Assessment of Ecological Effects for Private Plan Change Ongaroto Road, Whakamaru

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Project number	Author	Review	Version	Date
PB0058	Brenda Bartels	Gerry Kessels	Draft 1	23/09/2022
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Executive Summary

Precision Built Limited has engaged 2 Awa Ecology to prepare an assessment of ecological effects report to accompany the application for a private plan change in Whakamaru. The land subject to this plan change encompasses an area of 31 ha at 1861 Ongaroto Road, which is located adjacent to the Lake Whakamaru Reserve. The recommendations in this report are for a future subdivision stage should the plan change be approved.

Nine broad vegetation types were identified within the site based on vegetation structure and composition. The site itself was planted in forestry until 2018 and forestry harvest and disturbance is evident with stumps, slash and wood chips throughout the site. Much of the site has recently been replanted in pine trees which are generally <1 m tall and are spaced approximately 2-3 m apart. Very little established vegetation remains onsite which is limited to a single row of mature cypress and pine trees with some regenerating indigenous vegetation in the understorey. Vegetation on site had low ecological value except for the regenerating indigenous understory which has low to moderate value.

Fauna surveys onsite detected both indigenous and exotic bird species that are common to open country, waterbodies and forests. Birds with a threat status have been recorded utilising adjacent lake/riverine habitats and they may visit the site from time to time.

Long-tailed bats (Threatened – Nationally Critical) use trees and shrubs, open water, waterways and open areas as foraging and commuting habitat. Bat surveys indicate a relatively low to medium detection of bats, indicating that bats were periodically utilising and occasionally feeding at the site during the survey period. Due to crepuscular activity, it is also possible that bats were roosting in close proximity to the detectors at the time of the survey.

Opportunistic searches did not result in the detection of lizards. Given the high level of disturbance at the site, lizards specifically copper skinks, are unlikely to be present or may be present in low abundance.

No freshwater streams were present onsite and the sedge grassland in vegetation type 9 has been conservatively assessed as a wetland until further assessment is undertaken at subdivision stage.

Assessment of effects

A change of zoning and land use from rural to residential poses a range of potential adverse effects to the ecological values that have been identified onsite. The potential and actual effects of the proposed plan change relate to:

- Effects on terrestrial fauna habitats;
- Effects on fauna due to disturbance and the ongoing land use change; and
- Effects from earthworks, sediment and stormwater.

Following the effects management hierarchy, the overall level of effect on the proposed development without mitigation is likely to be moderate and any effect moderate or greater requires mitigation. Therefore, the following measures will need to be implemented to mitigate effects:

- Mitigating the effects of the vegetation removal of linear tree features which provide commuting and foraging habitat for bats through the establishment of a buffer zone using indigenous vegetation to separate the public reserve from private lots (with an average width of c.27 m and 5.58 ha).
- Any vegetation removal of mature trees should ideally take place outside of the peak bird breeding season (October to February inclusive). Tree feeling should not occur during the

period when bats are in torpor (1 May to 1 October). If tree removal cannot be achieved outside of the bird breeding season, then those areas should be assessed by an appropriately qualified ecologist for nesting birds immediately prior to vegetation removal (this can be undertaken at the same time as the pre-felling bat checks).

- The effects of artificial lights will be minimised through low light design with a 0.3 lux limit (at the site boundary) and a planted buffer zone which will prevent light spill over effects from the development.
- The sedge grassland in vegetation type 9 has been conservatively assessed as a wetland until further assessment is undertaken at subdivision stage. Any earthworks or discharges in proximity to this vegetation type will need to ensure compliance with the National Environmental Standards for Freshwater (NES-F).
- It is anticipated that any potential adverse effects associated with contaminant discharge to the Waikato River at Lake Whakamaru will be able to be controlled and mitigated as long as they are fit for purpose and designed and incorporated and following best practice guidelines and regulations. This will need to be assessed at the detailed design stage.
- Areas of bare earth are immediately vegetated or covered to reduce the risk of erosion and sedimentation and weed colonisation on bare ground.
- A detailed Management Plan for the site, which will include the following:
    - Pest animal control measures, including but not limited to recommended methods, spacings of traps and frequency. Pest animal control is required in perpetuity.
    - Given the presence of threatened indigenous fauna onsite and in the wider environment (reserve area) and the close proximity existing SNA's including Lake Whakamaru, the control on domestic cats is recommended by way of a covenant. Cats are known predators of indigenous wildlife in New Zealand.
    - Fauna management plans if required. For example, any requirements required for bats to avoid, minimise and /or mitigate potential impacts on bats and will include avoidance timing and pre-felling bat protocols if potential bat roost trees are to be felled.
    - A detailed restoration planting plan including but not limited to the number and size of plants, control of weeds and ongoing maintenance and monitoring other specific considerations include:
        - Early planting of the mitigation/enhancement and reserve areas, ahead of development to provide habitat benefits as soon as possible is recommended.
        - Retention and enhancement of the indigenous understorey in vegetation type 6 and vegetation type 9.
        - Indigenous species planted should be from the Central Volcanic Plateau Ecological Region[1].
    - Monitoring of the near shore Waikato River (Lake Whakamaru) water quality pre, during and post construction to ensure that there is no adverse effect on the water quality. This will include samples for sediment, nutrients and *E.coli*.

In the long-term the proposed ecological planting area totalling 6.3 ha will likely have a net positive effect on the ecological values of the flora and fauna at 1861 Ongaroto Road.

[1] What to plant in the central volcanic plateau ecological region | Waikato Regional Council

1 INTRODUCTION

1.1 Scope

Precision Built Limited has engaged 2 Awa Ecology to prepare an assessment of ecological effects report to accompany the application for a private plan change at 1861 Ongaroto Road, in Whakamaru. The site is located on the shores of Lake Whakamaru on a parcel of land which is sloped in a south-westerly direction from Ongaroto Road toward Lake Whakamaru Reserve. The site has recently been cleared of forestry and has a high level of modification and disturbance.

The purpose of this AEcE is to:

- Describe the vegetation, habitats and fauna present at the site.
- Determine the ecological values of the site.
- Assess the potential and actual effects of the proposed plan change.

1.2 Site location and characteristics

1.2.1 Ecological context

The property at 1861 Ongaroto Road on the banks of Lake Whakamaru is located in the Atiamuri Ecological District (ED). The Atiamuri ED covers c.222,240 ha within the bio-climatic lowland zone in the Central Volcanic Plateau Ecological Region, on Immature Orthic Pumice soils (Fundamental Soil Layer - New Zealand Soil Classification)[2]. The pumice soils in this area are well drained, with excess water rapid drained and topsoil's typically have sand texture and are moderately stony.

Prior to human settlement the vegetation was mostly mixed podocarp forest with submontane podocarp-broadleaved forest at higher altitudes (Beadle et al., 2004; Bycroft and Shaw 2008).). Most of the ED is now in exotic plantation forests and pasture, with established adventive species throughout. Remaining indigenous vegetation comprises small, logged podocarp broadleaved forest and fragmented areas of secondary forest often adjacent to plantation forest (Beadle et al., 2004). The Threatened Environment Classification is a classification system that is based on how much native vegetation remains, past habitat loss and current levels of legal protection (Walker et al. (2005) and Walker et al. (2007)). The Classification combines this information into six categories, with the entire project area located within the 'Chronically Threatened' category, the second highest threat category indicating that 10-20% indigenous cover remains.

The Waikato River is identified as a Significant Natural Area (SNA)and Outstanding Natural Landscape (ONL) 5- Lake Whakamaru and Whakamaru Gorge section of Waikato River.

[2] S-Map Online | Manaaki Whenua - Landcare Research

1.2.2 Site description

The site is bordered to the northwest by Ongaroto Road and the southwest by Lake Whakamaru Reserve on the Waikato River. The land use in the immediate area is predominantly forestry in the steeper hill county and pasture on the gentler slopes closer to the edge of Lake Whakamaru/Waikato River.

The site itself has been planted in forestry until 2018 when the pine trees onsite were felled. The site has recently been replanted in pine trees which are generally <1 tall and are spaced approximately 2-3 m throughout the site. Evidence of forestry harvest is present at the site with stumps, slash and wood chips present. Very little established vegetation remains onsite which is limited to a single row of mature cypress and pine trees with some regenerating indigenous vegetation in the understorey.

The Waikato River at Lake Whakamaru is on the boundary of two districts with Taupo District Council to the south of the river and South Waikato District Council to the north. The proposed development site is within the South Waikato District. Lake Whakamaru is listed as an Outstanding Natural Feature and is surrounded by Significant Natural Areas (SNAs - areas that meet at least of the significance criteria in the Waikato Regional Plan). The Ongaroto scrub (FID:112) covers 42.32 ha and borders the Waikato River at Lake Whakamaru, upriver of the site.

On the opposite side of the river SNAs border the river edge including an unprotected margin strip along the river edge (SNA ID: 077), as well the Whakamaru Conservancy area (SNA ID: 237) which is Department of Conservation protected land. Other SNAs located nearby on the southern side of the lake include the Kaahu Scenic Reserve (SNA ID: 205) and Maraemanuka Stream (SNA ID: 068) (Figure 1).

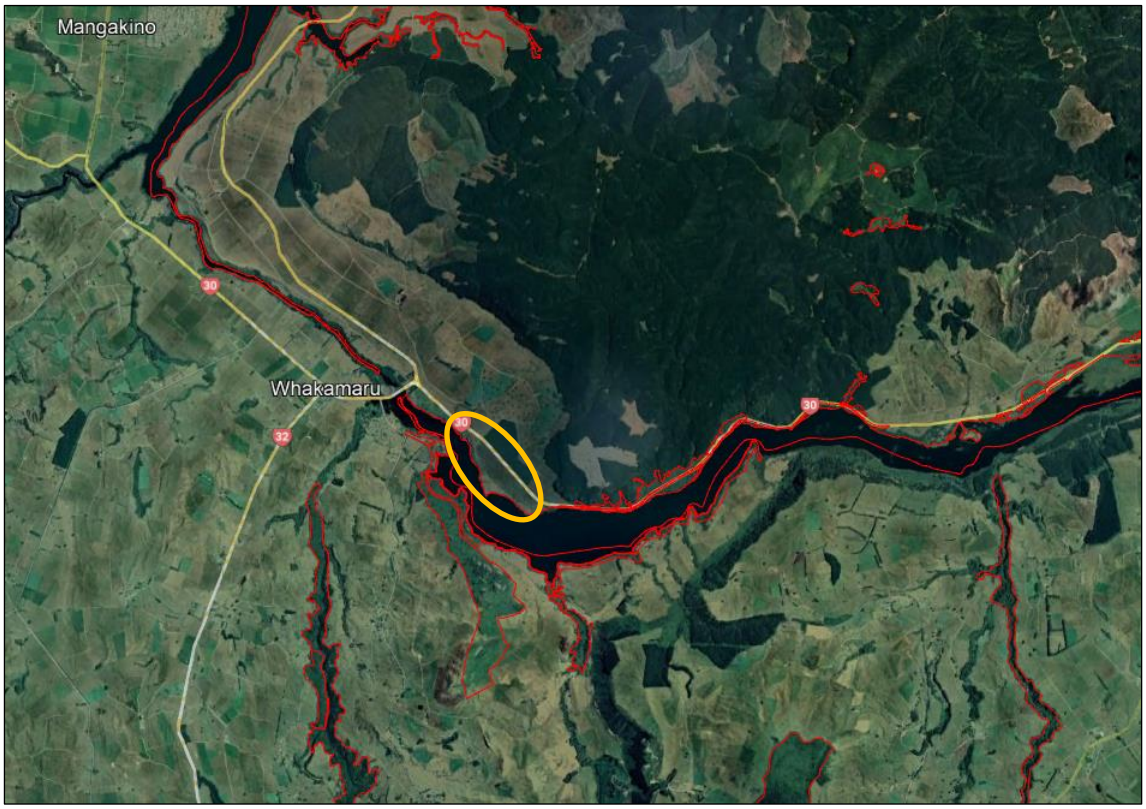

Figure 1: Location of 1861 Ongaroto Road, Lake Whakamaru within the yellow circle. SNA areas are located within the red lines.

2 METHODOLOGY

2.1 Desktop review

A desktop literature review was undertaken to determine the ecological context of the site. Resources reviewed included:

- Soil layer in S-Maps[3];
- Significant Natural Areas[4]
- Threatened Environments Classification.
- The New Zealand Freshwater Fish Database (NZFFD)[5];
- The BioWeb Database[6], and the National Bat database[7]; and,
- iNaturalist[8] and New Zealand Birds online[9] and NZ Bird Atlas[10].

2.2 Field survey

The ecological assessment of this site was undertaken on the 3 September 2022. The general nature of the site was described, and assessments were undertaken of the vegetation and biota.

2.2.1 Terrestrial vegetation survey

The vegetation was assessed, classified, and mapped, during the site visit. All vascular plants encountered during the site visit were recorded and vegetation composition and plant communities described. Common plant names are used in the site descriptions below, where available. For botanical names refer to the plant list in Appendix I.

2.2.2 Birds

All birds heard or observed during the site assessment were recorded. These were supplemented by a desktop survey of existing database and literature sources.

2.2.3 Bats

Three acoustic Automated Bat Monitors (ABMs – DOC model 'AR4') were deployed for 15 nights from 27 October until 11 November 2022. All detectors were calibrated to have the same time and date settings (NZST) and were pre-set to start monitoring one hour before sunset until one hour after sunrise. The distance between detectors of distinct monitoring locations was at least 50 m apart to increase the chance of independent bat monitoring. The recorders were suspended at least 2 m above the ground to reduce superfluous detections caused by terrestrial insects (usually cicada species). The locations of the ABMs are shown in Figure 2. ABMs record any sound that may be a bat call or echolocation. When a potential bat pass triggers the ABM, it records one file for each pass. The recordings are prepared in the form of a compressed image of a spectrogram, and are saved onto an SD card in the form of bitmap format images. The images were viewed using DOC-developed

[3] https://smap.landcareresearch.co.nz/maps-and-tools
[4] https://hcc.maps.arcgis.com/
[5] The New Zealand Freshwater Fish Database (NZFFD) administered by the National Institute of Water and Atmospheric Research (NIWA).
[6] BioWeb Database. Administered by the Department of Conservation (DOC).
[7] National Bat Database. Administered by DOC.
[8] https://www.inaturalist.org/observations
[9] http://nzbirdsonline.org.nz/
[10] http://ebird.org

"BatSearch 3.2" software. The frequency spectrum assessed ranges from 0 Hz to 88 kHz and images represent 1-6 seconds of recording.

Weather conditions during the monitoring period were considered suitable for the majority of the survey period (Appendix II).

2.2.4 Herpetofauna

A survey for lizards was carried out in conjunction with vegetation surveying using daytime habitat searches. This method involves visual searches of habitat (using the naked eye and binoculars) for basking and/or feeding skinks and geckos, and physical search of day time lizard retreats, e.g. tree bark, rocks, logs, standing dead trees, vegetation, leaf litter, for inactive lizards.

2.2.5 Freshwater and wetland habitats

Any areas that appeared to be potential natural wetlands were assessed as per the wetland delineation assessment was carried out to determine the position of any wetlands on the property following the methodology of Clarkson (2013) and Fraser *et al.* (2018) and using the 2021 wetland plant list (Clarkson *et al.* 2021).

2.3 Ecological impact assessment (EIANZ)

The ecological effects assessment was undertaken in accordance with the Ecological Impact Assessment Guidelines developed by the Ecological Institute of Australia and New Zealand (EIANZ)(Roper-Lindsay et al., 2018). The use of the standard framework and matrix approach within these guidelines and well as professional ecological judgement provides a robust, consistent and transparent ecological effects assessment which is considered best practice.

A EIANZ guidelines uses a standard framework to determine the following:

- Step one - Assessing the ecological value of the environment (Appendix II Table 1Appendix II Table 2)
- Step two - Assessment of the magnitude of ecological effect from the proposed activity (Appendix II Table 3).
- Step three - Determining the overall level of effect to determine if further mitigation, offset or environmental compensation is required (Appendix III Table 4).

3 ECOLOGICAL FEATURES

3.1 Terrestrial vegetation at the site

Nine broad vegetation types were identified within the 31 ha site based on vegetation structure and composition. Vegetation types are mapped in Figure 2, brief descriptions of each type are provided below, and species are listed in Appendix I.

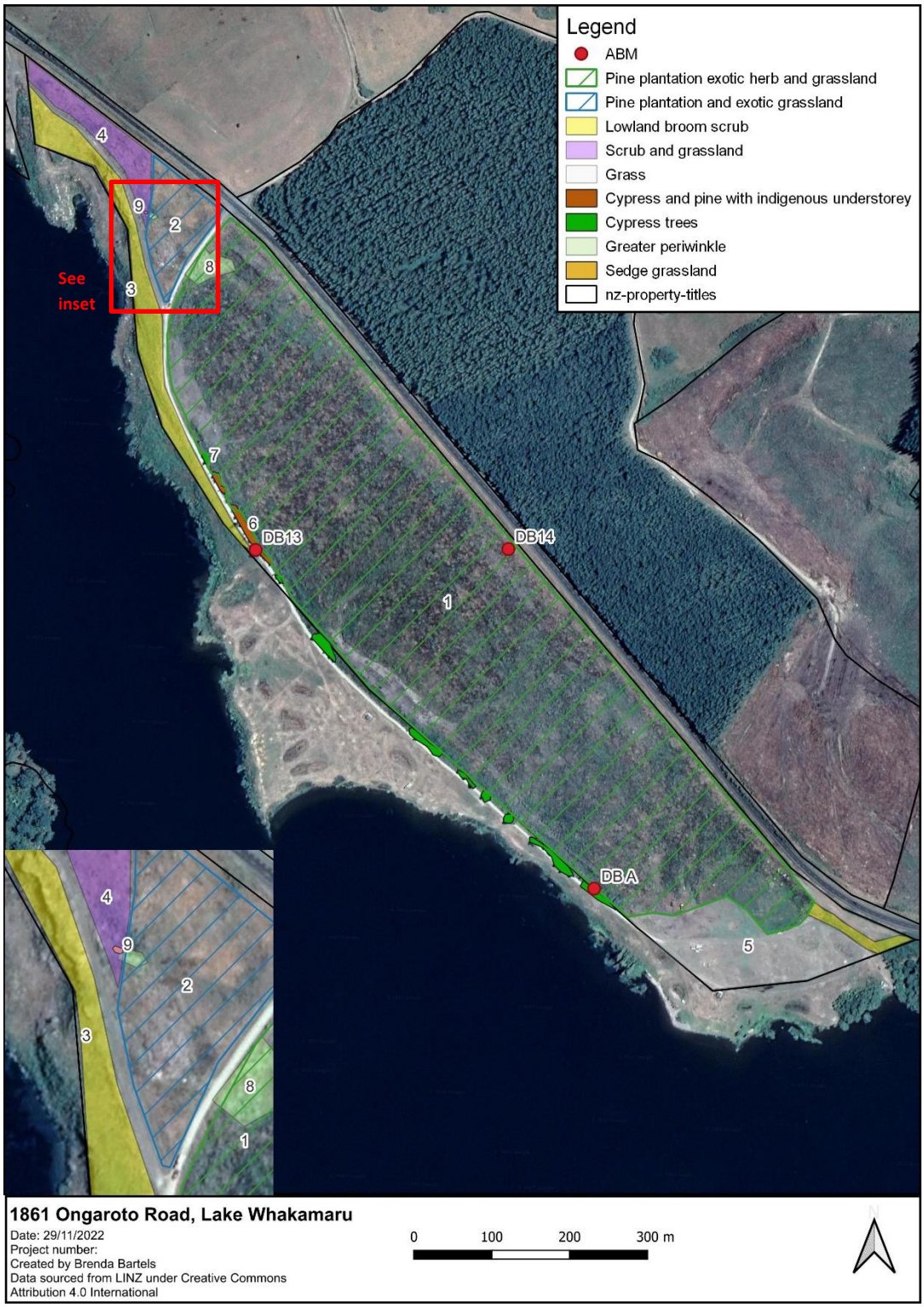

Figure 2: Site location map with vegetation types. Existing track onsite have not been classified. ABM = Automated Bat Monitors.

3.1.1 1.Pine plantation and exotic herb and grassland (24.7 ha)

Vegetation type 1 has recently been planted back into pine trees. Trees are spaced approximately 2-3 m apart and are c. 1 m tall (Photo 1). The surrounding area is covered in pine slash and grasses and herbs which are common in disturbed areas have established including fleabane (*Conyza albida),* Yorkshire fog *(Holcus lanatus),* Hawkbit (*Leontodon taraxacoides*), Catsear (*Hypochaeris radicata*), Browntop (*Agrostis capillaris*), Broom *(Cytisus scoparius),* Foxglove *(Digitalis purpurea),* Australian fireweed *(Senecio bipinnatisectus),* and dead Buddleia *(Buddleja davidii)* to name a few. Occasional small indigenous karamu (*Coprosma robusta*) and mahoe (*Melicytus ramiflorus*) were observed.

Large areas of mulch bark are present (Photo 2), which appear to be where forestry machinery was used (Photo 3). Mulch is supressing weed growth here.

Photo 1: Pine plantation block with predominantly grasses and herbs as the groundcover.

Photo 2: Are of pines with bark mulch in the background

Photo 3: Evidence of machinery use.

3.1.2 2.Pine plantation with exotic grassland (c.0.92 ha)

On the opposite side of the main entrance to the site is another area of pine plantation. This area was not part of the historic pine plantation and as such the ground is less disturbed with no noticeable slash present. The groundcover here is predominantly rank grass and blackberry (*Rubus fruticosus*).

Photo 4: Pine plantation with a groundcover of long rank grass and blackberry.

3.1.3 3.Lowland broom scrub (c.1.49 ha)

The lowland broom scrub is dominated by broom with buddleia, bracken, lupin, fleabane and wilding pines. Self-seeded pines are quite common in places (Photo 5). Buddleia is more common in the southern patch of this vegetation type (Figure 2), adjacent to the area of grass (Photo 6). Low growing vegetation is also common including exotic grasses and herbs. The vegetation here is all less than 2 m tall.

Photo 5: Low land scrub dominated by broom with wilding pines.

Photo 6:Scrub vegetation dominated by broom and buddleia.

3.1.4 4.Scrub and grassland (c.0.63 ha)

The scrub and grassland area has not been planted with pines and is dominated by rank grasses. Other common species here include wilding pine, blackberry, bracken and buddleia. A few pampas (*Cortaderia selloana*) specimens were observed as well as Himalayan honeysuckle (*Leycesteria formosa*).

Photo 7: Scrub and grassland vegetation type, with bracken and pampas to the right of the photo.

3.1.5 5.Grass (c.2.18 ha)

The southern edge of the property bordering the Lake Whakamaru Reserve has been cleared of pine stumps and slash and contoured to allow the establishment of grass and a temporary dwelling. The grass has recently been sown and borders a larger area of grass within Lake Whakamaru Reserve (Photo 8).

Photo 8: Grass area bordering Lake Whakamaru Reserve.

3.1.6 6. Cypress and pine with indigenous and exotic understory (c.770 m^2)

This vegetation type is on a relatively steep escarpment on the property boundary. The canopy is a single row of trees, comprising both pines and cypress (c.8m tall). The understorey has both indigenous and exotic trees and shrubs. Exotic species were dominated by broom with some blackberry, buddleia and barberry (*Berberis glaucocarpa*). Indigenous species were more common than exotics here and included karamu, bracken, mahoe, five finger (*Pseudopanax arboreus*), hangehange (*Geniostoma ligustrifolium*) and tutu (*Coriaria arborea*). Ferns were also common

including kiokio (*Blechnum novae-zelandiae*), silver fern (*Cyathea dealbata*), wheki (*Dicksonia squarrosa*) and mamaku (*Cyathea medullaris*) (Photo 9). A single kotukutuku or native tree fuchsia (*Fuchsia excorticata*) was observed, this specimen was c.5 m tall and in flower (Photo 10).

Photo 9: Indigenous understorey of ferns and shrubs, beneath pine trees.

Photo 10: Kotukutuku (c.5m tall) with flower inset.

3.1.7 7. Cypress trees (c.100 m^2)

A single row of Cypress trees borders the property and Lake Whakamaru Reserve (Photo 11), the majority of this vegetation type is located just outside of the property boundary, however there are a few of these trees onsite.

Photo 11: Single row of Cypress trees on property boundary with Lake Whakamaru Reserve.

3.1.8 8. Greater periwinkle (c.0.18 ha)

There are two areas where greater periwinkle (*Vinca major*) dominates, one within the main pine plantation area (Photo 12) and another just outside of the planted area in a depression (Photo 13). This climbing species forms a thick carpet amongst other vegetation including grasses and herbs.

Photo 12: Pine trees amongst a dense growth of greater periwinkle.

Photo 13: Dense growth of greater periwinkle.

3.1.9 9.Sedge grassland (c.8 m^2)

A small patch of umbrella sedge (*Cyperus sp)* was observed adjacent to the greater periwinkle, in a depression. This sedge had no seed heads at the time of the site visit so the species could not be identified, but it is likely to be *Cyperus eragrostis*, which was identified by its seeds within the Lake Whakamaru Reserve. The sedge was growing amongst a range of grass and weed species including Yorkshire fog, greater periwinkle, blackberry, cocksfoot (*Dactylis glomerata*), fleabane, Australian fireweed and beggards tick (*Bidens frondosa*).

The wetland delineation protocols were assessed here, and this site was indeterminate as it failed the dominance test and passed the prevalence test (see Section 3.3.1). One of the main species (Greater periwinkle) did not have a plant status rating. At this stage this area has been conservatively assessed as a wetland until further assessment is undertaken at subdivision stage.

Photo 14: Umbrella sedge grassland.

3.2 Terrestrial fauna

3.2.1 Birds

Birds' common to open country, vegetated areas and waterbodies were recorded during the site visit (Table 1). Indigenous species including tui was heard while onsite and fantail, silvereye, sacred kingfisher and black cormorant (*Phalacrocorax carbo*: At Risk - Relict) were observed. It should be noted that the black cormorant was observed flying along the lake edge and not on the property, however, they may fly over the property from time to time.

The desktop review indicated that a total of 43 species of bird have been recorded at the nearby Dunham's Point Reserve[11] and Mi Camp (< 6 km from the site). Fifty-nine species have been observed at the Whakamaru Dam[12] and 33 at Sandy Bay point[13] which is located < 1 km away on the opposite bank of the riverine lake to the proposed plan change development (species list in Appendix IV). Many of the species recorded are those associated with large open bodies of water and are unlikely to be present at or use the site.

A total of fourteen of the species recorded have a threat status the majority of these birds are those associated with water including several species of cormorant as well as gulls and terns. White heron (*Ardea alba*: Threatened – Nationally critical) has been recorded at Whakamaru Dam, however, this is likely to be a rare sighting and it is considered unlikely to be present at or visit the site. Threatened species that may use the site as a fly way (but are unlikely to visit the site due to a lack of habitat or food sources) are New Zealand kaka (*Nestor meridionalis*: Recovering), and cormorant species. One species of note that was not recorded at the site, but has been recorded at Whakamaru Dam, is the New Zealand Pipit (*Anthus novaeseelandiae*: At Risk – Naturally uncommon).

Table 1: Birds recorded during the site visit by casual observation.

Common name	Scientific name	Conservation threat status (Robertson et al 2021)
Ring-necked Pheasant	*Phasianus colchicus*	Introduced and Naturalised
New Zealand Kingfisher	*Todiramphus sanctus vagans*	Not threatened
Silvereye	*Zosterops lateralis*	Not threatened
Tui	*Prosthemadera novaeseelandiae novaeseelandiae*	Not threatened
Song Thrush	*Turdus philomelos*	Introduced and Naturalised
Blackbird	*Turdus merula*	Introduced and Naturalised
North Island Fantail	*Rhipidura fuliginosa placabilis*	Not threatened
Chaffinch	*Fringilla coelebs*	Introduced and Naturalised
House Sparrow	*Passer domesticus*	Introduced and Naturalised
Australian Magpie	*Gymnorhina tibicen*	Introduced and Naturalised
Welcome swallow	*Hirundo neoxena*	Introduced and Naturalised
Black cormorant	*Phalacrocorax carbo*	Relict

11 Dunham's Pt Reserve & MiCamp Whakamaru, South Waikato District County, WKO, NZ - eBird Hotspot – accessed 21/02/23
12 Whakamaru Dam area, Taupo District County, WKO, NZ - eBird Hotspot – accessed 21/02/23
13 Whakamaru--Sandy Bay Reserve, Taupo District County, WKO, NZ - eBird Hotspot – accessed 21/02/23

3.2.2 Bats

Long-tailed bats (*Chalinolobus tuberculatus*, Threatened – Nationally Critical) have relatively large home ranges with an average individual home range of 700-1600 ha (O'Donnell 2001), with a larger range for breeding females. In terms of habitat use, bats are known the use linear habitat features such as rows of trees or shelterbelts and waterways. As an edge-adapted species, it is likely that long-tailed bats use open pasture spaces predominantly for commuting next to trees, while foraging mostly occurs in pasture adjacent to shrubland, trees and open water adjacent to linear features, edges and gaps (O'Donnell 2001). In other areas along the Waikato River (for example Hamilton City) the river itself provides an important commuting and foraging corridor for bats. Bats may utilise these features onsite and in the wider environment.

Bats are also known to utilise mature exotic and indigenous trees with suitable structural features as potential roost trees. Potential bat roost trees are those that are >15 cm diameter at breast height (DBH) and have one or more of the following attributes:

- Cracks, crevices, cavities, fractured limbs, or other deformities, large enough to support roosting bat(s);
- Sections of loose flaking bark large enough to support roosting bat(s);
- A hollow trunk, stem or branches; and/or
- Deadwood in canopy or stem of sufficient size to support roost cavities or hollows.

The national bat database shows that long tailed bats have been recorded in the past (c.20 years ago) in an area of forestry c. 12 km away. Bats have been recorded more recently approximately 6 km away (G Kessels *pers obs*).

3.2.2.1 Bat survey results

Three ABMs were deployed for 15 nights between 17 October and 11 November 2022. DB13 was functional for 11 nights of the survey; DB14 and DB-A were functional for the entire survey period. This resulted in the detection of bat activity at all three locations (Figure 2; Table 2). A low to moderate level of bat activity was detected within the landscape during the survey. A total of 180 bat passes were recorded, averaging 4.2. bat passes per ABM per functioning night. An overview of the bat activity results is shown in Figure 3, Figure 4 and Figure 5. The highest level of bat activity was recorded on DB-A, with 94 passes recorded, averaging 6.3 passes per survey night.

Crepuscular activity was low to medium across the site (Figure 4). A total of 19 bat passes were detected in the first hour after sunset (19:30 - 20:30) across the whole survey span and site. Of these, 4 passes were detected at DB13, 9 passes were detected at DB14, and 6 were detected at DB-A. A total of 6 passes were detected in the first hour before sunrise (5:00 - 6:00) across the entire survey span and site, with 3 passes at DB13 and 3 passes at DB14. There were also 3 feeding buzzes recorded by DB-A, indicating foraging.

The relatively low to medium detection of bats indicates that bats were periodically utilising and occasionally feeding at the Whakamaru site during the survey period, which is confirmed by feeding buzzes. Due to crepuscular activity, it is possible that bats were roosting in close proximity to the detectors at the time of the survey. The data has a bimodal shape, indicating that the bat passes at dawn could be bats commuting back to their roosts nearby.

Table 2: Distribution of total bat activity levels recorded at all ABM detectors.

Site	Total passes	Number of nights detector was functional	Bat passes per night	Bat passes per night within 1-hour after sunset (20:00 – 21:00)	Bat passes per night within 1 hour before sunrise (05:00 – 06:00)
DB13	26	11	2.4	4	3
DB14	60	15	4.0	9	3
DB-A	94	15	6.3	6	0

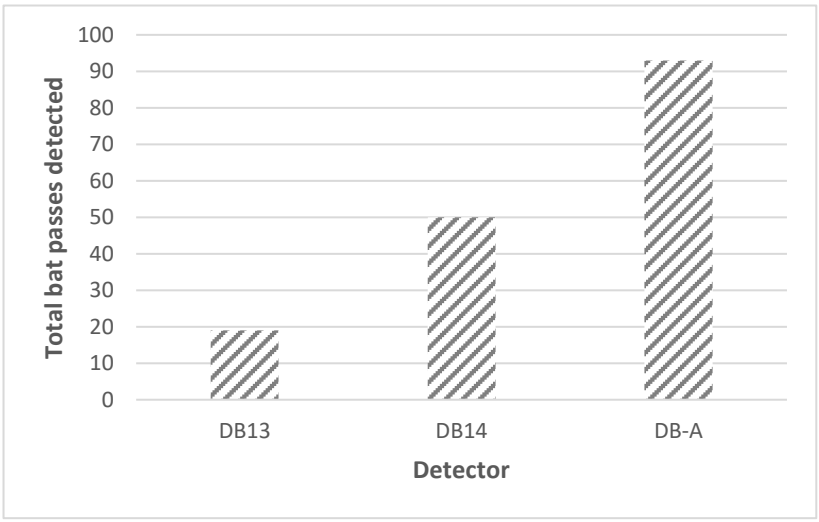

Figure 3: Total bat passes for each ABM (Total number of bat-positive detections between 27/10/22 – 11/11/22).

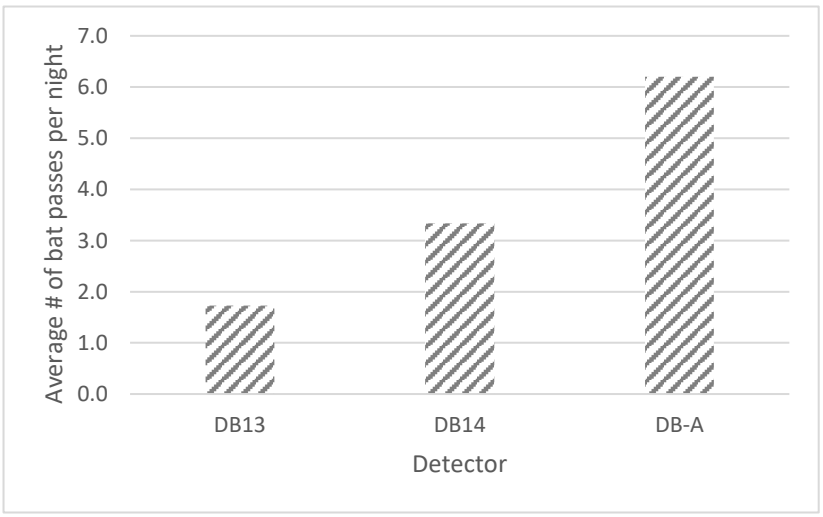

Figure 4: Average number of bat passes per recorded night for each ABM.

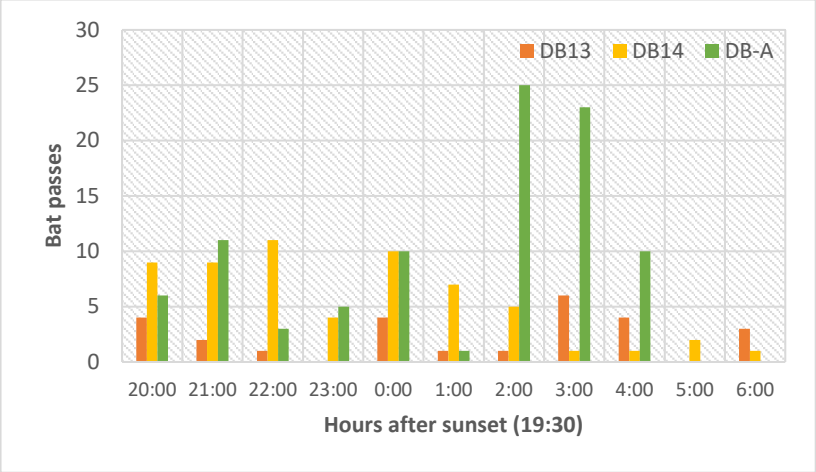

Figure 5: Total bat passes per hour after sunset, per detector. Data collated across the entire survey period.

3.2.3 Herpetofauna

The vegetation onsite has the potential to support native skinks, particularly copper skink. Lizards were searched for briefly by rolling logs and other cover that appeared potentially suitable; however, none were found. Copper skinks (*Oligosoma aeneum*, At Risk – Declining) (Hitchmough *et al*., 2021)., may occur within the plan change area. However, given the high level of disturbance at the site, including the clear felling of the site in 2018. Lizard populations are often in low densities in mainland New Zealand due to habitat modifications and predation from introduced pest animals. If present this species is likely to be in low abundance and given their cryptic behaviour and difficultly to find further surveys may not result in detection.

Other indigenous lizard species known from the central Waikato, such as forest gecko (*Mokopirirakau granulatus*, – Declining), Pacific gecko (*Dactylocnemis pacificus*, – Not threatened) and Auckland green gecko (*Naultinus elegans*, – Declining) are unlikely to be present.

3.3 Freshwater

No freshwater streams were present onsite and the sedge grassland in vegetation type 9 has been conservatively assessed as a wetland until further assessment is undertaken at subdivision stage.

The site is also in close proximity to the Waikato River and associated lake margin wetlands.

3.3.1 Wetlands

A wetland is an ecosystem that is either permanently or intermittently saturated with water. Wetlands support a distinct assemblage of organisms that are adapted to wet conditions. Wetlands can perform important ecosystem services and functions.

The protection of wetlands has become part of national policy, with the National policy Statement for Freshwater Management (NPS-FM) which came into force in September 2020 (with subsequent updates). The Essential Freshwater package introduced policies and regulations to protect ‘natural wetlands’ with nationally consistent standards.

The wetland delineation protocols were assessed in the Sedge grassland (Vegetation type 9), and this site was indeterminate as it failed the dominance test and passed the prevalence test (Table 3). One of the main species (Greater periwinkle) did not have a plant status rating. At this stage this area has been conservatively assessed as a wetland until further assessment of the soil and hydrology can be undertaken at subdivision stage.

Table 3: Results of the wetland delineation assessment.

Common name	Species code	Status	Cover (%)
Greater periwinkle	VINmaj		15
Beggar's tick	BIDfro	FACW	2
Broad-leaved fleabane	CONsum	FACU	5
Australian Fireweed	SENbip	FACU	10
Blackberry	RUBfru	FAC	2
Umbrella sedge	CYP sp.	FACW	33
Cocksfoot	DACglo	FACU	28
Yorkshire fog	HOLlan	FAC	5
Total cover			**100**
Improved pasture			NO
Dominance test			NO
Prevalence index			2.63
Prevalence test			**YES**
Wetland Vegetation			**Indeterminate**

3.3.2 Waikato River – Lake Whakamaru

The Waikato River is the longest river in New Zealand at 452 km. The river is of great significance to iwi and this significance is described in the South Waikato District Plan (Operative) in the Statement of Significance of the Waikato River. The Waikato River also has high conservation value and provides a range of habitats for indigenous flora and fauna including several nationally threatened species. Land use change and development of the wider catchment has led to degradation and changes to the Waikato River ecosystem which can negatively impact on the rivers cultural and ecological values (Department of Conservation 2014).

The Vision and Strategy for the Waikato River (Te Ture Whaimana o te Awa o Waikato) recognises the significance of the Waikato River, with the vision, objectives, and strategies applicable to Waikato River tributaries and catchment. The Vision and Strategy (V&S) is acknowledged as the primary, direction-setting document for the Waikato River and activities are required to provide for the protection and restoration of the Waikato River, and that this will require "betterment" to an extent proportionate with the scale of the activity and its effects. Although there are no freshwater habitats onsite, the site is near the Waikato River. With respect to the proposed plan change, any effects on site will need to be managed in a way to ensure there is no detrimental effect on the Waikato River. In the long term the plan change has the potential to increase the biodiversity of the area, through weed control and planting of indigenous vegetation.

3.3.2.1 Lake Whakamaru Ecology

Lake Whakamaru is the fourth hydro lake downstream of Taupo and is 7.4 km^2 in area and 36 m deep (Edwards et al., 2009). Hydro power generation has significantly altered the hydrology of the middle section of the Waikato River, which was once high gradient and characterised by gorges and extensive rapids

The water quality at Lake Whakamaru tailrace is moderate (Table 4). The long term 'State' of the water shows that may parameters are very likely degrading, in particular nitrogen, phosphorous and *E. coli*. Nutrient concentrations can effect nuisance plant and algal growth, while *E.coli,* which is a bacterium commonly found in the digestive systems and faeces of humans and animals, is a human

health risk in high counts. The water clarity and turbidity in this section of the river appear to be improving over time.

Table 4: Water quality at Lake Whakamaru from the LAWA website.

Parameter	unit	5 year median	State	Trend
E.coli	n/100ml	10n/100ml	very likely degrading	in the best 25% of all sites
Clarity	m	2.42m	very likely improving	in the best 50% of all sites
Turbidity	NTU	1.13 NTU	very likely improving	in the best 50% of all sites
Total nitrogen	mg/L	0.326	very likely degrading	in the best 50% of all sites
Total oxidised nitrogen		0.18	very likely degrading	in the best 50% of all sites
Ammoniacal nitrogen	mg/l	0.01	NA	In the worst 50% of all sites
DRP	mg/l	0.01	likely degrading	in the best 50% of all sites
Total phosphorous		0.023	very likely degrading	in the best 50% of all sites

Fish species in Lake Whakamaru are limited to those that can form land-locked population or have been released as introduced species or as part of the eel trap and transfer programme (where eels are captured below Karapiro Dam and transferred above the hydro dams). Species distribution records from the New Zealand Freshwater Fish Database indicate that several native species have been recorded within Lake Whakamaru, namely; longfin eel (*Anguilla dieffenbachia* – At Risk – Declining), shortfin eel (*Anguilla australis*), common smelt (*Retropinna retropinna*), common bully (*Gobiomorphus cotidianus*) as well as the large macroinvertebrate, koura (*Paranephrops*). Koura numbers are known to have significantly declined in the upper Waikato River overtime including in Lake Whakamaru (Clearwater et al., 2014). The introduced species catfish (*Ameiurus nebulosu*s), goldfish (*Carassius auratus*), rudd (*Scardinius erythrophthalmus*), and brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) have also been recorded in Lak Whakamaru.

The Waikato River at Lake Whakamaru also provides habitat for a number of indigenous bird species, including those with a threat status (Section 3.2.1).

4 ECOLOGICAL VALUE

The ecological value of the vegetation in the proposed plan change area is summarised in Table 5. The ecological value of Vegetation types 1-5, & 7-9 is **low** and is comprised of exotic grasses, herbs and shrubs and pine plantation. Weeds are common throughout this area.

Vegetation type 6 has an indigenous understory and is considered to have **low to moderate** ecological value in an otherwise highly disturbed environment. This vegetation type is not considered to be ecologically significant as it does not meet the Waikato Regional Policy Statement (WRPS) ecological significance criteria. Nonetheless, retention and enhancement of this vegetation is recommended.

Nearby SNAs which border the Waikato River are ecologically significant and have high ecological value. These areas will not be directly affected as a result of the proposal, and the restoration proposed is likely to aid in forming a linkage or corridor between these habitats.

The ecological values associated with fauna are provided in

Table 6.

The Waikato River provides habitat for several threatened bird and fish species and has **high** ecological value.

Table 5: Assigning ecological value to the vegetation/habitat at the site using the EIANZ criteria.

Habitat type	Representativeness	Rarity/Distinctiveness	Diversity & pattern	Ecological Context
Vegetation types 1-5 and 7-8 **Low ecological value**	Low - Low growing exotic vegetation comprising grasses, herbs and some weedy scrub (broom) is not representative of the vegetation that would have naturally occurred here	Low – Highly disturbed environment, although mature trees may provide commuting habitat for mobile bird species.	Low – The vegetation is dominated by exotic species with weeds but may still provide habitat for indigenous species.	Low – The area is considered to have low quality habitat for indigenous fauna and provides little connectivity or buffering to other habitats.
Vegetation type 9 – conservatively assessed as a wetland at this stage **Low ecological value**	Low to moderate - The sedge grassland is comprised of exotic species and not representative of what would have naturally occurred here. Nonetheless, wetlands are an under-represented habitat type and are afforded protection in the NES-F.	Low – Disturbed environment.	Low - Dominated by exotic species with weeds.	Low – Does not meet the significant assessment criteria including criterion 6 as it does not support indigenous plant or fauna communities. Does not provide connectivity to other habitats.
Vegetation type 6 **Low to moderate ecological value**	Moderate – Exotic canopy trees with a largely indigenous understory. Understory species are naturally occurring.	Low to moderate – The understory is indigenous vegetation that may provide habitat provides habitat and commuting for mobile bird species (i.e. fantail).	Low to moderate – Understory is dominated by indigenous vegetation and may provide habitat for indigenous species.	Low to moderate – low to moderate quality habitat and provides little connectivity or buffering to other habitats.

Table 6: Ecological value of fauna using the EIANZ criteria.

Species	Threat status	Presence	Ecological Value
Long-tailed bat	Threatened – Nationally Critical	May be present	**Very high**
Locally common indigenous bird species (i.e., tui, fantail)	Not threatened	Present	**Low**
Indigenous birds with a threat status (i.e., black cormorant)	At Risk – Declining	Present in nearby habitats	**High**
Copper skink	At Risk – Declining	May be present	**High**

5 ECOLOGICAL IMPACT ASSESSMENT

A change of zoning and land use from rural to residential poses a range of potential adverse effects to the ecological values that have been identified onsite.

This section provides an overview of the actual and potential ecological effects of the project, followed by an assessment of ecological effects following the EcIA methodology outlined in Appendix III.

5.1 Potential effects associated with the proposed zoning change

Potential and actual effects of the proposed change in land use relate to:

- Effects on terrestrial fauna habitats;
- Effects on fauna due to disturbance and the ongoing land use change; and
- Effects from earthworks, sediment and stormwater.

5.2 Effects on terrestrial flora

Historical land-use across the site at 1861 Ongaroto Road has resulted in an almost complete removal of vegetation. Currently, the vegetation is comprised of planted pine trees (<1 m tall) as well as exotic grasses, herbs and shrubs common to disturbed areas, with many of the species also considered weeds. Despite the history of modification and disturbance some indigenous vegetation does persist and this vegetation should be protected and enhanced where possible (i.e. the indigenous understorey of vegetation type 6).

Mature exotic trees are planned to be removed as part of the development (pines and cypress trees c.8 m tall in vegetation types 6 and 7). These large exotic trees have **low** ecological value in themselves; however they provide commuting and foraging habitat for threatened fauna (see Section 5.3).

The creation of bare earth as a result of construction has the potential for weed colonisation, and this is highly likely given the nearby seed source. Therefore, any open areas should be immediately hydro seeded or mulched, this will also reduce the risk of erosion.

Provided the existing indigenous vegetation is retained and the area of enhancement through planting of indigenous species is greater than that lost through clearance the magnitude of effects from vegetation clearance is considered to be **low.** Resulting in a **low** overall level of effect. (Fauna effects are discussed in Section 5.3).

5.3 Effects on indigenous fauna

Future zoning change from rural to residential land-use may indirectly affect native terrestrial fauna through the loss of habitat and food resources. Other possible indirect effects associated with land-use change include alterations to light and noise disturbance, an increase in introduced animal predators, as well as general disturbances during and post-construction and development during vulnerable months (i.e. breeding seasons). As the site borders the popular Lake Whakamaru Reserve some human activity already occurs at the site, which resident fauna are likely to be adapted to. However, increased human occupation and housing will likely increase the occupation of pest animals (rats, mice, mustelids and cats). These pest animals predate on indigenous fauna and some form of control will be required.

Removal of vegetation has the potential to adversely affect terrestrial fauna, through damage to nests, associated eggs, fledglings and loss of individuals killed during activities associated with construction. Native fauna (bats, birds and lizards) are protected under the Wildlife Act 1953 and it is illegal to harm or disturb them without a Department of Conservation issued Wildlife Act Authority. Actions should therefore be undertaken to ensure they are unharmed during activities associated with the proposed plan change development.

5.3.1 Birds

The vegetation onsite, particularly mature exotic trees, may contain indigenous birds and clearance of this vegetation has the potential to cause injury to or death of native birds, particularly during the breeding season. Native birds within the area should be able to emigrate out of the area, unless unfledged chicks are present in nests. Only common, non-threatened native species were found on site which have a **low** ecological value, and the loss of a small number of these birds would have minimal effects on the local or regional populations.

To reduce the likelihood of bird mortality, vegetation removal of mature trees should take place outside of the peak bird breeding season (October to February inclusive). If vegetation clearance cannot be achieved outside of these dates, then those areas should be assessed by an appropriately qualified ecologist for nesting birds immediately prior to vegetation removal. If active nests are detected, vegetation removal should be put on hold until the area is deemed to be clear of nesting birds by an appropriately qualified ecologist. Avoidance of the peak bird nesting season will reduce the magnitude of effects is considered **very low**, resulting in a **low** overall level of effect.

The proposed planting of indigenous vegetation in reserve areas throughout the site (c. 6.3 ha Appendix V), will improve the habitat for birds in the long term.

5.3.2 Bats

Long-tailed bats have a **very high** ecological value and a low to medium level of bat activity has been recorded at the site. Bats were found to be periodically utilising and occasionally feeding at the site.

Land-use changes have the potential to affect long-tailed bats directly and indirectly in the immediate area. Urban development, such as roads, housing, and other infrastructure, may cause several adverse effects on long-tailed bat habitats, including habitat loss, habitat fragmentation, changes in microclimates, and increases in noise, and lighting (Smith et al. 2017). In Hamilton, Le Roux and Le Roux (2012) found that road and street light density alongside residential housing was associated with a decline in recorded bat activity. Indirect effects may include an increase in predation pressure in the landscape due to an increase in pest numbers (e.g. rats, cats).

Despite this, long-tailed bats behavioural characteristics appear to exhibit some tolerance and plasticity to urbanisation if the right habitat features remain within and adjacent to the urban area (e.g., Dekrout et al 2014, Le Roux & Le Roux 2012). In Hamilton, research indicates that bats persist in the southern areas of the city where rural-residential land use is predominant.

5.3.2.1 Loss and modification of bat habitat

Urban development can result in the loss, fragmentation and modification of habitat for bats. Long-tailed bats are edge adapted, their wing morphology and the structure of their echolocation calls are adapted for foraging along edges and gaps (O'Donnell 2001). The vegetation at 1861 Ongaroto Road is predominantly grassland with recently planted small pine trees with areas of exotic scrub, the occasional small tree (<15 cm DBH) and a row of Cypress and pine trees along the boundary with the

reserve (vegetation type 6 and 7). As an edge adapted species it is likely that this row of trees provides a linear feature and micro-habitat for commuting and foraging. Large exotic trees in this area will be removed, this area totals 870 m^2 although not all this area will be removed as the indigenous understorey will be retained.

Mitigating the effects of this vegetation removal is the establishment of a buffer zone using indigenous vegetation to separate the public reserve from private lots (Appendix V). Ecologicla planted areas will be established along most of the reserve boundary and total 5.58 ha (see Appendix V). This vegetation will include species that are endemic to the Central volcanic plateau ER and Atiamuri ED and both large and small trees will be established. Larger trees such as titoki, rewarewa, totara and matai will act as bat roost trees in the future, while faster growing specimens including cabbage tree and kanuka will provide habitat in the short term. The indigenous vegetation will be planted prior to the removal of the exotic trees to reduce the time lag before the new habitat is available. The planted indigenous vegetation will act as commuting corridors, feeding areas and potential long term roost habitat. The establishment of suitable habitat with linear features that is 50 times greater than the habitat to be lost will result in a net gain for bats and biodiversity in the area.

Prior to the removal of any potential roost trees with a DBH >15 cm and which contain habitat features such as cracks, crevices and flaky bark, a Bat Management Plan (BMP) will need to be developed to avoid, minimise and /or mitigate potential impacts on bats. This will include timing to avoid when bats are in torpor (i.e. vegetation clearance should not be undertaken 1 May- 1 October) which will reduce injury or mortality if the trees are occupied by bats (refer to tree felling protocols detailed in Appendix VI). Should a tree be occupied by long-tailed bats, felling of the tree will need to be avoided until the tree is no longer occupied. If the tree is not occupied, it can be felled. This would be a precautionary measure because roost use and occupancy of trees by long-tailed bats is not well understood, and even the loss of one occupied roost tree could have significant adverse effects on the local bat population.

Temporary effects of the vegetation removal will be minimised and mitigated through the establishment of the buffer zone planting prior to vegetation removal. In addition, this rural landscape has many dark vegetated areas that provide higher quality habitat than the vegetation on site (including along the river edge) which bats can utilise while the buffer planting matures.

In respect to loss and modification of habitat, long-tailed bats and their habitats have a **very high** ecological value. Although bat activity was low to moderate and the habitat onsite is considered of low quality, bats use the area (and wider area) for commuting and foraging, resulting in a **low** magnitude of effect and a **moderate** overall level of effect before mitigation of residual effects have been applied. Adverse effects will be adequately managed through the implementation of a BMP and the proposed mitigation and enhancement planting. Reducing the overall level of effects to **low**.

5.3.2.2 Artificial lighting effects on bats

Bats are almost exclusively nocturnal and extremely sensitive to artificial light at night (ALAN) (Voigt et al. 2018). Several international studies have shown that bats alter their behaviour in the presence of artificial light sources (e.g. Downs et al. 2003, Bat Conservation Trust 2018[14]). Overseas research also stresses the importance of preserving dark corridors for bats to minimise the effects of artificial light on bat activity (Zeale et al. 2018). Any level of ALAN above that of moonlight masks the natural rhythms of lunar sky brightness and, thus, can disrupt patterns of foraging and mating. (Perkin et al.

[14] Home - Bat Conservation Trust (bats.org.uk)

2011, Voigt et al. 2018). Wavelength, intensity and directionality of the light all influence the presence and behavior of bats (Mathews et al. 2015).

Although only a low to moderate level of bat activity was detected at the site the effects of artificial lighting associated with houses, outdoor lighting and street lighting could impact feeding and commuting habitat of bats within and adjacent to the site. Outdoor artificial lighting should be designed to minimise the effects to bats as much as possible by using amber colored lighting (<3000K, 620-750 nm) with low lux (<0.3 lux at 10 m from the source) pointing downwards (Voigt et al. 2018, Haddock et al. 2019). These lighting requirements are recommended at the boundary of the subdivision, including within 20 m of Ongaroto Road.

In addition to this the concept plan shows and average buffer width of c.27 m of indigenous vegetation to be established along most of the property boundary with the adjacent reserve which will mitigate light spill over effects.

In respect to artificial lighting effects, long-tailed bats and their habitats have a **very high** ecological value. Long tailed bat activity was low to moderate resulting in a **low** magnitude of effect and a **moderate** overall level of effect before mitigation of residual effects have been applied. The effects of outdoor artificial lights will be minimised through low light design with a 0.3 lux limit at 10m from their source and a planted buffer zone which will prevent light spill over effects from the development. These measures will reduce the overall level of effects to **low**.

5.3.3 Herpetofauna

Copper skinks have a 'At Risk – Declining' threat status and are considered to have **high** ecological value. It is possible that the occasional copper skink may be present at this site, however, given the highly disturbed nature of the site which was clear felled of all existing vegetation in 2018 and the limited suitable habitat available, their presence is likely to be limited.

Potential direct and indirect effects of development can include habitat loss, and food resources loss. However, no indigenous vegetation will be removed as part of the proposal and the indigenous vegetation in Vegetation type 6 will be retained and enhanced. This coupled with the rural residential lifestyle development proposed (low density housing) and the high amount of enhancement and restoration proposed including pest animal control in the form of a cat ban and pest animal control measures will enhance and protect lizard habitat and food sources in the long term. Therefore, the magnitude of effect on lizards and their habitats is considered to be **low**. This will result in a **low** overall level of effect.

5.4 Potential discharges (sedimentation, stormwater, wastewater)

The Waikato River has **high** ecological value and is culturally significant and protection of the ecological values of the Waikato River is imperative and any effects on site will need to be managed in a way to ensure there is no adverse effect on the Waikato River. Given the close proximity of the proposed development site to the Waikato River and the general sloping nature of the site, management of any surface water runoff will be an important consideration.

There are no watercourses on the site that flow into the Waikato River and the boundary of the site is located at least 25m from the river, with the proposed lots and building sites at least 50m from the river edge. This set back and the highly permeable and expected high soakage rate of the soil (Titus 2023) will help minimise adverse effects of runoff from the site. However, specific measures will need to be implemented as part of any future development on the land to ensure that contaminants from the proposed development do not enter downstream waterways.

Potential discharges will need to comply with appropriate legislation, including but not limited to the Vision and Strategy for the Waikato River, National Policy Statement for Freshwater Management (NPS-FM) (MfE, 2022), National Environmental Standards for Freshwater (NES-F)[15], The Waikato Regional Policy Statement. In particular the obligation of Te Mana o te Wai to protect the health and well-being of water bodies and freshwater ecosystems and regulations around earthworks within or within a 10 m set-back of a natural wetland and discharges within 100 m of natural wetlands.

Earthworks will need to avoid the sedge grassland (Vegetation type 9) which is located in Reserve Area A. Earthworks cannot undertaken within 10 m of this vegetation type and any discharges within 100 m of the wetland (including the stormwater swale) will need to ensure that there is no hydrological connection and no adverse effect to the wetland.

5.4.1 Sedimentation and erosion

The Immature Orthic Pumice soils onsite are rapidly draining soils which are also easily erodible when exposed to water (and wind). Erosion and sedimentation pose a risk to the wider environment, as increased sediment in the receiving environment can impact water quality within the freshwater environment and result in sediment deposition, changing habitat features. It is imperative that erosion control measures are put in place to ensure there is no adverse effects on the Waikato River, including maintaining vegetation as cover, particularly on steep escarpment, and as windbreaks over the entire area.

Activities undertaken as part of the plan change has the potential to generate sediment, which, if unmitigated, could potentially enter the Waikato River. The Site Suitability and Natural Hazard report indicates that the soils show susceptibility to “Rilling” and “Scouring”, as such swales on slopes will require to be appropriately designed to account for scouring. Riprap scour protection and planting (grass) may be required (Titus 2023).

Areas of bare earth are immediately vegetated or covered to reduce the risk of erosion and sedimentation and weed colonisation on bare ground.

It is anticipated that sediment and erosion will be adequately controlled through a sediment and erosion plan which will be designed in accordance the Waikato Regional Council guidelines, mitigating potential adverse effects to the receiving environment. This will need to be assessed at the detailed design stage.

5.4.2 Stormwater

Activities associated with the plan change include new subdivisions and roads which usually alter land surfaces to make them less permeable to water, by both compaction of land surface and increased imperviousness (e.g. roads and new buildings). This can result in increased stormwater runoff and catchment scale erosion and flooding impacts. Stormwater management needs to be considered when any new development is being planned to protect the receiving environment. Issues specific to the proposed plan change and subdivision relate to the easily erodible pumice soil. This soil is highly permeable, and a high soakage rate is expected (this will need to be proven prior to detailed design (Titus 2023)).

The stormwater assessment undertaken by Titus 2023 shows that there are five culverts beneath State Highway 30 (SH30) which discharge upper catchments to the proposed development. Four

[15] Resource Management (National Environmental Standards for Freshwater) Regulations 2020 (LI 2020/174) (as at 05 January 2023) Contents – New Zealand Legislation

overland flow paths have been identified within the proposed development site (Titus 2023). The proposed development will convey and treat stormwater through the road network swales and/or stormwater swales within the identified reserve areas/corridors (Appendix VI), culverts will be required under the subdivision roads to convey flows. Where Water Quality volume cannot be achieved via roadside swales, residence time and volume, then it is anticipated that the additional treatment can be achieved via appropriately sized and located soakage devices. Discharges will be in accordance with WRC standards and regulations.

In addition to the conveyance of flows, the road network swales and stormwater swales will need to be designed to allow detention and treatment of the stormwater. The stormwater assessment is high level and detailed design has not been developed at this stage. During detailed design, aspects on suitable treatment, including species will be required. If suitable treatment and detention cannot be achieved through the swale system and soakage devices, stormwater detention basin/s or stormwater wetland/s may be able to be developed at the foot slope of the site (where any overland flow will naturally drain too. In addition to this low impact development is recommended to treat stormwater onsite and large lot sizes will help by restricting the overall proportion of impervious surfaces. Other key low impact elements include working with nature to avoid or minimise impervious surfaces, utilising vegetation to assist in trapping pollutants and sediment, limiting earthworks, incorporating design features that reduce impacts, and enhancing biodiversity. Examples of low impact design details may include:

- Rooftop rainwater collection systems;
- Open road sections with vegetated swales;
- Bioretention devices for treatment and detention (e.g. Tree pits, vegetated swales, raingarden); and.
- Soil amendments (e.g. adding compost or other soil conditioning material into topsoil before spreading it back over the site - improves water retention and soil characteristics).

Ensuring stormwater is treated and detained onsite will be essential to protecting the water quality within the Waikato River at Lake Whakamaru. It is anticipated that conveyance, treatment and detention devices will be able to mitigate any potential adverse effects as long as they are fit for purpose and designed and incorporated and following best practice guidelines and regulations. This will need to be assessed once the final plans have been designed.

5.4.3 Wastewater

An on-site Wastewater Management Effects and Options Summary report has been prepared to specifically address potential effects from on-site wastewater discharge (Orminston Associates Ltd 2022), the following measures will be undertaken:

- Wastewater treatment systems will be treated by secondary treatment only and will meet the required treatment standard off 20 g/m3 BOD5 and 30 g/m3 Total Suspended Solids.
- Disposal areas will be planted with appropriate vegetation.
- Separation distances from water bodies will be at least 50m which exceeds the specified minimum of 15 m clearance.
- The separation between winter groundwater level and the bottom of the disposal trench is required t be at least 600 mm and groundwater depths were > 2.2 m in the ten bore holes drilled onsite.

With these measures in place the effect to surface water has been assessed as less than minor (Orminston Associates Ltd 2022). In addition to this there will be a planted buffer zone between the subdivision and the lake side reserve, further reducing any potential effects of overland flow.

5.4.4 Potential discharge summary

It is anticipated that any potential adverse effects associated with contaminant discharge to the Waikato River at Lake Whakamaru will be able to be controlled and mitigated as long as they are fit for purpose and designed and incorporated and following best practice guidelines and regulations. This will need to be assessed once the final plans have been designed.

To further ensure that there are no adverse effects on water quality it would be possible to develop additional detention/treatment device/s within the identified buffer reserve area at the boundary of the site. This would act as a back-up device to detail/treat any contaminants and would be in addition to what is required for adequate conveyance. Ideally this would be installed prior to the earthworks stage.

Water quality monitoring could also be undertaken immediately pre, during and post construction to prove that there is no adverse effect on the Waikato River at Lake Whakamaru.

6 SUMMARY

This report has been prepared to accompany the application for a private plan change in of 31 ha at 1861 Ongaroto Road in Whakamaru. This report assesses the ecological effects for a future subdivision stage should the plan change be approved.

The magnitude and level of effects after proposed measures to avoid, remedy, and mitigate have been undertaken are summarised in Table 7. For most of the plan change area the ecological value of the vegetation and habitat is low. Vegetation in the indigenous understory of vegetation type 6 is assessed as low to moderate.

Fauna ecological values range from very high for threatened species to low for common indigenous bird species.

The overall level of effect on terrestrial fauna without mitigation is likely to be moderate and the following measures will need to be implemented to mitigate effects:

- Any vegetation removal of mature trees should take place outside of the peak bird breeding season (October to February inclusive) and the period when bats are in torpor (1 May to 1 October). If tree removal cannot be achieved outside of these dates, then those areas should be assessed by an appropriately qualified ecologist for nesting birds immediately prior to vegetation removal (this can be undertaken at the same time as the bat pre-felling checks).
- Mitigating the effects of the vegetation removal of linear tree features which provide commuting and foraging habitat for bats through the establishment of a buffer zone using indigenous vegetation to separate the public reserve from private lots (with an average width of c.27 m and 5.58 ha).
- The effects of artificial lights will be minimised through low light design with a 0.3 lux limit (at the site boundary) and a planted buffer zone which will prevent light spill over effects from the development.
- The sedge grassland in vegetation type 9 has been conservatively assessed as a wetland until further assessment is undertaken at subdivision stage. Any earthworks or discharges in proximity to this vegetation type will need to ensure compliance with the National Environmental Standards for Freshwater (NES-F).
- It is anticipated that any potential adverse effects associated with contaminant discharge to the Waikato River at Lake Whakamaru will be able to be controlled and mitigated as long as they are fit for purpose and designed and incorporated and following best practice guidelines and regulations. This will need to be assessed once the final plans have been designed.
- Areas of bare earth are immediately vegetated or covered to reduce the risk of erosion and sedimentation and weed colonisation on bare ground.
- A detailed Management Plan for the site, which will include the following:
    - Pest animal control measures, including but not limited to recommended methods, spacings of traps and frequency. Pest animal control is required in perpetuity.
    - Given the presence of threatened indigenous fauna onsite and in the wider environment (reserve area) and the close proximity existing SNA’s including Lake Whakamaru, the control on domestic cats is recommended by way of a covenant. Cats are known predators of indigenous wildlife in New Zealand.

- Fauna management plans if required. For example, any requirements required for bats to avoid, minimise and /or mitigate potential impacts on bats and will include avoidance timing and pre-felling bat protocols if potential bat roost trees are to be felled.
- A detailed restoration planting plan including but not limited to the number and size of plants, control of weeds and ongoing maintenance and monitoring other specific considerations include:
  - Early planting of the mitigation/enhancement and reserve areas, ahead of development to provide habitat benefits as soon as possible is recommended.
  - Retention and enhancement of the indigenous understorey in vegetation type 6.
  - Indigenous species planted should be from the Central Volcanic Plateau Ecological Region[16].
- Monitoring of the near shore Waikato River (Lake Whakamaru) water quality pre, during and post construction to ensure that there is no adverse effect on the water quality. This will include samples for sediment, nutrients and *E.coli*.

In the long-term the ecological planting area totalling 6.3 ha will have a net positive effect on the flora and fauna at 1861 Ongaroto Road.

Table 7: Summary of the activity, magnitude of effect, and overall level of effect without and with mitigation.

Activity and effect	Ecological value	Magnitude of effect	Overall level of effect without mitigation	Overall level of effect with mitigation
Vegetation clearance	Moderate	Low	Low	Low
Fauna disturbance due to vegetation clearance– birds and lizards	Low to high	Low	Moderate	Low
Fauna disturbance due to vegetation clearance- bats	Very high	Low	Moderate	Low
Fauna disturbance due to artificial lighting – bats	Very high	Low	Moderate	Low
Sedimentation and erosion	High	Anticipated that potential adverse effects can be mitigated following best practice guidelines and regulations. This will need to be assessed at the detailed design stage.		
Stormwater	High			

[16] What to plant in the central volcanic plateau ecological region | Waikato Regional Council

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Appendix I Botanical list

Scientific name	Common name
Acaena sp. *	Bidibid
*Agrostis capillaris**	Browntop
Berberis glaucocarpa	Barberry
*Bidens frondose**	Beggards tick
Blechnum novae-zelandiae	Kiokio
*Buddleja davidii**	Buddleia
*Conyza albida**	Fleabane
Cirsium sp.*	Thistle
Coriaria arborea	Tutu
*Cortaderia selloana**	Pampas
Coprosma robusta	karamu
Cyathea medullaris	Mamaku
Cyathea dealbata	Silver fern
Cyperus	Umbrella Sedge
*Cytisus scoparius**	Broom
*Cupressus**	Cypress
*Dactylis glomerata**	Cocks foot
Dicksonia squarrosa	Whekī
*Digitalis purpurea**	Foxglove
*Galium aparine**	Cleavers
*Hypochoeris radicata**	Catsear
*Erica lusitanica**	Spanish Heath
Fuchsia excorticata	Kotukutuku, tree fuchsia
Geniostoma ligustrifolium	Hangehange
*Holcus lanatus**	Yorkshire fog
*Hypochaeris radicata**	Catsear
*Isolepsis sp**	
*Leontodon taraxacoides**	Hawkbit
Leucanthemum sp.	Oxeye daisy
*Lotus pedunculatus**	Lotus
*Leycesteria formosa**	Himalayan honeysuckle
*Lupinus arboreus**	Tree lupin
Melicytus ramiflorus	Māhoe
Poa sp.	
Paspalum sp.	
*Phytolacca octandra**	Inkweed
*Pinus radiata**	Radiata pine
Plantago sp.*	Plantain
Pseudopanax arboreus	Five finger
Pteridium esculentum	Bracken
Pteris macilenta	Sweet fern
*Rubus fruticosus**	Blackberry
*Senecio bipinnatisectus**	Australian Fireweed
Solanum nigrum	Black nightshade
*Sonchus oleraceus**	Sow thistle

*Stachys byzantine**	Woolly hedge nettle
*Stachys sylvatica**	Hedge woundwort
*Ulex europaeus**	Gorse
*Vinca major**	Greater periwinkle

*Exotic species

Appendix II Bat survey weather data

Summary of weather conditions during the survey period. Temperatures in °C, precipitation in mm and wind speed in m/s. Data from NIWA CliFlo database, station nr 37016 (Pureora Forest Cws).

Date	Maximum Temperature at dusk (approx. 20:00) (°C)	Minimum Temperature at dusk (approx. 20:00) (°C)	Maximum Precipitation (mm) until 4h after sunset	Maximum Wind speed (m/s) until 4h after sunset
27/10/22	28.8	11.2	0	2.2
28/10/22	30.8	13.4	0.2	5.1
29/10/22	32	15.4	5.4	7.1
30/10/22	27.2	12.9	0	8.1
31/10/22	31.2	13.8	0	2.8
1/11/22	30.6	11.2	0	5.5
2/11/22	33.9	15.3	0	5.4
3/11/22	29.4	11.8	0	4.6
4/11/22	25.7	9.7	0	5.1
5/11/22	26.5	10.4	0	4.4
6/11/22	26.5	12.2	0	4.4
7/11/22	27.2	12.1	0	4.8
8/11/22	30.4	12.4	0	4.8
9/11/22	31.4	14.5	0	5.5
10/11/22	22.9	9.4	0	10.1

Bat surveys were undertaken by Titia Schamhart of Dr Bat NZ Ltd [Level 3 Bat Competency Certification – DOC]

Minimum temperatures at dusk for bat emergence are >7°C, ideally >10°C (O'Donnell 2000, O'Donnell and Sedgeley 2012)[17,18]. In this context, minimum dusk temperatures remained between 9.3°C and 15.4°C during the entire survey period (Table above), with just 2 evenings being <10°C.

Maximum rainfall within the 4 hours after dusk was less than 4 mm over the entire survey period except the third night (5.4 mm), with only a small amount of rain recorded on the second night (0.2 mm), and therefore rainfall is unlikely to have affected bat emergence during 15 nights of surveying (O'Donnell 2000)[1].

Wind conditions were suitable across the entire survey period minus three night, with maximum wind gusts from dusk until dawn below 5.6 m/s (Smith et al. 2017)[19].

This leaves for a total of 12 suitable survey nights, which is in line with best practice.

[17] O'Donnell, C. 2000. Conservation status and causes of decline of the threatened New Zealand Long-tailed Bat Chalinolobus tuberculatus (Chiroptera: Vespertilionidae). Mammal Review 30:89–106.
[18] O'Donnell, C., and J. Sedgeley. 2012. Introduction to bat monitoring v1.0:33.
[19] Smith, D., K. Borkin, C. Jones, S. Lindberg, F. Davies, and G. Eccles. 2017. Effects of land transport activities on New Zealand's endemic bat populations: reviews of ecological and regulatory literature October 2017:249.

Appendix III Ecological Impact Assessment Guideline tables

Appendix II Table 1: Assigning ecological value (Roper-Lindsay et al. 2018).

Description	Value
Feature rates Very Low for at least three assessment attributes and Low to Moderate for the remaining attribute(s).	Negligible
Feature rates Very Low to Low for most assessment attributes and moderate for one. Limited ecological value other than providing habitat for introduced or tolerant indigenous species.	Low
Feature rates High for one assessment attribute and Low to Moderate for the remainder, OR The Project area rates Moderate for at least two attributes and Very Low to Low for the rest. Likely to be important at the level of the Ecological District.	Moderate
Feature rates High for at least two assessment attributes and Low to Moderate for the remainder, OR The Project area rates High for one attribute and Moderate for the rest. Likely to be regionally important.	High
Feature rates High for at least three assessment attributes. Likely to be nationally important.	Very High

Appendix II Table 2: Assigning ecological value at a species level for terrestrial and freshwater species (Roper-Lindsay et al. 2018).

Threat Class	Threat Sub-class	Value
Exotic: Introduced and Naturalised	-	Negligible
Indigenous: Common/not threatened	-	Low
Indigenous: Locally uncommon or distinctive species	-	Moderate
Indigenous: At Risk	1. Naturally uncommon 2. Relict 3. Recovering	Moderate
	4. Declining	High
Indigenous: Threatened	1. Nationally Critical 2. Nationally Endangered 3. Nationally Vulnerable	Very High

Appendix II Table 3: Assessment and criteria for describing the magnitude of effects (Roper-Lindsay et al. 2018).

Description	Magnitude
Very slight change from existing conditions. Change barely distinguishable, approximating "no change"; and/or having negligible effect on the known population or range of the feature.	Negligible
Minor shift away from existing conditions. Change arising from the loss/alteration will be discernible, but underlying attributes will be similar to pre-development circumstances; and/or having a minor effect on the known population or range of the feature.	Low
Loss or alteration to one or more key features of the existing condition, such that post-development attributes will be partially changed; and/or loss of a moderate proportion of the known population or range of the feature.	Moderate
Major loss or alteration of key features of existing conditions, such that post-development attributes will be fundamentally changed; and/or loss of a high proportion of the known population or range of the feature.	High
Total loss or very major alteration to key features of existing conditions, such that the post-development attributes will be fundamentally changed and may be lost altogether; and/or loss of a very high proportion of the known population or range of the feature.	Very high

Appendix II Table 4: Matrix for determining the overall level of the described ecological impacts (Roper-Lindsay et al. 2018).

Effect Level		Ecological Value				
		Negligible	**Low**	**Moderate**	**High**	**Very High**
Magnitude of impact	**Positive**	Net Gain	Net Gain	Net Gain	Net Gain	Net Gain
	Negligible	Very Low	Very Low	Very Low	Very Low	Low
	Low	Very Low	Very Low	Low	Low	Moderate
	Moderate	Very Low	Low	Moderate	High	High
	High	Very Low	Low	Moderate	Very High	Very High
	Very High	Low	Moderate	High	Very High	Very High

Appendix IV: Birds nearby from desktop review

Appendix IV Table1: Birds recorded nearby from eBird. Common names are provided along with the scientific name and threat status for threatened species. Green cells = native, unshaded = introduced. Links to the raw data is provided in the footnotes for Section 3.2.1.

Species name	Scientific name	Threat status	Whakamaru Dam	Dunham Point	Sandy Bay Point
Canada Goose			x	x	
Black Swan			x	x	x
Paradise Shelduck			x	x	x
Australasian Shoveler			x	x	x
Pacific Black Duck			x	x	
Mallard			x	x	x
Mallard x Pacific Black Duck (hybrid)			x	x	
Gray Teal			x	x	x
New Zealand Scaup			x	x	x
California Quail			x	x	
Wild Turkey			x		
Ring-necked Pheasant			x	x	
New Zealand Grebe/dabchick	*Poliocephalus rufopectus*	Nationally increasing	x	x	x
Rock Pigeon			x		
Spotted Dove			x		
New Zealand Pigeon			x		
Shining Bronze-Cuckoo			x	x	
Eurasian Coot			x		x
Australasian Swamphen			x	x	x
Pied Stilt			x	x	x
Masked Lapwing/spur-winged plover			x	x	x
Black-billed Gull	*Chroicocephalus bulleri*	At Risk - Declining	x		
Silver Gull/bred-billed gull	*Chroicocephalus novaehollandia*	At Risk - Declining	x		
Kelp Gull/Southern black-backed gull			x	x	x
Caspian Tern	*Hydroprogne caspia*	Threatened - Nationally vulnerable	x	x	
Little Pied Cormorant	*Microcarbo melanoleucos*	At Risk -Relict	x	x	x
Great Cormorant	*Phalacrocorax carbo*	At Risk - Relict	x	x	x
Little Black Cormorant	*Phalacrocorax sulcirostris*	At Risk - Naturally uncommon	x	x	x
Pied Cormorant	*Phalacrocorax varius*	At Risk - Recovering	x	x	x
cormorant sp.	*Phalacrocorax sp.*		x		
Great Egret	*Ardea alba*	Threatened - Nationally critical	x		
White-faced Heron			x	x	x
Royal Spoonbill	*Platalea regia*	At Risk - Naturally uncommon	x		
Swamp Harrier			x	x	
Morepork				x	
Sacred Kingfisher			x		x
New Zealand Kaka	*Nestor meridionalis*	At Risk - Recovering	x		
Yellow-crowned Parakeet	*Cyanoramphus auriceps*	At Risk - Declining	x		
Eastern Rosella			x		
Tui			x	x	x
New Zealand Bellbird			x		x
Gray Gerygone/warbler			x	x	x
Whitehead			x	x	
Australian Magpie			x	x	x
New Zealand Fantail			x	x	x
Rook			x		
North Island Robin	*Petroica longipes*	At Risk - Declining		x	
Tomtit			x		
Eurasian Skylark			x	x	
Welcome Swallow			x	x	x
Silvereye			x	x	x
European Starling			x	x	x
Common Myna			x	x	x
Song Thrush			x	x	
Eurasian Blackbird			x	x	x
Dunnock			x	x	
House Sparrow			x	x	x
New Zealand Pipit	*Anthus novaeseelandiae*	At Risk - Naturally uncommon	x		
Common Chaffinch			x	x	x
European Greenfinch			x	x	x
Lesser Redpoll			x	x	x
European Goldfinch			x		
Yellowhammer			x		x

Appendix V: Overall concept plan for 1861 Ongaroto Road, Whakamaru (source: Mansergh Graham Landscape Architects)

Site Total: 316891m²
Lots Total Area: 257350m²
Vegetation covenants: 55846m²
Road Reserve: 31865m²
ROW Total: 7834m²
Reserve Total:19842m²
Total area of ecological planting: 63312m²
(Reserves (excluding F & H) + Vegetation covenants)

Reserve A: 474m²
Reserve B: 910m²
Reserve C: 1159m²
Reserve D: 2632m²
Reserve E: 1408m²
Reserve F: 11923m²
Reserve G: 883m²
Reserve H: 453m²

Note:Areas are rounded to the nearest meter

Appendix VI: Bat tree felling protocols

The following protocol applies to all trees to be felled. These protocols follow industry best practice[20].

Protocols for minimising the risk of felling bat roosts

(Bat Roost Protocols (BRP))

Version 2: October 2021 approved by the New Zealand Department of Conservation's Bat Recovery Group

The use of these protocols should be a final step in the avoid/remedy/mitigate hierarchy. Avoidance of felling bat roost trees should be the first step in any project.

Purposes of this document:

1. To outline why protection of roosts is important for the persistence of New Zealand bats and why removal of known and potential roosts should be avoided.
2. Where roost removal cannot be avoided, to set out the minimum requirements and protocols for removing trees in areas where bats are present, to minimise the risk of killing bats.

This protocol does not eliminate the risk to bats of death or injury because bats or active bat roosts can be missed. The best way to eliminate risk of felling an active roost is to avoid felling any known or potential roosts.

Context

The status of New Zealand bats

New Zealand's two extant bat species (pekapeka) are classified as threatened.

Long-tailed bats are classified as 'Nationally Critical' because the species is likely to have a 70% decline in numbers within three generations.

Lesser short-tailed bats comprise three subspecies. The northern subspecies is classified as 'Nationally Vulnerable' because there are 1000-5000 mature individuals and the predicted decline in numbers is 10-50% within three generations. The central subspecies is 'Declining' because there are 20 000-100 000 mature individuals, and the predicted decline is 10-50% within three generations. The southern subspecies is 'Recovering' because there are 1000-5000 individuals, and the predicted increase is >10% within three generations.

Threats to bats

This document deals specifically with roost protection; however, roost protection is only part of the wider issue of habitat loss. Habitat loss through land clearance, habitat degradation, fragmentation and disturbance and loss of roosts reduces roosting, foraging and socialising areas. Individual bats and colonies are also threatened by the local felling of individual trees.

Bats have large home ranges which can include unprotected peri-urban habitat. Protecting habitat and maintaining connectivity of vegetation are crucial for bats being able to persist and flourish in the environment.

Predation and competition by introduced predators: mustelids, rats, cats, and possums have all been implicated in the decline of bats[1].

Roosts are critical to the survival of bats

Roosts are where bats gather to shelter during the day and at night. They are used to socialise, mate, give birth, and raise young. Bats have very specific requirements when they are choosing roosts and are not just choosing any

[1] O'Donnell CFJ; Christie JE; Hitchmough RA; Lloyd B; Parsons S 2010. The conservation status of New Zealand bats, 2009. New Zealand Journal of Zoology 37: 297– 311.

1

[20] Department of Conservation. 2021. Protocols for minimising the risk of felling bat roosts (Bat Roost Protocols (BRP)) Version 2: October 2021 approved by the New Zealand Department of Conservation's Bat Recovery Group

tree[2]. The specialised features of roosts make them rare and almost irreplaceable in any landscape or habitat type except over very long-time frames. People sometimes falsely suggest that "bats can just move to another tree". This is not the case, particularly where trees suitable as roosts are limited[3].

Bats demonstrate high site fidelity to existing roosts and their specific roosting areas, and they move on a rotation among these. Because roost trees are likely to be rare, and are occupied to fulfil specialised requirements, felling breeding roost trees even when bats are absent will have a significant negative effect. If the number of suitable roosts and their surrounding habitat is reduced in the landscape, bats are forced to use roosts that are less thermally efficient. This means they will use more energy to survive, resulting in reductions in survival and lower reproductive success. In this way, roost removal is likely to result in higher risk of local extinction.

Bats can roost in native or exotic vegetation – therefore it should not be presumed that exotic species such as pine trees will not support bats. Roosts, including maternity roosts, have been found in many exotic species including, but not limited to, pine, poplar, oak, and acacia species, black locust, willow, eucalyptus and Tasmanian blackwoods.

Bats are at risk of being injured or killed when trees are felled

If a tree is felled with a bat in it, it is highly likely that the bat will be injured or killed, although this may not be apparent at the time because injuries, such as bruises and fractures, which would hinder bats' ability to fly well, may take time to be obvious.

The highest risk of injuring or killing bats or trapping them within their roosts is when they are heavily pregnant, when young are still dependent on the roost (late November – February) and when bats are more likely to be in torpor (May – September). Heavily pregnant bats are slower and less agile, and young bats cannot fly, so their chances to escape are reduced when roost trees are felled. Also, it is possible that if the larger female-dominated maternity roosts are cut down when females are raising their young to independence (October-March), a whole colony of bats could be destroyed at one time.

During winter bats use torpor (a type of hibernation) more often than during other times of year, so if trees are cut down in winter, bats may be unable to rouse from torpor and to fly away in time to escape. Additionally, it is significantly harder, sometimes impossible, to detect bats roosting in trees during torpor. For these reasons, trees with potential bat roost features must not be cut down in winter. Bats also use torpor for short periods during summer, for example, if the weather gets cold, so the risk of killing or injuring bats that cannot escape falling trees exists at any time of the year.

Bat roost protocols and the RMA

The occurrence of bats and bat habitat is a matter of 'significance' under Section 6(c) of the Resource Management Act (RMA). Bat roost protocols have become a standard part of bat management plans that may be required under RMA consents. Where developments require consents, and bats (a threatened species) are present, the developments should 'Avoid' impacting bats and bat habitat. Bat roost protocols only attempt to minimise the number of bats killed by tree felling, therefore implementing bat roost protocols where bats are present should be considered a last resort after following the RMA hierarchy of "avoid, remedy, mitigate, offset, compensate".

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[2] Whilst we use the word tree frequently in this document, we acknowledge that bats also use non-tree vegetation as roosts and the terms tree and vegetation should be considered as interchangeable in the context of this document. We acknowledge that there are also non-vegetation roosts that are used and require protection. These include rocky bluffs, caves and occasionally buildings.

[3] Many references available, for example, Borkin KM; Parsons S. 2011. Sex-specific roost selection by bats in clearfell harvested plantation forest: improved knowledge advises management. Acta Chiropterologica 13(2): 373-383; Borkin KM; O'Donnell CFJ; Parsons S. 2011. Bat colony size reduction coincides with clear-fell harvest operations and high rates of roost loss in plantation forest. Biodiversity and Conservation 30; Sedgeley JA; O'Donnell CFJ 1999b. Roost selection by the long-tailed bat, *Chalinolobus tuberculatus*, in temperate New Zealand rainforest and its implications for the conservation of bats in managed forests. Biological Conservation 88:261–276; Sedgeley JA; O'Donnell CFJ 2004. Roost use by long-tailed bats in South Canterbury: Testing predictions of roost site selection in a highly fragmented landscape. New Zealand Journal of Ecology 28:1-18.

This protocol has therefore been framed following the RMA hierarchy by first focusing on the avoidance of effects, helping to identify and avoid the removal of roost trees, and to minimise the risk to bats of death or injury if avoidance is not possible. This approach is usually informed by gathering data on bats in the local areas and seeking advice from a competent bat ecologist.

Identifying and protecting *both active and inactive (i.e., trees used by bats at other times of year) roosts* by avoiding their removal is an important step in supporting the survival and persistence of bats.

Bat roost protocols and the Wildlife Act 1953

NZ bats are absolutely protected species under the Wildlife Act 1953. It is an offence to catch alive or kill, hunt, possess, molest, or disturb bats under the Act. Any projects where tree or vegetation removal overlaps with the occurrence of bats, there is a risk of killing or injuring any bats that may be present. Following the bat roost protocols minimises the chance of killing or injuring bats.

Bat roost protocol

When and how to use the protocol

Whenever vegetation removal is proposed in areas where bats are potentially present and where their habitat may be impacted, follow the decision tree (Figure 1) below as a guide to what sort of action should be undertaken. The decision tree is designed firstly to avoid felling bat roost trees, secondarily aimed at moving roost trees, and only if unavoidable, felling roost trees (but only once vacated).

None of the methods of inspecting roosts described below eliminates the risk of failing to identify bats when they are present. Therefore, techniques such as filling in cavities with expandable foam are not supported as a tool. This is because there is a risk of trapping bats that have not been detected within cavities. In addition, this method removes roosts from the landscape that bats are dependent on.

Definitions

Competencies: a set of competencies developed by the NZ Bat Recovery Group[4] to ensure that anyone working with bats is competent to do so. Contact bathandler@doc.govt.nz for a list of competencies and requirements to become an authorised competent bat worker.

Competencies referred to in this document:

2.1 Bagging storage, handling, measuring, weighing, sexing, aging, temporary marking and releasing appropriately:
For long-tailed bats: 50 individuals
For short-tailed bats: 50 individuals

3. High risk activities – Roost felling (all of these competencies include the understanding of what to do when bats are found during tree felling as per Appendix 6 of 'Initial veterinary care for New Zealand Bats' https://cdn.ymaws.com/www.nzva.org.nz/resource/resmgr/docs/other_resources/Initial_Vet_Care_NZ_Bats.pdf)

3.1 Assessing roost tree use using Automatic Bat Monitors - Demonstrate correct timing, placement, and interpretation of data for 10+ times according to DOC's Tree Felling Protocols.

3.2 Undertake roost watches/emergence counts at 10+ occupied roosts where the entrance is visible.

3.3 In at least two different forest/habitat types, including the forest/habitat type where trees are going to be assessed: evaluate 10+ potential roost features in trees (e.g., cavities, peeling bark, epiphytes).

Authorised competent bat worker: A bat worker who has met the required ethical standards to be registered as a competent, authorised bat worker by the New Zealand Bat Recovery Group for the work which they are undertaking.

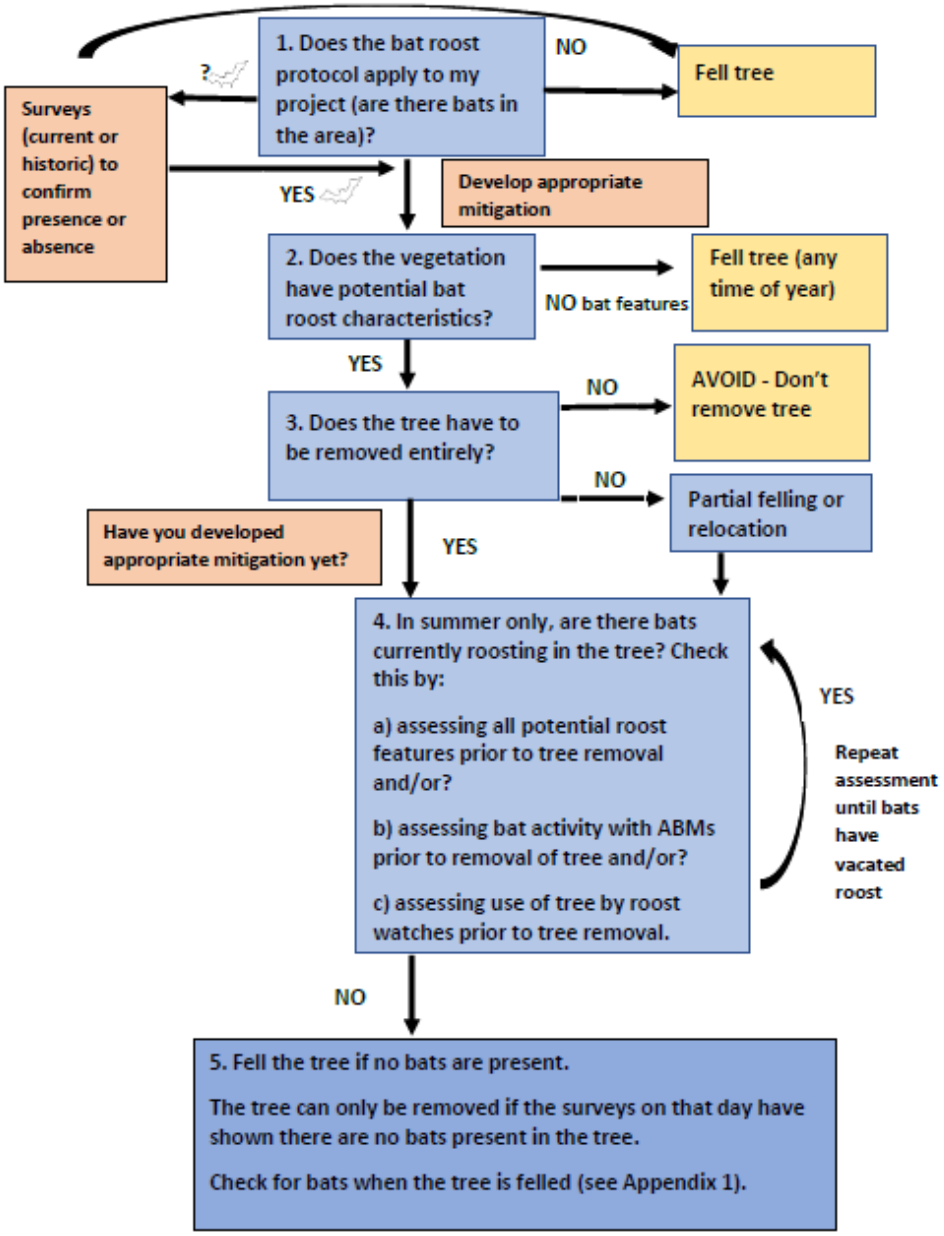
ABM: automated bat monitoring unit/detector

[4] A group of bat specialists that advise on bat issues and assess bat competencies

3

Figure 1. Tree removal in bat areas flow chart

Each numbered step relates to a step in the Decision Tool for Tree Removal. Follow each step fully in the text to work through the process.



Mitigation/compensation

If trees are felled and habitat lost, then compensation measures should be considered to address the adverse effects. What these measures should be is beyond the scope of this document. Provision of artificial roosts in the short-term and planting for the long-term are some of the methods commonly used in development projects, but their effectiveness is untested and a future research need.

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Step 3. Does the tree have to be removed entirely?	Response	Who can make this assessment?	When?
a) Is the only option to remove the tree entirely?	If yes, continue to step 4 If no, consider leaving the tree in place, cutting off specific limbs only or relocating the tree. If any felling, partial felling (where the part to be felled has potential bat roost features) or tree relocation takes place you **MUST** proceed to step 4. If a roost (active/inactive) is confirmed, then advice should be obtained at a project level in writing from DOC before proceeding.	Project leader	Any time

Notes for Step 3

Trees must only be relocated when bats are absent and when standard automated bat monitoring unit (ABM) weather conditions are met (see notes section 4b for appropriate weather conditions), and in consultation with an authorised bat ecologist with all competencies of level 3: 'High risk activities – Roost felling'.

Step 4. Are there bats currently roosting in the tree? (Follow a or b or c or a combination)	Response	Who can make this assessment?	When
a) Are potential features being used by roosting bats? A tree climber may be required to check all features (see notes for 4a below). If roost is occupied repeat 4a another day until roost is vacated.	If yes, **THE TREE MUST NOT BE FELLED UNTIL BATS HAVE VACATED IT.** If no, the tree can be removed on the day of the tree inspection following step 5. If bats continue to use the roost, then the tree must not be cut down until the bats leave the roost. At this point re-consider again whether this tree must be felled. Advice must be obtained at a project level in writing from DOC prior to felling the tree.	An approved person at Competency Level 3.3 or an experienced tree-climber (e.g., an arborist) working with an approved person at Competency Level 3.3. If the latter, the tree climber must provide information along with photographs or video footage, to the approved person at Competency Level 3.3 who assesses and decides whether the tree can be removed. If roosts are known or confirmed through this process, then this information must be communicated to the nominated DOC bat ecologist for this project.	October 1st to April 30th when the temperature is 7°C or greater at official sunset in the South Island or 10 °C or greater in the North Island.
b) Is bat activity recorded at any time during two consecutive, valid survey nights preceding tree felling[13]? At least two nights are required as it is possible for bats to enter or leave a roost without echolocating, or to not leave the roost for a night.	If yes (bats are detected), survey must continue on subsequent nights[14] until no bat activity is recorded for two consecutive nights (to indicate bats have left the area) prior to felling. **OR** roost features of each tree must be visually assessed via climbing as in 3. If bat activity is consistent in the area and 2 nights with zero bat passes cannot be obtained, Go to 4c or 4a. If no bats are detected for two consecutive nights, the vegetation can be removed on the day immediately following the survey nights using the method in 5.	An approved person at Competency Level 3.1	October 1st to April 30th and when conditions meet the requirements for standard ABM weather conditions (see 4b notes).
c) Are bats observed entering the vegetation? This involves watching vegetation to identify bats returning to or exiting roosts. It should only be used in combination with previous ABM monitoring (4b) (see notes 4c for method). At	If yes (bats are seen at either watch), it is a confirmed roost. Removal of a roost should be avoided to minimise effects	An approved person at Competency Level 3.2[15].	Between October 1st and April 30th only **AND** when weather parameters meet

[13] Le Roux et al (2013) found that in and around Hamilton "The longest consecutive monitoring period without bat detections at each site was three nights during winter." Le Roux et al 2013. New Zealand Journal of Zoology (2013): Spatial and temporal variation in long-tailed bat echolocation activity in a New Zealand city, New Zealand Journal of Zoology, DOI: 10.1080/03014223.2013.827125.

[14] Subsequent nights may be those immediately following bat detection or later dates.

[15] If more than one person is required for a roost watch at a tree, a minimum of one approved person at Competency Level 3.2 must be present on site for the duration of the roost watch to supervise.

least two nights are required as it is possible for bats to enter or leave a roost without being detected, or to not leave the roost for a night.	of vegetation removal on bats. Techniques used previously to ensure previously active roosts are no longer active have included the following: Watches must continue on subsequent nights until no bats are observed entering or exiting the roost for two consecutive nights (to indicate the roost is no longer active) prior to felling. If no bats are observed entering or exiting for two consecutive nights, the vegetation can be removed on the day immediately following the survey nights using the method in 5.		the roost watch requirements.

Notes for Step 4.

4a) Tree climbing and inspection

Care must be taken while climbing trees to avoid disturbing, removing or destroying tree features with bat roost potential such as sections of loose bark or cavities in dead wood. Using mobile elevated platforms can be a good option. Bats are less likely to be active over colder periods, so climbing to check whether bats are present in potential roost features must take place between October 1st to April 30th when the temperature is 7 °C [16] (South Is) or 10 °C (North Is) or greater at official sunset on the night previous to inspection.

A tree climber may be required to check all potential bat roost features:

- Can bats be seen? An endoscopic camera should be available for this step and every possible corner of each potential roosting feature inspected, i.e., cavity/crack etc. Cracks, holes, and splits may lead to cavities or may be superficial. A cavity may be wet indicating no/low potential as a bat roost.

[16] O'Donnell CFJ 2000. Influence of season, habitat, temperature and invertebrate availability on nocturnal activity of the New Zealand long-tailed bat (*Chalinolobus tuberculatus*). New Zealand Journal of Ecology 207-221.

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- Can bats be heard? Search of tree features should be accompanied by use of a hand-held bat detector. If bats are present and not in torpor, then detection of presence listening at 25 kHz (for social calls) and 40 kHz (for echolocation calls) may help to determine if long-tailed bats are present. Short-tailed bat social calls are often audible or detected at 25-27 kHz.
- Is guano present or urine staining?

4b) ABM survey work

Bat activity is to be recorded using ABMs. Location of ABMs must provide sufficient coverage to be able to determine if bat roosts are present in one or more of the trees[17]. 'Valid' survey nights must have the following features:

- Begin one hour before official sunset and end one hour after official sunrise.
- Temperature 10°C or greater for the first four hours after official sunset time for the North Island and 7°C for the South Island[18].
- Precipitation < 2.5 mm in the first 2 hours after official sunset, and < 5 mm in the first 4 hours after official sunset.

Prior to the commencement of surveys, ABMs must be checked for correct operation at a site where bat activity is known to be regular, or by using the DOC – Bat Recorder Tester (Tussock Innovation Ltd) phone app made for this and available from Google Play Store. Faulty or suspect ABMs must not be deployed, and ABMs must be redeployed if faults occur.

4c) Roost watches

The following weather conditions define a valid night for roost watches:

- Temperature greater than 10°C all night between official sunset and sunrise for the North Island and 7 °C for the South Island.
- Precipitation < 2.5 mm for each two-hour period between official sunset and sunrise

Roost watches should include the deployment of ABMs and analysis of data for the night of the roost watch.

Emergence watches

- Each tree must be watched initially from sunset until it becomes too dark to see by sufficient people to observe all potential exit points. This must be supported by the use of handheld detectors. The aim of emergence watches is to identify potential roost locations within the vegetation. Infra-red and thermal imaging cameras may be useful in this process.

[17] Department of Conservation-manufactured AR4 bat detectors are considered likely to detect long-tailed bats only over short distances i.e., up to 30-60 m distant from the detector (S. Cockburn, Department of Conservation, pers. Comm.). This is similar to detection distances of other detector types.

[18] South Island temperatures are based upon O'Donnell (2000) as above. North Island temperatures are based on data collected in Kinleith plantation forest, centred around Tokoroa, Central North Island; Smith D, Borkin K. 2017. Appendix B: Influence of climate variables on long-tailed bat activity in an exotic conifer plantation forest in the central North Island. P 136-145. In: Smith, D, K Borkin, C Jones, S Lindberg, F Davies and G Eccles (2017). Effects of land transport activities on New Zealand's endemic bat populations: reviews of ecological and regulatory literature. NZ Transport Agency research report 623. 249pp.

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Roost re-entry watches

The time when bats return to roosts can vary based on temperature and time of year.[19,20]

- Observers must then return the next morning and watch the tree to determine whether bats return to the vegetation.
- Roost re-entry watch timing should be based on patterns of activity recorded onsite with ABMs, i.e., as a guide watches should begin two hours prior to when the last passes were recorded on the ABMs on previous nights and finish one hour after official sunrise time. Where this information is not available and at minimum, watches shall begin two hours prior to official sunrise until one hour after sunrise. Infra-red and/or thermal imaging cameras may be useful as a supplementary tool in this process.

The methods above (Climbing and inspecting; ABM use and roost watches) can be implemented as in steps 4.

If bats are sighted, or sign detected, or a roost (active/inactive) is confirmed, the approved bat ecologist, as soon as possible, shall:

- Call the tree felling supervisor to inform them which affected tree(s) cannot be felled due to detection of bat sign.
- Send an email to the site manager, and a bat ecologist representing the council and DOC detailing the results of the survey and outlining the measures for protection or relocating the roost tree.
- A record (including photos) of any vegetation containing bat roosts shall be kept detailing the date; size, location and species of tree or other vegetation; roost type, e.g., cavity, peeling bark, broken branch; detail outlining how presence of bats was confirmed; the number of bats present; and species present, if known.

Step 5. Fell the tree if no bats present	**Response**	**Who can make this assessment?**	**When**
NB: Vegetation removal must take place on the day of tree inspection or the day immediately following night surveys that confirm that there are no bats present.			
a) If you have undertaken a visual inspection of the vegetation (following step 4a, then the vegetation can be removed **ONLY ON THE DAY OF INSPECTION** and meets the valid weather conditions (defined in notes 4c) at official sunset the day prior to inspection. If you have undertaken ABM surveys or roost watches 4b or 4c the vegetation can be removed **ONLY ON THE DAY IMMEDIATELY FOLLOWING SURVEY COMPLETION** (i.e., if the survey ends in morning the tree can be felled the same day only).		People who are familiar with the document shown in footnote[21], and physically able to check/inspect tree for signs of bats once felled.	When the inspection method chosen allows.

[19] Dekrout AS 2009. Unpublished PhD thesis. University of Auckland, New Zealand Pp 168.
[20] Griffiths R. 2007. Activity patterns of long-tailed bats (Chalinolobus tuberculatus) in a rural landscape, South Canterbury, New Zealand. New Zealand Journal of Zoology, 34:3, 247-258, DOI: 10.1080/03014220709510083.
[21] https://cdn.ymaws.com/www.nzva.org.nz/resource/resmgr/docs/other_resources/Bat_Care_Advice.pdf

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Trees must be inspected for signs of bats once felled and before removing from the site, if safe to do so. Follow Appendix 1 if bats are detected during vegetation removal.			

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Appendix 1. If bats are detected during tree relocation or removal

NB: Vegetation removal must take place on the day of tree inspection or the day roost watches or two consecutive nights of ABM data have confirmed that there are no bats present. If practical, trees are to be inspected for signs of bats once felled and before removing from site. People inspecting trees should be familiar with the Bat Care Advice document shown in footnote[22] and able to check/inspect tree for signs of bats once felled.

If during the felling of a tree bats are detected, felling of that tree must stop immediately if safe to do so, and DOC and an approved bat ecologist at Competency Level 2.1 must be consulted.

If bats do not fly away or are potentially injured/found on the ground, felling can only re-start once permission has been obtained from DOC after consultation with an approved bat ecologist at Competency Level 2.1.

If bats are detected once the tree has been felled, all further work must stop, and DOC and an approved bat ecologist at Competency Level 2.1 must be contacted. The felled tree must be thoroughly inspected by the approved bat ecologist for further bats.

If any bats are found on the ground or in the tree once felled, place the bat in a cloth bag in a dark, quiet place at ambient (or slightly warmer) temperature and take to a veterinarian for assessment as soon as possible. A maximum of two bats should be kept in one bag. After delivering the bat to the vet, contact an approved bat ecologist at Competency Level 2.1 in consultation with the vet and DOC (0800 DOC HOT, 0800 362 468).

Bats must be kept for three days under observation and must be kept out of torpor for this time. Additional detail is found at the links provided in this footnote[23]. Vets must euthanise bats whose injuries are causing suffering and are not likely to heal sufficiently to allow rehabilitation and return to the wild. The approved bat ecologist at Competency Level 2.1 and vet must consult with DOC to consider appropriate rehabilitation options where suffering is minimal and chances of return to the wild are high.

Euthanised bats or any dead bats (or bat parts) found must be handed to DOC.

[22] https://cdn.ymaws.com/www.nzva.org.nz/resource/resmgr/docs/other_resources/Bat_Care_Advice.pdf
[23] https://cdn.ymaws.com/www.nzva.org.nz/resource/resmgr/docs/other_resources/Initial_Vet_Care_NZ_Bats.pdf

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