreplaceability or vulnerability of the biodiversity affected.

3 Landscape context: A biodiversity offset should be designed and implemented in a landscape context to achieve the expected measurable conservation outcomes taking into account available information on the full range of biological, social and cultural values of biodiversity and supporting an ecosystem approach.

4 No net loss: A biodiversity offset should be designed and implemented to achieve in situ, measurable conservation outcomes that can reasonably be expected to result in no net loss and preferably a net gain of biodiversity.

5 Additional conservation outcomes: A biodiversity offset should achieve conservation outcomes above and beyond results that would have occurred if the offset had not taken place. Offset design and implementation should avoid displacing activities harmful to biodiversity to other locations.

6 Stakeholder participation: In areas affected by the project and by the biodiversity offset, the effective participation of stakeholders should be ensured in decision-making about biodiversity offsets, including their evaluation, selection, design, implementation and monitoring.

7 Equity: A biodiversity offset should be designed and implemented in an equitable manner, which means the sharing among stakeholders of the rights and responsibilities, risks and rewards associated with a project and offset in a fair and balanced way, respecting legal and customary arrangements. Special consideration should be given to respecting both internationally and nationally recognised rights of indigenous peoples and local communities.

8 Long-term outcomes: The design and implementation of a biodiversity offset should be based on an adaptive management approach, incorporating monitoring and evaluation, with the objective of securing outcomes that last at least as long as the project's impacts and preferably in perpetuity.

9 Transparency: The design and implementation of a biodiversity offset, and communication of its results to the public, should be undertaken in a transparent and timely manner.

10 Science and traditional knowledge: The design and implementation of a biodiversity offset should be a documented process informed by sound science, including an appropriate consideration of traditional knowledge.

The intention of the New Zealand Government Guidance (NZ Guidance; https://www.doc.govt.nz/about-us/our-policies-and-plans/guidance-on-biodiversity-offsetting/) was to ensure that solutions addressing residual effects are ecologically sound and demonstrably result in no net loss or a net gain. The NZ Guidance is contextually related to Goal 3 of the New Zealand Biodiversity Strategy (2000), which is to halt the decline in New Zealand's indigenous biodiversity. Although the NZ Guidance is not a statutory document it is a valuable tool for the design and assessment of ecologically sound management of adverse effects and reflects the relevant government departments' view on biodiversity offsetting. It is supported by additional resources that provide more detail on the design, implementation and assessment of biodiversity offsets.

In 2018 the Regional Councils BioManagers Group released its guidance 'Biodiversity Offsetting under the Resource Management Act' (Maysek et al. 2018). The purpose of this Local Government Guidance (LG Guidance; https://www.lgnz.co.nz/our-work/our-policy-priorities/3-environment/biodiversity/) is to provide councils and resource consent applicants with guidance on applying biodiversity offsets under the RMA. The document draws on international best practice informed by BBOP and was designed to be consistent with the NZ Government Guidance.

Several of the BBOP principles, especially those regarding cultural values and knowledge, stakeholder consultation, and the effects management hierarchy are already embedded within the RMA. However several principles are not embedded in the RMA but are of key importance in designing an offset proposal (Appendix B Table 1).

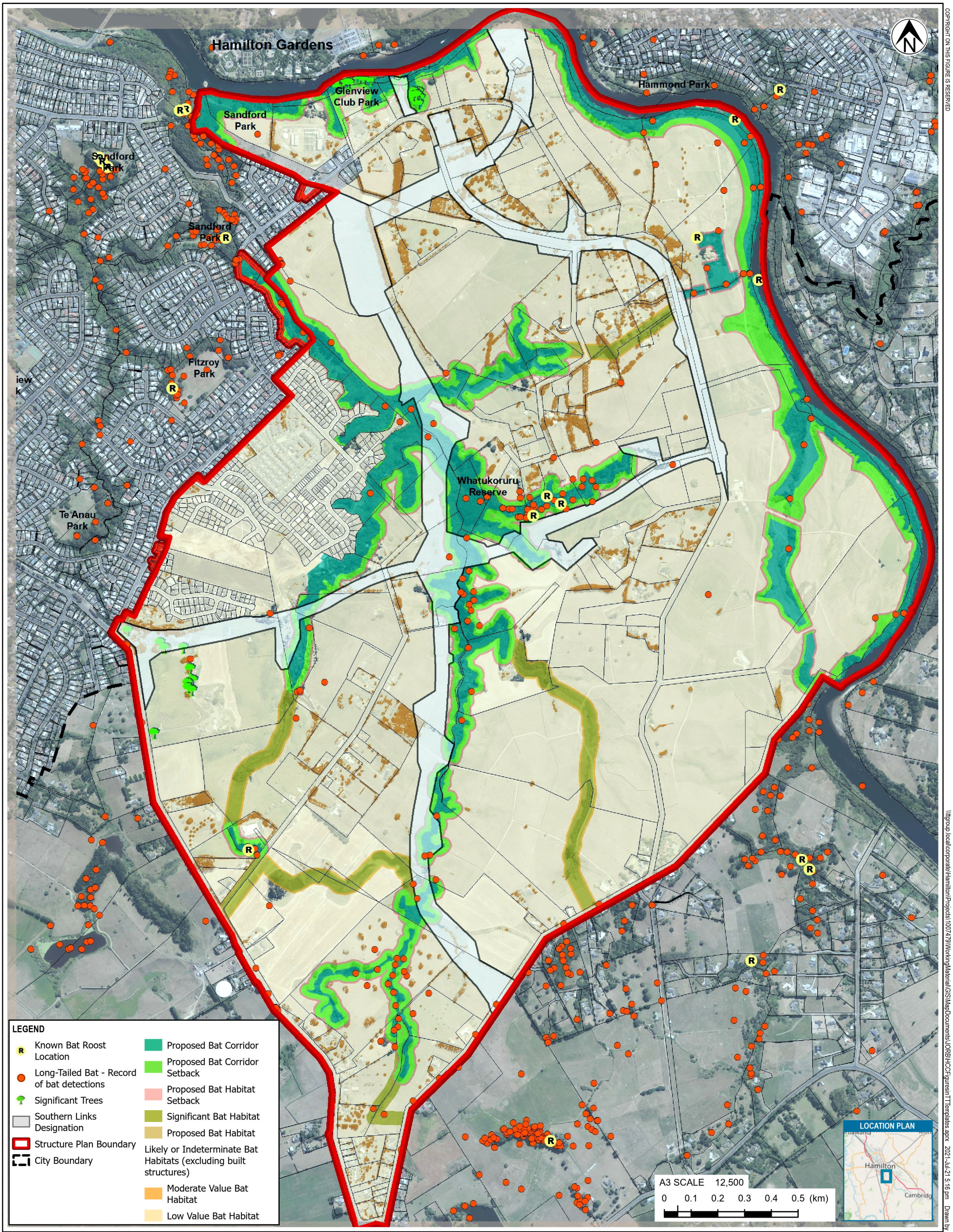
Appendix B Table 1: Principles of biodiversity not explicitly captured in the RMA

Principle	Explanation (paraphrased from Maseyk et al. 2018)
Limits to offsetting	Many biodiversity values are not able to be offset, and if they are impacted then they will be permanently lost. This principle reflects a standard of acceptability for offsetting, and offsetting should not be seen as a pathway to allow uncompensated losses.
No net loss	The goal of a biodiversity offset is a measurable outcome that can reasonably be expected to result in no net loss, and preferably a net gain of biodiversity. A no-net-loss outcome requires that at a specified point in time biodiversity values will be returned to the point they would have been if the impact and offset had not occurred.
Landscape context	The design of a biodiversity offset should consider the landscape context of both the impact site and the offset site, taking into account interactions between species, habitats, and ecosystems, spatial connections, and system functionality.
Ecological equivalence	Ecological equivalence describes the degree to which the biodiversity gain attributable to an offset is balanced with the biodiversity losses due to development across type, space, and time; and therefore, whether the exchange achieves no net loss. Typically, achieving ecological equivalence will require a ”like-for-like” exchange (same type of biodiversity). Demonstrating ecological equivalence differentiates biodiversity offsetting from environmental compensation.
Additionality	A biodiversity offset must achieve gains in biodiversity above and beyond gains that would have occurred anyway in the absence of the offset.
Permanence	The biodiversity benefits at an offset site should be managed to secure outcomes that last at least as long as the impacts and preferably in perpetuity.

The principle of following the mitigation (effects management) hierarchy before applying biodiversity offsets or environmental compensation is fundamental to biodiversity outcomes when it is lost to subdivision and other development. The RMA does not explicitly require the application of the ‘mitigation hierarchy’ and provides no preference between avoid, remedy, mitigate. However, the principle is advocated by BBOP, internationally accepted as good practice and is increasingly being incorporated into statutory planning instruments across New Zealand, including within Policy 11.2.2 of the operative Waikato Regional Policy Statement (WRPS). The Hamilton District Plan requires offsets to be used as a tool through Rule 24.3.3(d); “The amount of money and/or land needed to offset any adverse environmental effects including river and gully restoration that cannot otherwise be avoided, remedied or mitigated.”

Thus biodiversity offsetting or compensation should be applied only *after* measures have been undertaken to avoid, remedy and mitigate adverse effects (Figure 1, Appendix C). This ensures that offsets or compensation are not inappropriately used to address adverse effects that could otherwise be managed earlier in the hierarchy. It also reduces the level of risk, scale of ongoing management and uncertainty of achieving no net loss, especially associated with compensation measures.

Appendix C: Figure



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NOTES: Map sourced from PSPA Ecological Significance Assessment Preliminary Report (Tonkin & Taylor 2021).
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REV	DESCRIPTION	GIS	CHK	DATE	APPROVED	DATE
0	First version	JORB	JJXC	21/07/21		JUL.21

PROJECT No.	1007479	
DESIGNED	GECU	JUL.21
DRAWN	JORB	JUL.21
CHECKED	PRC	JUL.21

CLIENT **HAMILTON CITY COUNCIL**
PROJECT **PEACOCKE STRUCTURE PLAN AREA SNA**
TITLE SIGNIFICANT BAT HABITAT AND OTHER PROTECTION AREAS FOR LONG-TAILED BATS
SCALE (A3) 1:12,500 FIG No. FIGURE 1. REV 0

Appendix D: Ecological Impact Assessment Guidelines Tables

Appendix D Table 1: Biodiversity values assigned to species (adapted from EIANZ, 2018)

Value	Species values
Very high	Nationally Threatened - Endangered, Critical or Vulnerable.
High	Nationally At Risk – Declining.
Moderate-high	Nationally At Risk - Recovering, Relict or Naturally Uncommon.
Moderate	Not Nationally Threatened or At Risk, but locally uncommon or rare.
Low	Not Threatened Nationally, common locally.

Appendix D Table 2: Biodiversity values assigned to habitats (adapted from EIANZ, 2018)

Attributes to be considered when assigning biodiversity value or importance to a site or area of vegetation/habitat/community.	
Matters	**Attributes to be considered**
Representativeness	Attributes for representative vegetation and aquatic habitats: • Typical structure and composition • Indigenous species dominate • Expected species and tiers are present Attributes for representative species and species assemblages: • Species assemblages that are typical of the habitat • Indigenous species that occur in most of the guilds expected for the habitat type.
Rarity/ distinctiveness	Attributes for rare/distinctive vegetation and habitats: • Naturally uncommon, or induced scarcity • Amount of habitat or vegetation remaining • Distinctive ecological features • National priority for protection Attributes for rare/distinctive species or species assemblages: • Habitat supporting nationally Threatened or At Risk species, or locally uncommon species • Regional or national distribution limits of species or community • 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 environmental conditions which have influenced the development of habitats and communities • The essential characteristics that determine an ecosystem's integrity, form, functioning, and resilience (from "intrinsic value" as defined in RMA) • Size, shape and buffering • Condition and sensitivity to change • Contribution of the site to ecological networks, linkages, pathways and the protection and exchange of genetic material • Species role in ecosystem functioning – high level, key species identification, habitat as proxy.

Appendix D Table 3: Scoring for sites or areas combining values for four matters in (Appendix D Table 2)

Value	Description
Very High	Area rates High for 3 or all of the four assessment matters listed in Appendix D Table 4. 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 Low or Very Low for remainder.

Appendix D Table 4: Criteria for describing magnitude of effect (EIANZ, 2018)

Magnitude	Description
Very high	Total loss of, or very major alteration to, key elements/features/ of the existing baseline[1] conditions, such that the post-development character, composition and/or 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 the post-development character, composition and/or attributes will be partially changed; AND/OR Loss of a moderate proportion of the known population or range of the element/feature.
Low	Minor shift away from existing baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances or patterns; AND/OR Having a minor effect on the known population or range of the element/feature.
Negligible	Very slight change from the existing baseline condition. Change barely distinguishable, approximating the 'no change' situation; AND/OR Having negligible effect on the known population or range of the element/feature.

[1]Baseline conditions are defined as 'the conditions that would pertain in the absence of a proposed action' (EIANZ, 2018).

Appendix D Table 5: Timescale for duration of effects (EIANZ, 2018)

Timescale	Description
Permanent	Effects continuing for an undefined time beyond the span of one human generation (taken as approximately 25 years).
Long-term	Where there is likely to be substantial improvement after a 25 year period (e.g. the replacement of mature trees by young trees that need > 25 years to reach maturity, or restoration of ground after removal of a development) the effect can be termed 'long term'.
Temporary[1]	Long term (15-25 years or longer – see above) Medium term (5-15 years) Short term (up to 5 years) Construction phase (days or months).

[1]Note that in the context of some planning documents, 'temporary' can have a defined timeframe.

Appendix D Table 6: Criteria for describing overall levels of effects on biodiversity values (EIANZ, 2018)

Biodiversity value (Appendix D Table 2) / Magnitude (Appendix D Table 4)	**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

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