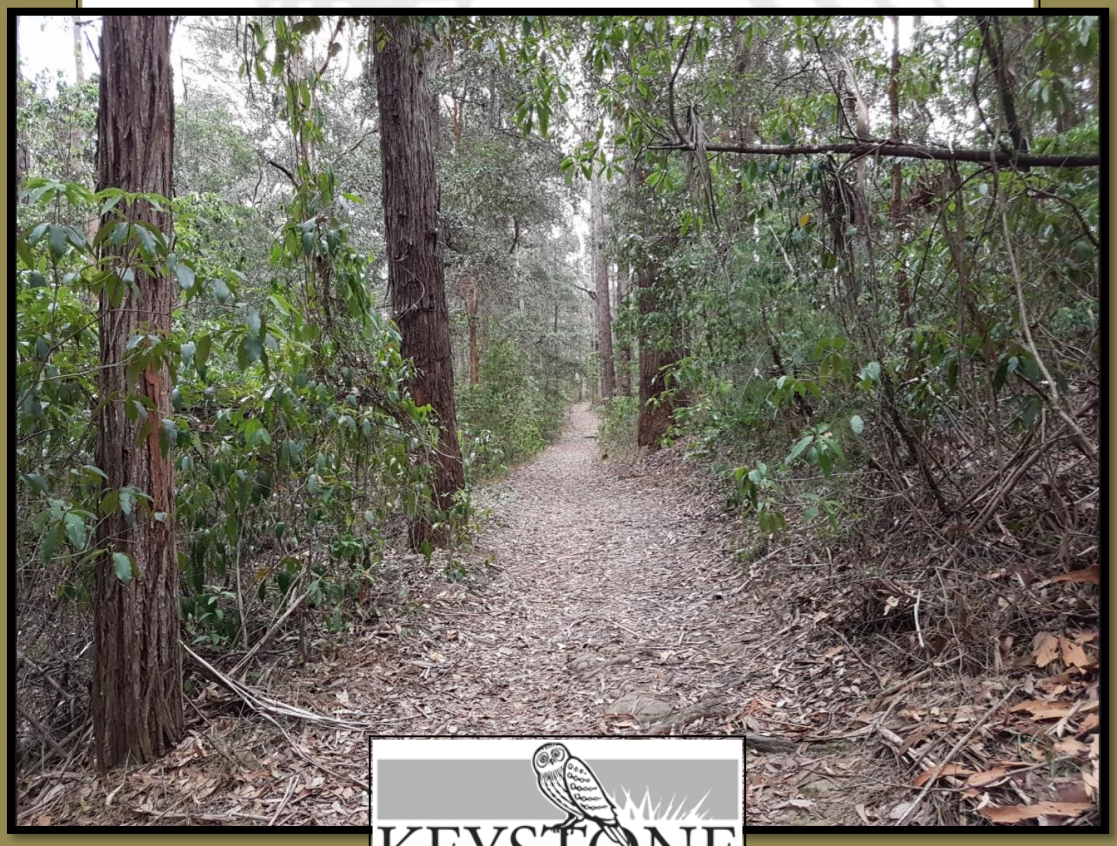
Biodiversity Assessment

55 Coonara Avenue
West Pennant Hills
The Hills LGA

For: Mirvac

REF: HiSC 15-770

8th February 2018



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Cover photograph: One of the existing walking tracks through Sydney Turpentine Ironbark Forest. These tracks link the site with the adjacent Cumberland State Forest and are regularly used by locals to walk their dogs.

Photo: E. Ashby, 29th December 2017

SUMMARY

Keystone Ecological has been contracted by Mirvac to prepare this Biodiversity Assessment in response to a request for further information regarding the Planning Proposal that will allow for residential redevelopment of the existing Business Park at 55 Coonara Avenue West Pennant Hills.

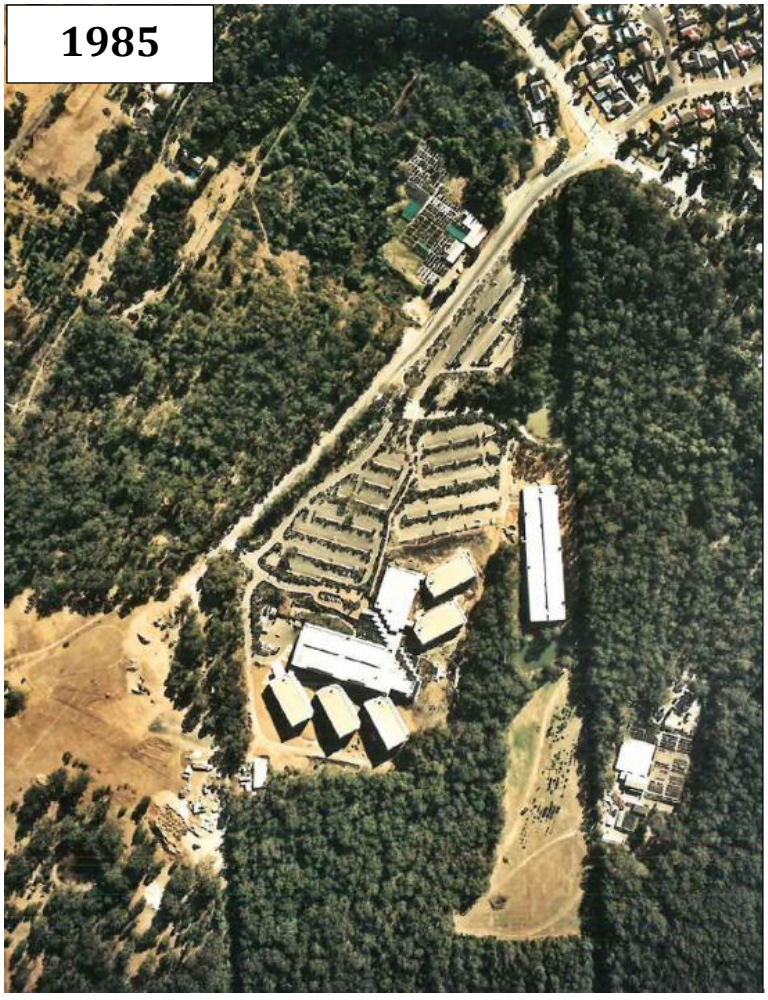
As per Council's request, this Biodiversity Assessment specifically addresses the likely impacts of the development on the most significant ecological features of the site, being:

- A large remnant of the Critically Endangered Ecological Community Blue Gum High Forest
- A large remnant of the Critically Endangered Ecological Community Sydney Turpentine Ironbark Forest
- *Ninox strenua* Powerful Owl realised breeding, roosting and foraging habitat

The potential impact was assessed for these communities and the owl per the planning framework in place at the time of submission, being the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999,* and the provisions of the NSW *Environmental Planning and Assessment Act 1979* and its interplay with the NSW *Threatened Species Conservation Act 1995.*

Flora and fauna surveys have been conducted and historical aerial photography analysed. The most important ecological features of the site have been so identified, and an acceptable footprint for development (including implementation of an Asset Protection Zone for bushfire hazard control) determined. The northern half of the subject site is currently developed as a Business Park and the proposed redevelopment is almost entirely confined to that existing footprint.

The site occupies almost 26 hectares. The Business Park development dates from the 1980s and is located mostly in the site's northern half. The built form, landscaped areas, drainage infrastructure and cleared areas now occupy 13.71 hectares.



SUMMARY

Prior to the development of the current commercial buildings and associated infrastructure, the site was used to grow citrus, and contained a series of large orchards, open paddocks, small buildings, and remnant bushland. The Business Park was located mostly within the already cleared parts of the site.

The development area was excavated prior to the construction of the office buildings and car parks. The building curtilage and the open car parks were then landscaped with Australian native trees. Given that the trees were planted in shallow excavations of sandstone, few have been or will be able to develop a mature form, and none have yet developed hollows. There is now little understorey in the landscaped areas, principally comprising canopy trees over ground covers, leaf litter or bare ground. Many areas support weed species or exotic plantings in the ground layer.

The remaining 12.12 hectares of the site are comprised of bushland of varying ages and disturbance history, with most being apparently remnant vegetation made up of the Critically Endangered Ecological Communities Blue Gum High Forest and Sydney Turpentine Ironbark Forest. These areas are in relatively good condition, exhibit structural complexity, encompass an entire topographic sequence from ridge to gully, and provide many habitat niches for fauna and flora. Importantly, they support many mature hollow-bearing trees, a scarce but important resource for hollow-dependant birds, bats, and arboreal mammals, including a number of threatened species. This area is currently zoned B7 business park and has no formal environmental protection in place.

It is proposed to dedicate the remnant and regrowth vegetation as a Stewardship Site, which is a permanent conservation covenant with tied funding for its conservation management in perpetuity. Conservation management is to be undertaken in accordance with an approved plan, and the actions and outcomes periodically audited by the Biodiversity Conservation Trust / NSW Office of Environment and Heritage. This arrangement will provide formalised access for the local community, and deliver certainty for the conservation of the forest, its habitats, and the species reliant on it.

SUMMARY

The site and the adjacent Cumberland State Forest comprise the core of the territory of a pair of Powerful Owls. Two of the five known nest trees are within the subject site, and the riparian corridor also contains potential roosting habitat.

All of the nest trees will be retained and protected, as will all of the potential roosting habitat. The entire site provides potential foraging habitat, with the highest quality habitat for its prey species being in the naturally forested parts, particularly for its most favoured prey, the Ringtail Possum. The landscaped areas contain the poorest quality foraging habitat (generally absent understorey, no hollow-bearing trees), interrupted by large areas of open hard stand, with lighting and human activity.

The areas of retained forest will be enriched and enhanced for the prey of the Powerful Owl, which will contribute to the amelioration of the temporary loss of potential poor quality foraging habitat in the landscaped areas surrounding the buildings and in the car parks. The landscaping proposed for the redevelopment will be informed by the need to reflect the surrounding endangered ecological communities, as well as the need to replace foraging opportunities for the Powerful Owl.

Potential impacts on the Powerful Owl have been avoided, minimised, and ameliorated by the following:

- Location of the development footprint in areas occupied by existing development;
- Implementation of a Landscape Plan that is informed by ecological advice;
- Observation of buffer zones to nest trees and roosting habitat;
- Imposition of controls for the timing of construction;
- Dedication of the remnant bushland as a Stewardship Site with an approved conservation management plan;
- Slow and careful removal of exotic species that provide roosting habitat and replacement with quick-growing natives;
- Enrichment of habitat for prey species;
- Imposition of traffic calming devices, signage, and education of residents;
- Prohibition of free-ranging Cats;
- Control of Dogs; and
- Use of design solutions to areas of potential collision (such as glass balconies).

The assessment of the likely impact on Sydney Turpentine Ironbark Forest and Blue Gum High Forest (both Matters of National Environmental Significance) pursuant to the EPBC Act 1999 concluded that a significant adverse impact is unlikely to occur.

The assessment of significance for the Powerful Owl (listed under the NSW TSC Act 1995) and the endangered ecological communities concluded that a significant impact is not likely to occur upon the threatened species, endangered ecological communities, or their habitats.

Therefore, neither a Referral to the Commonwealth Department of Environment and Energy or a Species Impact Statement are required.

In summary, the proposal is considered to deliver a “maintain or improve” biodiversity outcome by:

- locating the development in the existing developed area;
- introducing a protection mechanism for the remnant forest; and
- funded conservation management of the remnant forest in perpetuity.

Therefore, the Planning Proposal is supported on ecological grounds.

DEFINITIONS

Some terms require definition and largely include those as per the threatened species assessment guidelines (DECC 2007) for matters listed under NSW legislation.

Broader study area: the physical area within 10 kilometres of the subject site.
Composition: both the plant and animal species present, and the physical structure of the ecological community. Note that while many ecological communities are identified primarily by their vascular plant composition, an ecological community consists of all plants and animals as defined under the Threatened Species Conservation Act that occur in that ecological community.
Direct impacts: are those that directly affect the habitat and individuals. They include, but are not limited to, death through predation, trampling, poisoning of the animal / plant itself and the removal of suitable habitat.
Indirect impacts: occur when project-related activities affect species, populations, or ecological communities in a manner other than direct loss. Indirect impacts can include loss of individuals through starvation, exposure, predation by domestic and/or feral animals, loss of breeding opportunities, loss of shade/shelter, deleterious hydrological changes, increased soil salinity, erosion, inhibition of nitrogen fixation, weed invasion, fertiliser drift, or increased human activity within or directly adjacent to sensitive habitat areas.
Life cycle: the series or stages of reproduction, growth, development, ageing and death of an organism.
Local area: the physical area within 2 kilometres of the subject site.
Local occurrence: the ecological community that occurs within the study area. However, the local occurrence may include adjacent areas if the ecological community on the study area forms part of a larger contiguous area of that ecological community and the movement of individuals and exchange of genetic material across the boundary of the study area can be clearly demonstrated.
Local population of a threatened plant species: comprises those individuals occurring in the study area or the cluster of individuals that extend into habitat adjoining and contiguous with the study area that could reasonably be expected to be cross-pollinating with those in the study area.
Local population of migratory or nomadic fauna species: comprises those individuals that are likely to occur in the study area from time to time.
Local population of resident fauna species: comprises those individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas (contiguous or otherwise) that are known or likely to utilise habitats in the study area.
Local population: the population that occurs in the study area. The assessment of the local population may be extended to include individuals beyond the study area if it can be clearly demonstrated that contiguous or interconnecting parts of the population continue beyond the study area, according to the following definitions.
Locality: the same meaning as ascribed to local population of a species or local occurrence of an ecological community.
Risk of extinction (community): the likelihood that the local occurrence of the ecological community will become extinct either in the short-term or in the long-term as a result of direct or indirect impacts on the ecological community and includes changes to ecological function.
Risk of extinction (population): the likelihood that the local population will become extinct either in the short-term or in the long-term as a result of direct or indirect impacts on the viability of that population.
Study area: the subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly. The study area should extend as far as is necessary to take all potential impacts into account.
Subject site: the area directly affected by the proposal.
Viable: the capacity to successfully complete each stage of the life cycle under normal conditions.

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1 INTRODUCTION

1.1 Background

Keystone Ecological has been contracted by Mirvac to prepare an assessment of the ecological features and likely impacts of a proposed development upon specific nationally and state listed flora and fauna and their habitats at 55 Coonara Avenue, West Pennant Hills in The Hills Shire Local Government Area (LGA).

The proposed development is part of a Planning Proposal that has been the subject of a Gateway Determination (dated 31st October 2017). That Determination was subsequently reported on by Council (letter dated 21st November 2017), and considered by Council (agenda and minutes of 12th December 2017 meeting).

Specifically, Gateway Condition 1(g) states:

> *"update the planning proposal as required to ensure the following matters are addressed:*
> *1. ecological values (flora and fauna);"*

Requirements for this condition are further explained in the Gateway Report, page 12:

> *"... the Department is satisfied adequate consideration and assessment of the sites ecological features has been prepared to support this proposal proceeding to Gateway Determination. It is noted however that a revised Ecological Assessment will need to be submitted to reflect the current lower yield of 600 dwellings.",* and
>
> *"It is also noted that detailed assessment of potential impacts on threatened species and EEC areas of the site will be subject to a detailed merit assessment as part of consideration of a future development application."*

Council's letter of 21 November 2017 states:

> *"To resolve the raised ecological issues the following is needed:*
> • *Additional information to demonstrate how remnant and regrowth Blue Gum High Forest & Sydney Turpentine Ironbark Forest will be retained and protected under a secure conservation agreement;*
> • *Further assessment of the potential impacts to the resident Powerful Owls based on a scheduled site meeting and potential Master Plan approaches. This should include:*
> *a) A site meeting to be arranged to accurately determine the location of the IBM nest tree/s and whether changes are needed to site layout;*
> *b) Revised detailed impact assessment for powerful owls during all stages of the development e.g. demolition, construction and occupation, based on the confirmed nest tree location;*

c) Detailed impact assessment of sports field lighting and potential light spill into owl nest tree territory;
d) Assessment of increased risk of vehicle strike and window collisions; and
e) Species Impact Statement where the proposal cannot be amended to avoid a significant impact to the Powerful Owl."

This Biodiversity Assessment (BA) is a response to those requests.

In relation to Council's item c) it is noted that Mirvac's Planning Proposal does not include sports field works, so this item has not been addressed here. It is understood that embellishment of the 2.494 hectare public open space area will be designed and constructed by Council following dedication of the land parcel.

Keystone Ecological has provided previous reports as part of the Planning Proposal process. The first report (*Development Constraints and Opportunities* Ashby 2016) identified the ecological features of the site and their constraints to development; that analysis was fundamental to the definition of a developable area. The second report (*Revised Ecological Assessment* Ashby and McTackett 2017) further explored the resultant Masterplan's likely impact on those important features.

Those previous reports, as well as additional investigations, are relied upon for this BA. In general, the following standard procedures guided this BA:

1. Review of the existing literature and information currently available for the subject site and general locality to determine issues for consideration;
2. Flora survey to identify species and vegetation communities present on the subject site;
3. Fauna survey to identify species present or likely to use the subject site;
4. Assessment of the conservation value of the species and communities recorded or identified with potential to occur on the subject site. This includes assessment of the condition of vegetation communities and the value of the subject site as fauna habitat;
5. Analysis of the likely significance of the impacts of the proposed action in accordance with Commonwealth and State legislative requirements and local guidelines on target communities and species; and
6. Identification of specific measures that may provide for amelioration of likely impacts upon the native flora and fauna of the subject site.

1.2 The Site and the Proposal

The subject site is located at Lot 61 DP 737386, 55 Coonara Avenue, West Pennant Hills, in The Hills LGA. It lies in the Sydney Basin Bioregion in the Cumberland Catchment sub-region. The approximate centre of the site is at grid reference 318036 E 6264363 N, on the Hornsby 1:25,000 topographic map.

The subject site is part of a partially-fragmented, partially natural forest in an otherwise urban landscape. It is close to other patches of native vegetation in the local area such as Lane Cove River

National Park to the north east, and Bidjigal Reserve to the south west. It is a large lot (25.83 hectares), in an area otherwise dominated by residential development. It is adjacent to another large holding (Cumberland State Forest), that together comprise over 60 hectares of ridge, slope and gully habitats. Aerial photography shows that these two sites are mostly vegetated, with buildings and roads nestled in amongst the urban forest.

The site is at its highest at its northern point (170 metres ASL), falling away to the south to its lowest point at its south western corner (100 metres ASL). The northern half of the site – the developed half – has a generally south east facing slope. An unnamed tributary runs diagonally across the bottom half of the site, which is dominated more or less by a south west facing slope. The unnamed tributary meets Darling Mills Creek approximately 450 metres to the south west of the site. Darling Mills Creek runs approximately parallel to the site's southern boundary.

The location and extent of the subject site is shown in Figure 1. The distribution of vegetation and development in the local area context is shown in Figure 2. A closer view is provided at Figure 3, and the site is illustrated in Photographs 1 to 20.

Historical land use is demonstrated in aerial photography from 1943, where it shows the site was an orchard (see Ashby 2016). This orchard was still a going concern in the early 1980s at the time of its redevelopment as headquarters for IBM (personal communication, David Louden, Landscape Architect for the IBM project). The pattern of clearing established for the orchard was largely mirrored by the IBM development, although the landscape was altered considerably with deep excavation, substantial terracing down the slope, the building of a perimeter roads, and the establishment of two dams and other stormwater management infrastructure (see Figure 4).

Office buildings fan out from a central L-shaped building, but the current built form is overwhelmingly dominated by three large open air car parks to the north of the office blocks, a smaller one to the south on the opposite side of the creek, and a multi-level covered car park on the site's eastern boundary.

The open car parks were divided up by a series of narrow and shallow excavated troughs that were back-filled with (probably) 200 millimetres of soil and (probably) 500 millimetres of mulch, within which shade trees were planted (personal communication David Louden). These effectively formed impermeable sandstone containers - not designed to accommodate the growth of large trees, but instead designed by engineers for civil works. Together with the impact of the surrounding hard surfaces (e.g. heat generation, further restriction of root growth, prevention of percolation of water, prevention of gaseous exchange), and the addition of polluted runoff, tree growth has been constrained (see Photographs 4 and 5).

The areas surrounding the buildings were extensively landscaped, principally using Australian native plants, with some of the species selection guided by the nursery staff at the adjoining Cumberland State Forest (personal communication David Louden). Some parts of the natural riparian area adjacent to the buildings were "enriched" with plantings of tree ferns and other terrestrial ferns, and understorey plantings were generally restricted to fast-growing species such as *Acacia* (probably *fimbriata*) (personal communication David Louden).

The current leases on the buildings are due to expire in 2019, and a campus-style business park in an otherwise suburban area is no longer viable. Therefore, Mirvac has proposed a residential redevelopment for the site. The current proposal is for 600 dwellings, made up of 200 houses and 400 larger apartment types, stepping down the slope from Coonara Avenue. The development will be publicly accessible and include public community facilities (including a playground and community facility building), and landscaped parks and gardens. The existing cleared area near the southern car park is to be dedicated to Council for future development as a playing field.

As the site is bushfire-prone, the residential development is to be protected from the adjacent bushland hazard by the implementation of an Asset Protection Zone (APZ) around the development's boundary. This is to have a variable width of between 18 and 39 metres, as detailed in previous reports. To minimise environmental impact, the APZ will take advantage of the existing perimeter road, and will be located entirely outside of the protected riparian zone associated with the unnamed tributary.

Figure 5A shows the Masterplan overlain on the existing footprint, demonstrating that the proposed development area is almost entirely restricted to the current developed footprint. Figure 5B shows the proposed APZ.

Previous investigations by others (OEH 2013, The Hills Shire Council 2008) have identified Blue Gum High Forest (BGHF) and Sydney Turpentine Ironbark Forest (STIF) on site (see Figure 6). The earlier reports by Keystone Ecological also highlighted the presence of these important vegetation communities. The remaining areas are of high conservation value and are proposed to be dedicated as a Stewardship Site, under the provisions of the *Biodiversity Conservation Act 2016*.

This is currently the subject of a separate investigation and report per the Biodiversity Assessment Method 2017 (*Biodiversity Stewardship Site Assessment Report*, Ashby and McTackett in preparation).

2 LEGISLATIVE BACKGROUND

The criteria used to assess likely impacts upon threatened species, populations or EECs varies between the Commonwealth and State jurisdictions. The following describes the legislative requirements for each level.

2.1 Commonwealth

The *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* is a nationally applicable Act that is administered by the Department of Environment and Energy. This Act requires approval for actions that are likely to have a significant impact on Matters of National Environmental Significance (MNES).

There are seven MNES that are triggers for Commonwealth assessment and approval. These are:

1. World Heritage properties;
2. National Heritage places;
3. Ramsar wetlands of international importance;
4. Nationally threatened species and communities;
5. Migratory species;
6. Nuclear actions; and
7. Commonwealth marine environment.

Threatened species and ecological communities are listed under Part 13, Division 1, Subdivision A of the EPBC Act (1999). Migratory species are listed under Part 13, Division 2, Subdivision A of the Act.

The Department of Environment and Energy identifies the following:

> *"Under the EPBC Act a person must not take an action that has, will have or is likely to have a significant impact on any of these matters of NES without approval from the Commonwealth Environment Minister. There are penalties for taking such an action without approval.*
>
> *In general, an action that may need approval under the Act will involve some physical interaction with the environment, such as clearing native vegetation, building a new road, discharging pollutants into the environment, or offshore seismic survey.*
>
> *If, following a referral, it is determined that an action is likely to have a significant impact, and approval is therefore required, the action is called a 'controlled action'. The proposal will then undergo a formal assessment and approval process, and cannot proceed unless approval is granted.*
>
> *If it is determined that an action is not likely to have a significant impact, then the action is not a controlled action. Approval under the EPBC Act is not required and the action may proceed, subject to obtaining any other necessary permits or approvals."*

2.2 State

Although the *Biodiversity Conservation Act 2016* commenced on the 25th August 2017, the transitional arrangements allow for the former planning provisions to apply to projects that were lodged prior to commencement, but are yet to be finalised. This Planning Proposal process began in 2015 and an application formally lodged in mid-2017.

The ***Environmental Planning and Assessment Act 1979 (EPA Act)*** sets out seven factors in Section 5A that require consideration in terms of the likely significance of the impact of an action. This Section 5A Assessment is known as an Assessment of Significance, or informally as a 'seven part test'.

For the purposes of this Act and, in particular, in the administration of sections 78A, 79C (1) and 112, these seven factors must be taken into account in deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats as listed under the *Threatened Species Conservation (TSC) Act 1995* and *Fisheries Management (FM) Act 1996.* If the application is for development on land that is, or is a part of, critical habitat, or is likely to significantly affect threatened species, populations or ecological communities, or their habitats, a Species Impact Statement must be prepared.

This Biodiversity Assessment considers these factors in accordance with the aforementioned legislative requirements. It also provides conclusions in regard to the necessity for a Species Impact Statement.

3 FLORA SURVEY AND RESULTS

3.1 Survey Methods

Prior to the site survey, and in addition to a literature review, the following was carried out:

1. Colour aerial photography was interpreted to delineate preliminary vegetation community boundaries and areas of disturbance on site.
2. A search of the *EPBC Act 1999* database using the Protected Matters Search Tool on the Department of the Environment and Energy website (www.environment.gov.au/erin/ert/epbc/index.html) was completed. The search area was confined to a 10 kilometre radius of the site. This identified species of conservation significance under the *EPBC Act 1999* that may require habitat assessment or targeted survey.
3. The online component of the OEH Wildlife Atlas (http://www.bionet.nsw.gov.au/) was interrogated for an area confined to a 10 kilometre radius of the site. This search provided valid records of species of threatened flora within the locality.
4. PlantNet, the online database of the National Herbarium of NSW at the Royal Botanic Gardens was also interrogated (http://plantnet.rbgsyd.nsw.gov.au/floraonline.htm) for rare or threatened species that have been recorded in the locality.
5. The Atlas of Living Australia (http://www.ala.org.au/) was interrogated for all threatened plant species recorded within 10 kilometres of the subject site. As well as records held by PlantNet and the OEH Wildlife Atlas, this online database also contains records from other institutions (such as State Forests of NSW) that may not otherwise be displayed.
6. Further investigation of potentially-important flora collections were made using Australia's Virtual Herbarium (http://avh.chah.org.au/), which makes available additional detail such as photographs of specimens, data from specimen labels, and more accurate locations.

Additional site investigations for this Biodiversity Assessment were undertaken on 12th, 29th and 31st December 2017. Prior site survey occurred in June 2014, September 2015, and September 2017.

Floristic survey was intended to characterise the 10 Habitat Types identified in the constraints assessment, and aid in further definition of the natural vegetation types present and their distribution.

Survey was carried out by identification of all species encountered during targeted random meander, as well as in 6 full floristic quadrats, each of 400 square metres. The locations of the December 2017 flora survey activities are shown in in Figure 7.

Specimens were collected for later identification of plants not readily identifiable in the field. Such specimens were identified according to Harden (1990, 1991, 1992, 1993) and the interactive flora (Flora Online) provided online by NSW National Herbarium of the Royal Botanic Gardens (http://plantnet.rbgsyd.nsw.gov.au/floraonline.htm).

3.2 Survey Limitations

All surveys have inherent limitations as they can only ever represent a sample in time and place of the site's flora.

Although each of the 10 Habitat Types previously identified were sampled by way of random meander, the flora survey was concentrated in the naturally-forested areas. Thus, a full species list of exotics and planted specimens has not been provided.

Besides the unavoidable sampling bias to the area surveyed, in this instance, the results of survey may also be constrained by recent rainfall and season of survey. Conditions have been very dry, with significant wilting evident in the vegetation. The season of survey also influences the plant species that may be detected: many grasses, for example, can only be identified when they are flowering and fruiting; many orchids can only be detected when they are flowering. However, for the flora species of interest for this site, the season and method of survey were appropriate.

3.3 Floristic Composition

In total, 69 species were recorded on the subject site, comprising:

- 54 locally-native, naturally-occurring species
- 13 exotic species
- 1 locally native species that had been planted; and
- 1 native but not locally native species that has been planted.

A further 78 species (of which 42 are locally-native) have been reported from Cumberland State Forest in habitats similar to those of the subject site.

A full species list, including those observed in Cumberland State Forest by others, is provided in Table 4.

At a species level, the natural vegetation of the site is not very diverse, with only 69 species recorded. However, at a higher level it is quite diverse, with those 69 species occurring in 43 families. Although the 3 most dominant families provide 25% of the species recorded (Poaceae: 4 native, 1 exotic; Myrtaceae: 6 locally native, 1 from the North Coast; Oleaceae: 1 native, 4 exotic), the vast majority of the families (93%) are represented by only 1 or 2 species.

The site also contains many serious weeds, some of which are currently regarded as Weeds of National Significance and were, until the recent repeal of the *Noxious Weeds Act 1993*, listed as Noxious Weeds. Some of the most serious weeds are those that are able to transform a vegetation community, and the habitats it provides to fauna. The transformer weeds observed on the subject site include *Lantana camara* Lantana, both Privets (*Ligustrum sinense* Small-leaved Privet, *Ligustrum lucidum* Large-leaved Privet), and *Olea europaea* subsp. *cuspidata* African Olive.

In some moist forests, Lantana has been implicated in the development of Bell Miner Assisted Dieback (BMAD), which is a listed Key Threatening Process. BMAD has been observed (and studied) in Cumberland State Forest (for example, see Stone and Simpson 2006). In essence, high numbers of Bell Miners chase out other birds and encourage large populations of sap-sucking insects in the tree canopies. Some tree species (e.g. *Eucalyptus saligna* Sydney Blue Gum) are particularly susceptible to the insect attack, and may die as a result.

This ecological disruption is partially the result of a dense understorey of Lantana, within which the Bell Miners nest. Recommended management actions include control of Lantana, and replacement with a more diverse natural understorey.

Both Privet species and African Olive produce a large number of shiny black fruits that are very attractive to birds. They are therefore spread far and wide, germinate readily, and have the capacity to entirely dominate understorey, and eventually canopy. Unchecked, such species will entirely replace the native vegetation, such as occurred at Mt Annan Botanic Garden.

3.4 Vegetation Types

Previous investigations by Keystone Ecological established the presence of 10 Habitat Types, based largely on their land use history:

- Type 1 - built form on excavated land;
- Type 2 - hardstand with landscaped strips of 25-30 year old canopy trees on excavated land. Many of these trees are not locally-native;
- Type 3 - dams with surrounding remnant and regrowth canopy trees and a variety of significant weeds;
- Type 4 - landscaped patches surrounding the buildings with 25 year old canopy trees on excavated land;
- Type 5 – open grassy area that was historically part of the orchard and on natural landform;
- Type 6 - open grassy areas on natural landform but not cultivated;
- Types 7 and 8 - natural woody regrowth (up to 71 years old) of an area cleared prior to 1943, and in an area with natural landform;
- Type 9 - young regrowth evident in 1943 (therefore >71 years old) and maintained as bush since then, in an area with natural landform; and
- Type 10 – (probably) natural remnant bushland.

Their distribution are depicted in Figure 7.

The naturally vegetated parts (Habitat Types 7, 8, 9 and 10) contain species of both BGHF and STIF (see Table 4).

The numbers of native species in each quadrat were insufficient to apply the diagnostic rules developed by Tozer (2003) and Tozer et al. (2010) for definition of vegetation communities. This is a consequence of disturbance from weed infestations, combined with sustained dry conditions.

There is a high degree of overlap of species between these communities, and there is probably a broad ecotone between them, with only a gradual change from one to the other. BGHF is described as occurring mostly in the upper parts of the landscape on shale and shale lenses, while STIF occupies transitional zones in lower topographic positions between upper shales and lower sandstones.

However, some broad patterns are evident for the major canopy trees of each community (see Figure 7).

The canopy trees in the areas at the northern end of the site and in the south eastern corner are dominated by *Eucalyptus saligna* Sydney Blue Gum; *Syncarpia glomulifera* Turpentine is absent.

The understorey of the patches of 8, 9 and 10 at the northern end of the site are highly modified, being dominated by Large-leaved Privet (see Photographs 1 and 2). Notably, this is near the area in Cumberland State Forest identified as most impacted by BMAD (Stone and Jackson 2006), as *Eucalyptus saligna* Sydney Blue Gum is very susceptible to this disruption.

However, some native understorey remains, and some of the species recorded in the quadrats in these areas are characteristic of BGHF but not of STIF.

Therefore, the natural vegetation in the northern end of the site (including at least the head of the central gully) and the south eastern corner are described here as BGHF.

The central section associated with the shallow gully supports a high percentage of *Syncarpia glomulifera* Turpentine, but no *Eucalyptus saligna* Sydney Blue Gum. These parts of the site are generally in better condition, although there are patches of weeds such as Lantana, particularly in narrow sections and along the interface with cleared parts. These are best described as STIF.

The upper parts of the vegetation on the western side of the gully are less clear in their affinities, and more data will need to be collected to better determine the vegetation type in this area. Such work is currently being carried out as part of the Stewardship Site study. Given the degree of overlap in descriptions of Tozer et al (2010) and OEH (2013), the boundaries as published by OEH (2013) are adhered to for the purposes of this study (pending further clarification) and the western part described as BGHF.

3.5 Flora Species of Listed Conservation Significance

A desktop search of the Protected Matters Search Tool and the OEH BioNet Wildlife Atlas online database for the broader study area revealed 44 threatened flora species that have previously been recorded within 10 kilometres of the subject site (see Table 1).

It is considered that none of these species have a high likelihood to occur.

Tetratheca glandulosa has been listed in BioNet as occurring within Cumberland State Forest. However, this is in error as the specimen number quoted was actually collected from a site to the south west. This species is more abundant in the sandstone country to the east and north.

3.6 Vegetation Communities of Listed Conservation Significance

Of the Threatened Ecological Communities listed under the State TSC Act (1995) and Commonwealth EPBC Act (1999), the Office of Environment and Heritage Threatened Species website lists 19 Threatened Ecological Communities as occurring or potentially occurring in the Cumberland subregion, of which the subject site is a part.

Of these listed communities, two were observed on site during survey:

- Blue Gum High Forest: A total area of BGHF is 8.97 hectares, and was the dominant vegetation in the northern and south eastern corners of the site; and
- Sydney Turpentine Ironbark Forest: This community occupies the remainder of the naturally-occurring vegetation, totalling 3.15 hectares.

Their approximate distribution across the subject site are shown in Figure 7.

4 FAUNA SURVEY AND RESULTS

4.1 Survey Methods

Prior to the site survey, and in addition to a literature review, the following was carried out:

1. Colour aerial photography was interpreted prior to field survey to delineate preliminary vegetation community boundaries and areas of disturbance on site.
2. A search of the EPBC Act (1999) database using the Protected Matters Search Tool on the Department of the Environment and Energy website (www.environment.gov.au/erin/ert/epbc/index.html) was completed. The search area was confined to a 10 kilometre radius of the site. This identified species of conservation significance under the EPBC Act (1999) that may require habitat assessment or targeted survey.
3. The online component of the OEH Wildlife Atlas (http://www.bionet.nsw.gov.au/) was interrogated for an area confined to a 10 kilometre radius of the site. This search provided records of species of threatened fauna within the locality.
4. The Atlas of Living Australia (http://www.ala.org.au/) was interrogated for all threatened fauna species recorded within 10 kilometres of the subject site. As well as records held by the OEH Wildlife Atlas, this online database also contains records from other institutions (such as the Australian Museum) that may not otherwise be displayed.
5. The eBird Australia database (http://ebird.org/ebird/australia/map/) was interrogated for specific records regarding the Powerful Owl. This database often contains reliable records that are not lodged in the BioNet database and is the repository of at least some of the data generated by citizen scientists as part of the BirdLife Australia Powerful Owl Project (BLAPOP).

A desktop search of the broader study area revealed a large number of threatened and common fauna species that have previously been recorded within 10 kilometres of the subject site (see Table 2). The habitat requirements of these species were analysed against the habitats available on site, together with results from past surveys in the adjacent Cumberland State Forest. A short-list of target species was then used to determine the type of targeted survey to be undertaken.

Of particular interest is *Ninox strenua* Powerful Owl and its prey, as well as microchiropteran bats.

Targeted site investigations for this Biodiversity Assessment were undertaken on 12th, 29th, 30th, and 31st December 2017 (see Table 3). Fauna species were also surveyed opportunistically during all other site visits in June 2014, September 2015, and September 2017.

The techniques used accounted for the following fauna groups:

Amphibians

- Active listening; and
- Audio recording; and
- Opportunistic survey during all times on site.

Reptiles

- Opportunistic survey during all times on site.

Diurnal Birds

- Active listening; and
- Audio recording; and
- Opportunistic survey during all times on site.

Nocturnal Birds

- Audio recording; and
- Habitat searches.

Terrestrial mammals

- Habitat searches;
- Opportunistic survey occurred during all times on site; and
- Opportunistic scat searches.

Arboreal mammals

- Audio recording;
- Habitat searches; and
- Specific habitat assessment for preferred Powerful Owl prey. Assessments were made of the habitat quality for arboreal mammals, but particularly for *Pseudocheirus peregrinus* Common Ringtail Possum. These assessments were made at each of the 6 flora quadrats, as well as in 8 additional plots. The sampling was concentrated in the areas to be most impacted by the proposed development, being the car park and in the landscaped gardens. All habitat assessment plots were approximately 400 square metres in extent. Their locations are shown in Figure 11.

  The features measured included the presence / absence of hollow-bearing trees, the presence / absence of understorey, and the nature / condition of that understorey.

  The areas of highest value are those with a number of hollow-bearing trees of various types, together with a dense native understorey. The areas of least value are those with no hollow-bearing trees and no understorey. A 5-point scale from 0 to 4 was established for understorey, and a point added to each plot if appropriate hollow-bearing trees were present:

  0 – little or no understorey
  1 – mid-dense exotic understorey
  2 – mid-dense native understorey
  3 –dense exotic understorey
  4 –dense native understorey

Megachiropteran bats

- Audio recording.

Microchiropteran bats

- Recording of microbats occurred from dusk to dawn during survey using 2 x Anabat Express at 2 locations. Microchiropteran bat calls were analysed using the Anabat 5.1 software package and compared to a known call library (Pennay et al. 2004).

4.2 Survey Limitations

The survey methods and target species were constrained by the scope of works, time of year, weather and the level of human activity on the site. Therefore active trapping for terrestrial or arboreal species was not undertaken. Also, comprehensive long-standing survey in the adjacent Cumberland State Forest by others (such as BirdLife Australia, Cumberland Bird Observers Club, State Forests scientific staff) has already established the presence of many of the species of interest (Powerful Owl, arboreal species known to serve as prey for the Powerful Owl, microbats), and so additional survey was considered unnecessary.

Nevertheless, it is an acknowledged limitation that, no matter how much effort or expertise is employed, not all species that use a site will be recorded during ecological survey. For many fauna species, this is due to their mobility, cryptic nature and unpredictable movement throughout their habitat. In addition, migratory species may be present on the site at some times of the year, and absent at others. In addition to ecological reasons, environmental factors (such as weather, drought and bushfire) may impact on the type and number of species recorded within a site at any one time.

4.3 Survey Results

A complete list of the species recorded on the subject site for this survey and in the adjacent State Forest is provided in Table 5.

Results are discussed here for the target fauna only.

4.3.1 Powerful Owl

Two short, faint calls of *Ninox strenua* Powerful Owl were recorded 5 minutes apart at dusk on 29th December. The even nature of each of the two hoots in each call indicates that it may be a male calling, and the timing indicates it may have been emerging from its roost. Unfortunately it is not possible to determine if the call was of a distant bird, or a very soft call from a bird close to the recording equipment.

The recording equipment was placed at the base of nest tree number 2, but there were no signs of recent use, such as whitewash or regurgitated pellets.

At this time of year, a successful breeding pair should have recently-fledged young with them out of the nest. However, no owlets were observed during survey, and there are no reports of such activity published by eBird or BirdLife Australia. By contrast, juveniles have been reported with one of the pairs at Terrys Creek Parklands in January 2018 (see Table 6). It is likely that the resident pair of Powerful Owls have again failed to breed.

4.3.2 Arboreal Mammals and other Powerful Owl Prey Species

Prey species considered here are Ringtail Possum, Brushtail Possum, Grey-headed Flying-fox, and medium-sized birds such as Rainbow Lorikeets.

The results of the habitat assessment for arboreal mammals are detailed in Table 7, and show that the habitat suitability for prey species is spread unevenly across the site. In general, the habitat of highest value is provided by the remnant forest (Habitat Type 10), with a complex native or exotic understorey, and a diversity of hollow-bearing trees. The habitat of least value is provided by the planted trees in the car parks (Habitat Type 2), where there is no understorey and no hollow-bearing trees.

However, not all of the landscaped areas are entirely lacking potential habitat for arboreal mammals. For example, sample site 15 (see Photograph 21) is located in Habitat Type 4 along the edge of the perimeter road, and has a dense and mostly native understorey. This is unlike most of the landscaped area (see Photographs 22 and 23 for more typical condition). The dense structure has arisen due to regular pruning of vegetation to prevent it impeding passing traffic. Such dense understorey habitat is preferred by Ringtail Possums for the establishment of nests sites, although no possums or dreys were observed.

Similarly, not all remnant areas on site support good habitat for prey species, again as a result of vegetation management. This is illustrated by the APZ on the western edge of the site. The understorey in this area is managed for bushfire hazard control (see sample site 13 and Photograph 20), and so it provides insufficient cover for the Ringtail Possum.

Nevertheless, it is judged that the site currently provides approximately 12.5 hectares of habitat suitable for the Ringtail Possum, of which approximately 0.5 hectares is within the landscaped parts of the site.

The Brushtail Possum is more of a generalist, not averse to moving across open ground, and is more able to exploit man-made landscapes. The area of habitat suitable available for this species is therefore greater than for the Ringtail, perhaps incorporating foraging habitat in the landscaped areas and, to a lesser extent, the trees planted in the car park. The area of foraging habitat suitable for Brushtail Possums may be up to approximately 20 hectares. However, sheltering and breeding habitat is still largely confined to the remnant bushland with appropriate hollow-bearing trees, probably occurring across approximately 12 hectares of the site.

Grey-headed Flying-fox is also a favoured prey item, and is known to forage on the eucalypt blossom in the adjacent Cumberland State Forest, and therefore likely to do so on the subject site. This species can occur seasonally in large numbers when good forage is available, and they are noisy and obvious. They also congregate in large camps, the nearest of which is at Parramatta Park (8.2 kilometres to the south west). All of the dominant Myrtaceae tree species on site are known to be exploited by the Grey-headed Flying-fox, especially *Eucalyptus saligna* Sydney Blue Gum in the summer, and *Syncarpia glomulifera* Turpentine in the spring. *Eucalyptus tereticornis* Forest Red Gum is amongst the car park plantings, which is also a favoured forage tree as it flowers in late winter when such resources are scarce.

Thus, all of the treed areas on site can be considered as potential foraging habitat for this prey species.

Potential bird prey species on site include Rainbow Lorikeets, a species that has adapted well to urban areas and bushland of the Sydney region. They also require native blossom for forage, as well as hollow-bearing trees for roosting and breeding. Other medium-sized parrots (such as Crimson Rosellas) are also likely to be taken by the Powerful Owl. Crimson Rosellas are more reliant on seed that Rainbow Lorikeets, although they will also feed on some tree blossom. It is also reliant on hollow-bearing trees for nesting.

All of the vegetation on site (including planted areas) can be considered potential foraging habitat for these prey species. Breeding habitat is restricted to the subset of remnant bushland with suitable hollow-bearing trees.

4.4 Habitat Value and Connectivity

The main fauna habitat features of the subject site are the sheltering and foraging resources provided by the woody vegetation, and the connectivity of the subject site to the adjacent Cumberland State Forest. Such a large area of relatively intact bushland is rare in the Sydney urban landscape.

Many hollow-bearing trees were identified across the site with hollows of various sizes and type (trunk, branch, basal, cracks) and orientations, thus providing potential roosting and breeding sites for a diversity of hollow-dependant fauna such as owls, small to large arboreal mammals and microchiropteran bats. No hollow-bearing trees were observed in the planted trees in the car park or landscaped curtilage.

The vegetation of the subject site contains a wide range of plant species, each offering different habitat elements to fauna. Dominant amongst the trees are species that provide potential nectar and pollen resources to bats, small mammals, birds and insects. Principal among these are *Eucalyptus saligna* Sydney Blue Gum, *Syncarpia glomulifera* Turpentine, *Eucalyptus pilularis* Blackbutt and *Angophora costata* Smooth-barked Apple.

However, not all of the trees areas are of equal value or quality. For example, despite the presence of potential foraging habitat for microbats amongst the car park trees, the survey equipment placed in the centre of the northern car park recorded fewer species and less activity than the equipment located in the remnant forest.

4.5 Fauna Species of Listed Conservation Significance

Results from the Protected Matters Search Tool and the OEH Wildlife Atlas online database searches revealed a number of listed species that may use the habitats of the site. Species of conservation significance recorded during survey are detailed in Figure 7, and their habitat requirements and likelihood to occur on site explored in Table 2.

A total of 4 or 5 fauna species of conservation significance were recorded on the subject site or near the subject site during survey:

1. *Ninox strenua* Powerful Owl
2. *Saccolaimus flaviventris* Yellow-bellied Sheathtail-bat
3. *Mormopterus norfolkensis* Eastern Freetail-bat
4. *Falsistrellus tasmaniensis* Eastern False Pipistrelle and / or *Scoteanax rueppellii* Greater Broad-nosed Bat

A further 7 fauna species of conservation significance have been recorded by others in the adjacent Cumberland State Forest in habitats similar to those that occur on the subject site:

1. *Hirundapus caudacutus* White-throated Needletail
2. *Apus pacificus* Fork-tailed Swift
3. *Lophoictinia isura* Square-tailed Kite
4. *Glossopsitta pusilla* Little Lorikeet
5. *Lathamus discolor* Swift Parrot
6. *Daphoenositta chrysoptera* Varied Sittella
7. *Artamus cyanopterus cyanopterus* Dusky Woodswallow
8. *Petroica phoenicea* Flame Robin
9. *Pteropus poliocephalus* Grey-headed Flying-fox

However, not all of these are regarded as having a high likelihood to occur on site – see Table 2 for analysis.

In addition, the following 4 species have been recorded within the broader study area and are considered to have a high likelihood to occur:

1. *Ninox connivens* Barking Owl
2. *Miniopterus australis* Little Bentwing-bat
3. *Miniopterus orianae oceanensis* Eastern Bent-wing Bat
4. *Pommerhelix duralensis* Dural Woodland Snail

As part of the Development Application process, specific development proposals will require impact assessment per the Biodiversity Assessment Methodology (2017) pursuant to the *Biodiversity Conservation Act 2016* and *Regulations 2017*, taking into account the fauna species and their habitats discussed above.

5 POTENTIAL IMPACTS AND AMELIORATION

A general principle of environmental management is to, in order of preference:

1. Avoid the impacts;
2. Minimise the impacts;
3. Mitigate the impacts; and
4. Compensate for residual impacts once all of the above options have been exhausted.

These have been embodied in the new *Biodiversity Conservation Act 2016*, and are applied here as best practice principles under the former planning provisions.

In order to minimise potential impacts, the proposed development and associated APZ are almost exclusively restricted to the existing developed footprint.

Overall, ecological impacts of the proposal arise primarily from the clearing of regrowth vegetation (and the loss of habitats contained therein); and disturbances arising during construction (noise), and occupation (noise, lights, traffic, predation).

These potential impacts and their amelioration are further explored below.

5.1 Clearing and Disturbance of Vegetation

The potential impact on the vegetation comprises:

- The area of permanent loss of vegetation within the footprint itself; and
- The ongoing vegetation reduction within the vegetated parts of the APZ.

Areas of impact for each vegetation community are detailed in the table overleaf.

Of the 0.47 hectares of remnant vegetation to be managed for the dual objectives of hazard control and biodiversity protection, the majority portion along the site's western boundary is already being so managed; therefore there is no change proposed. The remaining areas of impact are principally made up of narrow slivers of vegetation at the edges of the existing development footprint.

It is important to note that these figures are estimates only, based on current mapping. More detailed land survey will better define the topography of the site, and therefore allow for a finer definition of vegetation boundaries. However, the scale of the impacts described are reliable.

Overall, 5.47 hectares of the site that contains vegetation will be cleared (this includes the car park areas that are dominated by hard stand), and 3.47 hectares will be managed for bushfire hazard. No area of natural remnant bushland will be cleared for the development footprint.

SUMMARY OF FATE OF HABITAT TYPES ON SITE						
Habitat Type	**Content**		**Within development zone (ha)**	**APZ area (ha)**	**Retained area (ha)**	**Total Area (ha)**
1	Built form on excavated land		3.15	0.16	0.00	**3.31**
2	Built form + planted trees on excavated land		4.13	0.96	0.15	**5.24**
3	Dams and immediate surrounds		0.00	0.11	0.15	**0.26**
4	Planted trees, some understorey + built form on excavated land		1.32	1.55	0.05	**2.92**
5	Cleared, cultivation history on natural landform		0.31	1.02	0.51	**1.84**
6	Cleared, no cultivation history on natural landform		0.00	0.00	0.14	**0.14**
7	STIF natural regrowth (up to 71 yrs old) on natural landform		0.00	0.00	0.16	**0.16**
8	BGHF natural regrowth (up to 71 yrs old) on natural landform		0.02	0.33 (0.13[M])	0.93	**1.28**
9	BGHF young regrowth at 1943 (currently >71 yrs old native regrowth) on natural landform		0.00	0.10	0.05	**0.15**
10	BGHF	natural remnant vegetation	0.00	0.52 (0.47[M])	7.02	**7.54**
	STIF		0.00	0.01	2.98	**2.99**
		TOTAL	**8.93**	**4.76**	**12.14**	**25.83**
[M] = Managed for dual objectives of hazard control and biodiversity protection through judicious weed control.						

The final footprint that is the subject of this impact assessment was located so as to avoid and minimise impacts as much as possible. The most important areas of vegetation on site were identified at the start of the project, and used as a constraint to the development's boundaries. The restriction of the footprint to the footprint of the existing development will avoid and minimise impacts to vegetation.

However, because significant landscaping works were undertaken as part of the IBM development, clearing of 35 year old trees and understorey vegetation is unavoidable.

The vast majority of the area to be cleared is made up of the trees planted in the car parks (the extent of the hard stand being 5.24 hectares), and trees and understorey (mostly ground covers) in the landscaped gardens around the buildings (1.32 hectares). A very small area (only 199 square metres - 0.02 hectares - or 0.08% of the site) of natural regrowth vegetation falls within the development footprint.

The growing conditions of the trees in the car parks prevent the full expression of the trees' mature size or nature. Although the project Landscape Architects used Australian native species for the IBM project, many are not native to the local area (e.g. *Corymbia citriodora* Lemon-scented Gum) or not native to the vegetation types that do or should occur on site naturally (e.g. *Eucalyptus tereticornis* Forest Red Gum).

There are many *Corymbia citriodora* Lemon-scented Gums planted in the car park, which is a species that occurs naturally from the far north coast of NSW and south east Queensland. This species has the capacity to cross species boundaries through the transfer of pollen and "pollute" the genetic makeup of other eucalypts. The removal of such a large genetic reservoir may be of advantage to the endangered vegetation on site (see below).

The presence of species that do not or would not occur naturally on site can have a profound influence on the site's ecology. *Eucalyptus tereticornis* Forest Red Gum has the potential to be such a species. Being a winter-flowering species, its pollen and nectar is provided at a time when such resources are otherwise scarce in the natural vegetation on site. Provision of unseasonal high-quality blossom has the potential to attract fauna species not otherwise occurring on site, with other flow-on effects.

While there will be a loss of up to 35 year old trees amongst the built form, they will be replaced by significant landscaping works around the new development of a similar scale to that in the area to be developed. The species selection will be guided by the use of local provenance species that are sympathetic to the existing native vegetation, all of it being BGHF or STIF EEC.

5.2 Clearing and Disturbance of EECs

Both EECs on site may be impacted by works to some degree, with the total area of impact being:

- Clearing of 199 square metres of BGHF in Habitat Type 8 (natural regrowth [up to 71 years old] on natural landform; and
- APZ fuel management across
    - 0.33 hectares BGHF in Habitat Type 8 (natural regrowth [up to 71 years old] on natural landform)
    - 0.10 hectares BGHF in Habitat Type 9 (young regrowth evident in 1943 [>71 years old] on natural landform)
    - 0.52 hectares BGHF in Habitat Type 10 (natural remnant bushland)
    - 0.01 hectares STIF in Habitat Type 10 (natural remnant bushland)

The small area of natural regrowth vegetation to be cleared (199 square metres) will be offset

with the retention and conservation management of the large area of remnant vegetation in the southern half of the site, comprising 11.14 hectares. This is an offset ratio of 560:1.

The largest ongoing impact to the EECs will be the implementation of the APZ. The APZ has been located outside of the natural vegetation as much as possible. Only 0.01 hectares of STIF will be so affected, which will be offset with the retention and conservation management of all of the remainder on site, which current mapping indicates is 3.14 hectares. This is an offset ratio of 158:1.

Up to approximately 0.95 hectares of BGHF will be impacted by the APZ. However, most (0.60 hectares) is located within the two patches of "managed land", where the fuel management can and is being achieved by an emphasis on weed control. Notably, this is already occurring along the western boundary. Nevertheless, the area to be impacted by fuel reduction works will be offset by the retention and conservation management of the remainder of BGHF on site, which current mapping indicates is 8.00 hectares. This is an offset ratio of 8.4:1.

The area of forest to be retained are proposed to be dedicated as a Stewardship Site, under the provisions of the *Biodiversity Conservation Act 2016*. A Stewardship Site is a permanently reserved area, with a legally-binding conservation management plan. The conservation management of the site is regularly audited by the Biodiversity Conservation Trust / NSW Office of Environment and Heritage.

This is currently the subject of a separate investigation and report per the Biodiversity Assessment Method 2017 (*Biodiversity Stewardship Site Assessment Report*, Ashby and McTackett in preparation). This will deliver conservation management of these important large areas of EEC in perpetuity, while formally allowing and managing public access.

5.3 Loss of Fauna Habitat

Fauna habitats associated with the vegetation to be removed and / or thinned include:

- Blossom of the canopy trees (favoured foraging resource for flying-fox, gliders, and many birds);
- Leaves of the canopy trees and understorey plants (favoured by Ringtail Possum, Brushtail Possum, and insects);
- Insects that feed on the tree canopy (favoured foraging resource of microbats, insectivorous birds);
- Perching and roosting sites for birds in tree canopy;
- Shelter sites for birds in understorey; and
- Soft fruits of mature Large-leaved Privets favoured by frugivorous birds.

No hollow-bearing trees were observed in the development areas.

Fauna species sensitive to noise, lights and vibrations may be deterred from using habitats in the immediate vicinity of the site during construction and the most sensitive to noise and lights during occupation.

The eventual conservation management of the retained bushland will require the removal of exotic trees such as Large-leaved Privet. Besides removing a foraging resource (soft black fruits), dense groves may provide roosting habitat for the Powerful Owl. This is further discussed below (see section 5.4).

The vegetation of the entire subject site provides potential habitat for many species of fauna, some of which are listed threatened species. However, the majority of the vegetation to be removed is within the car park and landscaped areas around the buildings, which provide relatively poor fauna habitat. These areas lack important habitat features such as structural complexity, floristic diversity and hollows.

Nevertheless, the removal of the fauna habitat in the car park and building curtilage will be temporary, and ameliorated by the implementation of a new Landscape Plan among the built form. This plan will recreate similar habitats, but based on a species selection that is more sympathetic to the local ecology. Thus, the landscaped areas will serve the additional objective of providing flora and fauna habitats.

However, the highest quality fauna habitats occur in the large area of fully-structured natural bushland, with many hollow-bearing trees, that contains natural landform (including riparian zones) and complex habitats. These areas are to be dedicated as a Stewardship Site, with conservation management actions implemented in perpetuity.

These areas currently do not enjoy formal recognition or protection of their significant ecological value. The proposed dedication as a permanent Stewardship Site will more than offset the temporary losses of poor fauna habitat in the trees of the car park and the landscaped zone.

Potential direct impacts on resident fauna will be ameliorated by the ecological supervision of the clearing process. Although no hollows were observed in the areas to be cleared, nest boxes suitable for arboreal mammals, small parrots and microbats are to be installed. These additional roosting / denning / nesting sites will enrich the forest for Ringtail Possums and other arboreal fauna as a boost to Powerful Owl foraging opportunities.

5.4 Specific Potential Impacts on Powerful Owl

The subject site is part of the territory of a known breeding pair, and, during the breeding season, is probably also used for foraging by at least two other pairs from nearby territories (personal communication, Dr Beth Mott, BirdLife Australia). The use of the site by this species is discussed in detail in section 7.4.2.

Bain et al. (2014) developed a set of guidelines specifically aimed at avoiding and mitigating development impacts on Powerful Owl. The most important of these recommendations refer to the distance of a development footprint from nest sites and roosting habitat, and the quantum of foraging habitat to be lost. These guidelines recommend a buffer zone of 100 metres to nest trees and a buffer of 50 metres to roosting habitat. A minimum of 450 hectares of foraging habitat (across a maximum 4 patches) within the territory around a nest site is to be retained. Further,

they recommend that proposals need careful consideration if more than 1 hectare of foraging habitat is to be removed where the remaining habitat is below the 450 hectare threshold.

Foraging habitat is provided within areas that support their prey species – principally arboreal mammals and birds. Therefore, the direct losses of potential foraging habitat on site are mainly through the removal of vegetation in the landscaped gardens surrounding the buildings (up to 2.87 hectares of Habitat Type 4), the APZ works in the vegetated parts around the dams (0.11 hectares of Habitat Type 3), and of the planted trees in the northern car park (up to 5.09 hectares of Habitat Type 2).

The proposed loss of potential foraging habitat exceeds the guideline's 1 hectare threshold. However, this is mostly made up of very poor foraging habitat, being principally strips of planted trees in a car park that probably only provide occasional perching habitat for birds and foraging habitat for birds and flying-foxes. The areas to be removed provides almost no potential habitat for their favoured prey, Ringtail Possums.

Also, it is noted that the foraging habitat available to the resident breeding pair also includes the far superior natural habitats in the adjacent territories in the Eric Mobbs Reserve / Bidjigal Reserve to the south west and in Berowra Valley National Park to the north east. These additionally available areas in large reserves comprising natural bushland are likely to provide sufficient area of foraging habitat to account for the loss of the sub-optimal foraging habitats in the development footprint.

In addition to the potential for other areas to accommodate the additional loss, it is to be further ameliorated and offset by the enhancement of the remainder of the site for prey species. This can be achieved by:

- Improving the composition and condition of foraging habitat for prey species through conservation management of the retained bushland, using low impact bush regeneration techniques with an emphasis on weed control. This is not occurring now;
- Improving the sheltering and breeding habitat of prey species by the installation of appropriate nest boxes / salvaged hollows. These will enrich, replace, or provide (where absent) habitat features that are important for the life cycle of hollow-dependant prey;
- Enrich the terrestrial habitat by the re-use of felled timber, particularly those larger logs with hollow sections; and
- Implementation of a Landscape Plan that is informed by ecological advice. This will include such things as plant species selection (with an emphasis on locally-native BGHF and STIF species), the weed potential of other chosen plants, structural elements that will advantage target fauna, use of water features, and sensitive lighting design.

The implementation of the Landscape Plan will also serve as a direct offset in the medium and long term by reinstating losses of existing landscaped land, although in an improved form.

Nesting habitat is known to occur in 5 trees on this site and the adjacent Cumberland State Forest. Nest tree number 2 occurs on the western bank of the main central gully, a few metres below the road south of the bridge to the eastern car park. **Roosting habitat** sought out by this species is usually in a riparian zone with a dense tree canopy. The resident pair has been observed roosting in such habitat in the gully to the east in Cumberland State Forest.

None of the nest trees or potential roosting habitat will be directly impacted by the proposal.

The existing nest trees as identified and mapped by Dr Beth Mott (BirdLife Australia) and Mr Mark Chidel (The Hills Shire Council) are between 38 and 97 metres from existing buildings / development (see Figure 8). However, until positions have been determined by land survey, the accurate distance of nest tree number 2 from existing and proposed development is still uncertain. Such works are scheduled for early February 2018.

Given the current positional information available for nest tree number 2, it is located approximately 65 metres from the nearest existing commercial building to the north west. Using the same measuring tools, the distance of the three closest proposed buildings are 78 metres, 94 metres and 109 metres to the north west.

Thus, the proposed development footprint will alter the conditions for only one of the two known nest trees on site, by **increasing** the buffer distance between nest tree number 2 and buildings by at least another 10 metres. The intervening area will remain as intact vegetation as a specific buffer for the nest tree.

Similarly, the closest proposed building to known roosting habitat is 304 metres. A number of other ameliorative measures to protect important habitat elements are also recommended. Of critical importance are retention of a dense vegetation structure in and around roosting and nesting habitat along gullies, the thermal dynamics of those gullies, the availability of roost and nest sites, and prey density.

The following ameliorative mechanisms that are specific to Powerful Owls are recommended:

- Impose traffic calming measures, coupled with an education campaign for residents, regarding the risk of car strike to the Powerful Owl. Car strike is an increasing and significant hazard, as it is thought Powerful Owls are spending more time foraging on the ground. With such a large wing span, they are slow and cumbersome taking off from the ground, and therefore very vulnerable to car strike.
- Prohibition of free-ranging Cats in the development, with only indoor Cats and / or those with enclosed runs to be permitted. This will remove a significant predator of prey species from the site.
- Dogs to be under control at all times, but especially near the bushland areas. There are currently no controls imposed on Dogs on site, with locals using the bushland for leash-free exercise.
- Impose design standards that do not use glass surfaces that pose a hazard to owls. Such design standards have been used successfully, reducing bird strike in other

developments.

- During works, impose a finish time of 4 p.m. for noisy works during autumn, winter, and early spring breeding season when the owls are most sensitive to disturbance.
- Areas to be revegetated / landscaped near roosting or nesting habitat must use fast-growing species to create a dense canopy.
- Weed management that might alter the dense under-canopy structure to be carried out slowly, to ensure continuity of the dense structure. This has been successfully implemented in Victoria (McNabb and McNabb 2011).
- In the areas between the nest tree and the buildings, retain bushland and / or a bushland character as a priority. This feature has been incorporated into the proposal.
- Boost the prey population by habitat enrichment.
- Activities in recreational areas that have the potential to disturb owls to be restricted:
    - Amplified noise to be prohibited at night, as such noise may drive the resident pair away from the adjoining roosting and nesting habitat;
    - Maintain grass cover instead of hard surfaces (such as asphalt), as heat reflection from artificial surfaces has the potential to impact on the microclimate of the adjoining roosting and nesting habitat; and
    - Prohibit the use of high wattage floodlights. The use of street lights directed to the ground and other lighting designed to reduce spill and glare are acceptable.

5.5 Indirect Impacts

Any developed area adjacent to bushland has the potential to impose indirect impacts as a result of enhanced "edge effects", particularly increasing the habitat available for weeds.

In this case, the most sensitive vegetation types to consider are BGHF and STIF. The dedication of the naturally forested areas containing BGHF and STIF as a Stewardship Site allow for the funding of a conservation Management Plan, which will then be implemented in perpetuity.

Any anticipated indirect impacts from edge effects – such as enhanced weed growth – are to be incorporated into this management document. As part of the Stewardship Agreement, the implementation and success of the management actions are audited and otherwise regularly reviewed by the Biodiversity Conservation Trust / NSW Office of Environment and Heritage.

Such indirect impacts are already occurring as a result of the existing development on site and adjacent off site development. Weed impacts most pronounced in the narrow patches of vegetation at the northern end of the site next to the car park, around and in the dams, in the narrow riparian zone, around the edges of the perimeter road, and at the edge of the cleared field adjacent to the eastern boundary. The weedy understorey in the western APZ is currently being controlled to minimise bushfire hazard, and there is evidence of some weed control in the riparian zone and along the southern perimeter road.

Such weed control will continue but be expanded under a site-wide conservation management document.

The Management Plan will also formalise use of pathways through the forest by the community. This will help foster a sense of ownership for the surrounding lands and also provide an opportunity to educate the general public with strategically located signage. Such engagement with the community may result in less litter and / or active participation in community-based land management campaigns (e.g. Landcare, Clean Up Australia).

5.6 Runoff

Alteration to the amount and quality of runoff from development areas has the potential to alter sensitive downslope environments. The introduction of hard surfaces (pathways, concrete pads for rest areas etc.) interrupts the percolation of rainwater through the soil profile and instead delivers water in greater volumes and at greater speeds downslope through drains and pipes.

However, such impacts are easily managed by the application of standard water controls.

The area mooted for redevelopment is already currently dominated by hardstand, and the site has a system of stormwater controls in place, including dams and detention basins. Such infrastructure is to be retained and / or upgraded to accommodate the new footprint.

The quantum and quality of runoff is unlikely to be significantly altered.

6 COMMONWEALTH ASSESSMENTS OF SIGNIFICANCE

6.1 Background to the Impact Assessments

Commonwealth. The EPBC Act 1999 Policy Statement 1.1 Significant Impact Guidelines (Department of the Environment 2013) outlines the procedures that must be followed when assessing likely impacts, and the significance of those impacts upon Matters of National Environmental Significance (NES).

The criteria set out by the guidelines vary slightly to the specific NES matters (i.e. threatened species, endangered ecological communities, migratory species and wetlands).

The following two Critically Endangered Ecological Communities listed as Matters of National Environmental Significance occur on the subject site:

- Blue Gum High Forest
- Sydney Turpentine Ironbark Forest

6.2 Blue Gum High Forest

Each criterion has been considered and a response provided below in regard to BGHF.

An action has, will have, or is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

i) reduce the extent of an ecological community

Response: The proposed development footprint will reduce the extent of this community by 199 square metres and subject a further 0.95 hectares to fuel reduction works within the APZ. This is made up of a few narrow slivers of regrowth vegetation at the interface between the development and the forested areas, most of which is in very poor condition with a highly disturbed and modified understorey.

This is a very small percentage of what occurs on site - 8.97 hectares - of which 8 hectares will be reserved and managed for conservation purposes in perpetuity.

ii) fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines

Response: The proposal will entirely remove only a very small area of this community.

It is reliant on highly mobile species for pollination (such as Grey-headed Flying-foxes, Rainbow Lorikeets) whose movements will not be impeded by the proposed development.

iii) adversely affect habitat critical to the survival of an ecological community

Response: Critical habitat for this community has not been declared or mapped.

iv) modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of water drainage patterns

Response: The proposal is almost entirely restricted to an area that has already been excavated and developed. The pattern of water distribution across the site will not alter as a result of its redevelopment for residential purposes.

v) cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting

Response: Life cycle drivers of the species that occur in communities such as this one include drought, fire and other disturbances. Drought cycles will remain uncontrolled. The proposal is unlikely to alter the fire regime currently experienced by the site as fire suppression will remain the main objective for the protection of adjacent residences and forest assets.

Probably the two functionally important group of plants within this community is the overstorey canopy species of eucalypts as they provide a raft of ecological services to the flora and fauna species that make up the community as well as to the system itself. For example, the trees keep the water table and its salt load deep, protect the soil from wind and water erosion through the binding effect of their intact root systems, provide shade and frost protection for new growth of understorey plants, and provide shelter, roost sites and foraging resources for many fauna species.

The proposal will retain the vast majority of the area that is currently naturally treed.

The site contains many significant weeds, and weed control measures will arise as part of the Stewardship Site Agreement. This will improve the condition of the remaining vegetation. Also, recommendations for landscaping include the use of local provenance species native to this endangered ecological community, so that no further threats to its species composition are introduced.

The proposal is therefore unlikely to create conditions that endanger the ecological functioning of the area occupied by the endangered ecological community on the site.

vi) cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

a. assisting invasive species that are harmful to the listed ecological community, to become established, or

b. causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community

Response: The land use proposed for the subject site will include landscape management and therefore current and future outbreaks of weeds may be controlled. There is the potential for oil and fuel spills to occur during construction but these may be contained within pollutant traps. It is also recommended that environmental management is incorporated into a site management plan that details *inter alia* appropriate spill responses to protect the retained vegetation.

With these safeguards in place, the quality of the BGHF is not likely to be significantly altered or compromised by the proposal.

vii) interfere with the recovery of an ecological community

Response: BGHF is a resilient community that recovers strongly after the removal of threatening processes (personal observation).

The proposal includes the dedication of the substantial areas of bushland as a Stewardship Site, with all of it concomitant protections and conservation management requirements. This will ensure the continued existence and recovery of this large remnant.

It is therefore considered that a significant negative impact is unlikely to occur in accordance with the criteria as set out by the Department of the Environment and Energy, and a referral to the Department is therefore not required.

6.3 Sydney Turpentine Ironbark Forest

Each criterion has been considered and a response provided below in regard to STIF.

An action has, will have, or is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

i) reduce the extent of an ecological community

Response: The proposed development footprint will not reduce the extent of this community but fuel reduction works will apply to 0.01 hectares within the APZ. This is made up of a few narrow slivers of vegetation at the interface between the development and the forested areas, most of which is in very poor condition with a highly disturbed and modified understorey.

This is a very small percentage of what occurs on site – 3.15 hectares - of which 2.98 hectares will be reserved and managed for conservation purposes in perpetuity.

ii) fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines

Response: The proposal will not remove any of this community, but a small area will be subject to fuel reduction works.

It is reliant on highly mobile species for pollination (such as Grey-headed Flying-foxes, Rainbow Lorikeets) whose movements will not be impeded by the proposed development.

iii) adversely affect habitat critical to the survival of an ecological community

Response: Critical habitat for this community has not been declared or mapped.

iv) modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of water drainage patterns

Response: The proposal is almost entirely restricted to an area that has already been excavated and developed. The pattern of water distribution across the site will not alter as a result of its redevelopment for residential purposes.

v) cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting

Response: Life cycle drivers of the species that occur in communities such as this one include drought, fire and other disturbances. Drought cycles will remain uncontrolled. The proposal is unlikely to alter the fire regime currently experienced by the site as fire suppression will remain the main objective for the protection of adjacent residences and forest assets.

Probably the two functionally important group of plants within this community is the overstorey canopy species of eucalypts as they provide a raft of ecological services to the flora and fauna species that make up the community as well as to the system itself. For example, the trees keep the water table and its salt load deep, protect the soil from wind and water erosion through the binding effect of their intact root systems, provide shade and frost protection for new growth of understorey plants, and provide shelter, roost sites and foraging resources for many fauna species.

The proposal will retain the vast majority of the area that is currently naturally treed.

The site contains many significant weeds, and weed control measures will arise as part of the Stewardship Site Agreement. This will improve the condition of the remaining vegetation. Also, recommendations for landscaping include the use of local provenance species native to this endangered ecological community, so that no further threats to its species composition are introduced.

The proposal is therefore unlikely to create conditions that endanger the ecological functioning of the area occupied by the endangered ecological community on the site.

vi) cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

a. assisting invasive species that are harmful to the listed ecological community, to become established, or

b. causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community

Response: The land use proposed for the subject site will include landscape management and therefore current and future outbreaks of weeds may be controlled. There is the potential for oil and fuel spills to occur during construction but these may be contained within pollutant traps. It is also recommended that environmental management is incorporated into a site management plan that details *inter alia* appropriate spill responses to protect the retained vegetation.

With these safeguards in place, the quality of the STIF is not likely to be significantly altered or compromised by the proposal.

vii) interfere with the recovery of an ecological community

Response: STIF is a resilient community that recovers strongly after the removal of threatening processes (personal observation).

The proposal includes the dedication of the substantial areas of bushland as a Stewardship Site, with all of it concomitant protections and conservation management requirements. This will ensure the continued existence and recovery of this large remnant.

It is therefore considered that a significant negative impact is unlikely to occur in accordance with the criteria as set out by the Department of the Environment and Energy, and a referral to the Department is therefore not required.

7 STATE ASSESSMENTS OF SIGNIFICANCE

7.1 Background to the Impact Assessments

Section 5A of the *EPA Act 1979* requires that the consent authority take into account seven factors when deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats. If a significant impact is judged likely to occur, a Species Impact Statement (SIS) is required.

The impacts of the proposal on BGHF, STIF, the Powerful Owl have been assessed using a Section 5A assessment of significance (or seven part test).

7.2 Blue Gum High Forest

7.2.1 Ecological Profile

Blue Gum High Forest in the Sydney Basin Bioregion is listed as a critically endangered ecological community under Schedule 1A of the Threatened Species Conservation Act (1995). It is listed as a critically endangered ecological community under the Schedules of the Environment Protection and Biodiversity Conservation Act (1999).

A moist, tall open forest community, originally restricted to the ridgelines in Sydney's north from Crows Nest to Hornsby, and extending west along the ridges between Castle Hill and Eastwood (OEH 2017)

To qualify under the EPBC Act (1999) listing, occurrences must satisfy certain condition criteria viz. remnants must have a canopy cover of greater than 10%, and a size greater than one hectare. However, remnants with canopy cover of less than 10% are also considered part of the community if the fragments are greater than one hectare in size, and occur in areas of native vegetation in excess of 5 hectares (Threatened Species Scientific Committee 2005).

While single isolated trees or stands of trees of characteristic canopy species are considered important as biodiversity reservoirs, these areas fall outside the Commonwealth definition of this ecological community due to their severe disturbance and modification (Threatened Species Scientific Committee 2005). No such distinction is drawn by the NSW Scientific Committee for its listing under the State's Threatened Species Conservation Act (1995).

The NSW Scientific Committee describes this community in its final determination (NSW Scientific Committee 2011) as being characterised by a number of species but that the species composition will be greatly influenced by the remnant's size and disturbance history. Structurally, the NSW Scientific Committee (2011) typifies this community as one dominated by a tall canopy of eucalypts with a multi-layered understorey of mesophyllous shrubs and small trees along with a diverse ground layer of herbs, ferns and some grasses.

The canopy is usually dominated by either *Eucalyptus pilularis* Blackbutt or *Eucalyptus saligna* Sydney Blue Gum but *Angophora costata* Smooth-barked Apple is frequently observed in

remnants close to the shale/sandstone boundary and sometimes on deep shale soils, as does *Angophora floribunda* Rough-barked Apple. *Eucalyptus paniculata* Grey Ironbark is typically found on upper slopes (NSW Scientific Committee 2011).

Using systematic survey and multivariate analysis, Tozer (2003) has attempted to define the vegetation communities of the Cumberland Plain and has determined that this community occurs mainly in areas with shale derived soil receiving more than 1050 millimetres of rain per year, although it may be present in sheltered locations with lower rainfall. The community is generally confined to altitudes higher than 100 metres above sea level on the Hornsby Plateau. He further defines this community by the species present and has determined that a survey plot of 0.04 hectares is expected to contain at least 17 positive diagnostic species in 95% of cases, provided the total number of native species in the plot is 34 or greater.

Prior to European settlement, this community probably covered an area of approximately 3,700 hectares (Tozer 2003) on the ridgelines in Sydney's north from Crows Nest to Hornsby, and extended west along the ridges between Castle Hill and Eastwood (OEH 2013). However, there is now less than 5% of the original extent of the community remaining intact (OEH 2013). The largest remnant reserved for conservation is Dalrymple Hay Nature Reserve / Browns Forest at St Ives in the Ku-ring-gai Local Government Area (Threatened Species Scientific Committee 2005).

Highly modified relics of the community persist as small clumps of trees without a native understorey and all remnants are now surrounded by urban development (NSW Scientific Committee 2011). This high level of fragmentation contributes to a very large reduction in the ecological function of the community, particularly as the rainforest understorey species rely on birds and mammals to disperse their seeds (OEH 2013). The loss of large trees removes essential habitat for a range of tree-dependent fauna (Gibbons and Lindenmeyer 1996) and the reduction of understorey complexity, through the reduction of native shrub cover, degrades habitat for a range of bird and mammal species (Catling 1991).

The main threat to this community is further clearing for urban development and subsequent impacts of fragmentation, understorey disturbance such as mowing that stops regrowth, urban run-off that leads to increased nutrients, sedimentation and weed invasion and inappropriate fire regimes (OEH 2013).

7.2.2 Blue Gum High Forest and the Subject Site

BGHF occurs across the site, largely as remnant forest, but also as small patches of regrowth. It occurs outside of the existing development footprint and occupies approximately 8.97 hectares.

7.2.3 Assessment of Significance

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Response:

This question is not relevant to an endangered ecological community.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Response:

This question is not relevant to an endangered ecological community.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Response:

A very small sliver of regrowth BGHF will be removed for the development footprint (199 square metres). Up to approximately 0.95 hectares of BGHF will be incorporated into the APZ and require fuel management. This is made up of a series of small patches, most being highly weedy. Fuel reduction can probably be achieved primarily through weed control.

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Response:

The proposal includes the dedication of the overwhelming majority of this vegetation type to a Stewardship Site, with conservation management.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Response:

Almost all of the proposed works are confined to the already developed parts of the site. Approximately 199 square metres of regrowth may be removed and a further 0.95 hectares subject to fuel reduction.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

Response:

The small scale of the impacted areas are unlikely to result in additional fragmentation or isolation of this community.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

Response:

The impacted areas are too small to be considered important for the long-term survival of this community.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

Response:

No critical habitat has been declared for this endangered ecological community.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

Response:

There is no recovery plan or threat abatement plan for this species. However, a number of recovery strategies have been identified (OEH 2015b).

1. Coordinate detailed review and assessment (tenure/zoning/ownership/threats) of mapped BGHF remnants, incorporating new remnants;
2. (Guidelines) Develop criteria and targets for protection of BGHF remnants;
3. (Habitat assessment) Identify and map priority sites for protection of BGHF remnants;
4. Liaise and support landholders to secure protection and active management of priority BGHF sites;
5. (Guidelines) Develop criteria and targets for threat management actions;
6. (Habitat assessment) Prioritise threat management actions;
7. Liaise with landholders to prepare site specific Plans of Management;
8. Undertake priority weed control works;
9. Implement appropriate fire management practices;
10. Undertake rehabilitation/restoration and/or regeneration actions at identified priority sites;
11. Undertake priority stormwater and erosion control works;
12. Control and regulate access and land use via fencing and signage;
13. Notify land owners/managers of presence of BGHF and discuss implications for use and management;
14. Investigate planning and incentives programs to promote and encourage protection and

management of BGHF, particularly on private land;
15. Development and implementation of EIA guidelines;
16. Development and implementation of best practice management guidelines for BGHF remnants;
17. Develop and implement a BGHF community education, awareness and involvement campaign;
18. Encourage or conduct research to determine ecological processes within BGHF, including fire ecology, soil seedbank and response to disturbance;
19. Undertake and facilitate research into best practice guidelines for threat management and conservation of BGHF remnants;
20. Develop and implement a threat management monitoring program;
21. Provide map of known occurrences to Rural Fire Service and seek inclusion of mitigative measures on Bush Fire Risk Management Plan(s), risk register and/or operation map(s); and
22. Assess and manage the impacts of mountain bike activities.

Of relevance to this proposal are the following (OEH 2015a):

1. Promote public involvement in restoration activities;
2. Apply necessary fire regimes to maintain the appropriate floristic and structural diversity;
3. Protect habitat by minimising further clearing of the community. This requires recognition of the values of all remnants of the community in the land use planning process, particularly development consents, rezonings and regional planning;
4. Promote regeneration by avoiding unnecessary mowing;
5. Protect habitat by controlling run-off entering the site if it would change water, nutrient or sediment levels or cause erosion;
6. Weed control; and
7. Undertake restoration including bush regeneration and revegetation.

The proposal has avoided and minimised the development's impact and further proposes to retain and dedicate the large remnant forest as a Stewardship Site with permanent protection and conservation management. The proposal is consistent with these recovery strategies.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Response:

The proposed works for the development footprint and bushfire protection requirements contribute to the Key Threatening Process "Clearing of Native Vegetation". However, this loss is at a very small scale and will not exacerbate this Key Threatening Process in any significant way.

In conclusion, the Planning Proposal is considered unlikely to threaten the viability of the local occurrence of BGHF. Thus, a Species Impact Statement is not required.

7.3 Sydney Turpentine Ironbark Forest

7.3.1 Ecological Profile

Sydney Turpentine Ironbark Forest is listed as an Endangered Ecological Community under Schedule 1 of the Threatened Species Conservation Act (1995). It is listed as a Critically Endangered Ecological Community under the Schedules of the Environment Protection and Biodiversity Conservation Act (1999).

It is a transitional community, found between Cumberland Plain Woodland in drier areas, and Blue Gum High Forest on adjacent higher rainfall ridges (OEH 2017a).

The entity listed under the EPBC Act (1999) is narrower in scope than that listed under the TSC Act (1995), as it includes only remnant patches that meet specific condition criteria, including patch size and canopy cover (Department of the Environment 2015). The Threatened Species Scientific Committee (2005) has determined that only high quality remnant patches are part of the Turpentine-Ironbark Forest ecological community listed under the EPBC Act (1999) if they contain some characteristic native plant species present in all structural layers and that have:

- Tree canopy cover of more than 10% in a patch of at least 1 hectare (Type 1); or
- Tree canopy of less than 10% in a patch greater than 1 hectare if the patch is located within native vegetation with an overall area of more than 5 hectares (Type 2).

The type 1 patches have the greatest conservation value and their size and high quality generally make them most resilient to disturbance (Threatened Species Scientific Committee 2005). The type 2 patches enhance the potential for connectivity and the viability of the ecological community, act as a buffer against disturbance and support gene flow in the plant and animal species associated with the listed ecological community (Threatened Species Scientific Committee 2005).

This community now predominantly occurs as scattered remnants on shale-derived soils on the rim of the Cumberland plain and in the lower Blue Mountains (Tozer et al. 2010), particularly near the shale / sandstone boundary in higher rainfall areas, and on the shale ridge caps on sandstone in the Hornsby Plateau (NSW Scientific Committee 2012, NSW NPWS 2004, OEH 2017a). It is usually in the more low-lying parts of the landscape, between 10and 180 metres above sea level (OEH 2013). Local concentrations remain near Thirlmere, Oakdale, Kurrajong, Dural, and Pennant Hills (Tozer et al. 2010).

Given its coincidence with urbanisation, it is highly fragmented with less than 10% (or 2,300 hectares) of its original extent remaining (Tozer et al. 2010). Small areas are reserved in Wallumatta and Newington Nature Reserves (NSW NPWS 2004), with only 250 hectares known in reserves (Tozer et al. 2010).

Remnants mostly occur in the Baulkham Hills, Hawkesbury, Hornsby, Ku-ring-gai, Parramatta, Ryde, Sutherland and Wollondilly local government areas (OEH 2017a).

More analysis needs to be done to determine its distribution. For example, a similar form of the community occurs more widely that seems to have affinities with and / or can be equated to Blue Mountains Shale Cap Forest endangered ecological community OEH 2017a).

In its natural state, it is typically a diverse open eucalypt forest community with an open shrub layer and grassy ground cover (Tozer et al. 2010). It shares many species with adjoining stands of Blue Gum High Forest (another endangered ecological community) (Tozer et al. 2010), with dominant canopy trees including *Syncarpia glomulifera* Turpentine, *Eucalyptus punctata* Grey Gum, *Eucalyptus paniculata* Grey Ironbark and *Eucalyptus eugenioides* Thin-leaved Stringybark (OEH 2017a). In areas of high rainfall (over 1050 mm per annum) *Eucalyptus saligna* Sydney Blue Gum is more dominant. The shrub stratum is usually sparse and may contain mesic species such as *Pittosporum undulatum* Sweet Pittosporum and *Polyscias sambucifolia* Elderberry Panax, particularly as fire is now largely excluded (NSW NPWS 2004).

Threats to this community include clearing for urban development, impacts from fragmentation, mowing (which stops regrowth), urban run-off that leads to increased nutrients and sedimentation, weed invasion and inappropriate fire regimes (OEH 2017a).

It is known to support foraging resources that are exploited by the threatened fauna species *Calyptorhynchus lathami* Glossy Black-Cockatoo, *Ninox strenua* Powerful Owl and *Pteropus poliocephalus* Grey-headed Flying-fox. Hollow-bearing trees may also provide nest sites for the bird species.

7.3.2 Sydney Turpentine Ironbark Forest and the Subject Site

STIF occurs particularly in the gullies and on the lower slopes on site, largely as remnant forest, but also as small patches of regrowth. It occurs outside of the existing development footprint and occupies approximately 3.15 hectares.

7.3.3 Assessment of Significance

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Response:

This question is not relevant to an endangered ecological community.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Response:

This question is not relevant to an endangered ecological community.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Response:

No areas of STIF will be removed for the development footprint. Approximately 0.01 hectares of STIF will be incorporated into the APZ and require fuel management.

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Response:

The proposal includes the dedication of the overwhelming majority of this vegetation type to a Stewardship Site, with conservation management.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Response:

Almost all of the proposed works are confined to the already developed parts of the site. Approximately 0.01 hectares will be subject to fuel reduction.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

Response:

The small scale of the impacted areas is unlikely to result in additional fragmentation or isolation of this community.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

Response:

The impacted areas are too small to be considered important for the long-term survival of this community.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

Response:

No critical habitat has been declared for this endangered ecological community.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

Response:

There is no recovery plan or threat abatement plan for this species. However, a number of recovery strategies have been identified (OEH 2015b).

- Incorporate consideration of EEC protection in regional open space planning.
- Develop and implement Cumberland Plain Reservation Strategy and create a protected bushland network through targeted land acquisition as land becomes available.
- Public authorities will promote management agreements to landholders through their ongoing land use planning activities.
- Encourage planning authorities to address EECs in development of environmental planning instruments and, where possible, seek biodiversity certification.
- Investigate the preparation of a recommendation for the declaration of critical habitat.
- Promote best practice management guidelines.
- Manage, to best practice standards, areas of EECs which have conservation as a primary objective, or where conservation is compatible. Priorities are to be based on DEC conservation significance assessment.
- Encourage and promote best-practice management of EECs on private land.
- Local Govt prepare plans of management in accordance with the Local Government Act for reserves containing EECs, which have conservation as a primary objective, or where conservation is compatible.
- Ensure the consideration of impacts on EECs when enforcing noxious weed or pest species control in EECs.
- Prepare and implement community awareness, education and involvement strategy.
- Management of EECs to be included in the conditions for Crown land trusts, lease and licence holders.
- Management of EECs is to be included in school environmental management plans where the school land contains EECs.
- Support community conservation by providing nursery or other facilities, for regeneration activities.
- Liaise with institutions to facilitate research relevant to the recovery of Cumberland Plain EECs.
- Investigate the development of a regular monitoring program to assess the change in extent of vegetation across the Cumberland Plain.

Of relevance to this proposal are the following (OEH 2017a):

- Promote public involvement in restoration activities;
- Apply necessary fire regimes to maintain appropriate floristic and structural diversity;
- Protect habitat by minimising further clearing of the community. This requires recognition of the values of all remnants of the community in the land use planning process, particularly development consents, rezonings and regional planning;
- Promote regrowth by avoiding unnecessary mowing;
- Protect habitat by controlling run-off entering the site if it would change water, nutrient or sediment levels or cause erosion;
- Control weeds; and
- Undertake restoration including bush regeneration and revegetation.

The proposal has avoided and minimised the development's impact and further proposes to retain and dedicate the large remnant forest as a Stewardship Site with permanent protection and conservation management. The proposal is consistent with these recovery strategies.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Response:

The proposed works for the development footprint and bushfire protection requirements contribute to the Key Threatening Process "Clearing of Native Vegetation". However, this loss is at a very small scale and will not exacerbate this Key Threatening Process in any significant way.

In conclusion, the Planning Proposal is considered unlikely to threaten the viability of the local occurrence of STIF. Thus, a Species Impact Statement is not required.

7.4 *Ninox strenua* Powerful Owl

7.4.1 Ecological Profile

The Powerful Owl is listed as Vulnerable under Schedule 2 of the *Threatened Species Conservation Act 1995* and the *Biodiversity Conservation Act 2016*. This species is not listed under the Schedules of the *Environment Protection and Biodiversity Conservation Act 1999*.

The Powerful Owl is the largest of the Australian Owls, with bold chevrons across the chest, large yellow eyes, and massive feet with sharp talons. Juvenile owls are largely white with small, dark streaks and dark eye patches (OEH 2017a).

This species is endemic to eastern and south-eastern Australia (OEH 2017a), recorded from most types of sclerophyll forest along the south east coast of Australia (Slater et al. 1995), but generally on the eastern slopes of the Great Dividing Range. In NSW, it is widely distributed throughout the eastern forests from the coast inland to tablelands, with scattered records on the western slopes and plains suggesting occupancy prior to land clearing (OEH 2017a).

Preferred habitat types include woodland and open sclerophyll forest, to tall open wet forest and rainforest, however it is often found roosting or nesting in large trees along gullies (Simpson and Day 1999). Although it requires large tracts of intact habitat, it can occur in fragmented landscapes as well. Many successful pairs are known from suburban Sydney as well as in the city, where they feed on Grey-headed Flying-fox and roost in the Royal Botanic Garden (personal observation).

The Approved Recovery Plan for Large Forest Owls (DEC 2006) reported that the estimated population size of this species in New South Wales is a minimum of 10,000, which includes approximately 2,000 breeding pairs. It is now at low densities throughout most of its eastern range, and rare along the Murray River. Former inland populations may never recover (OEH 2017a).

Despite the reportedly low densities across most of its range, in his review of urban wildlife, Kavanagh (2004) noted increasing numbers of Powerful Owl records in the northern suburbs of Sydney. It was hypothesised that this may be due to a greater awareness of the species among birdwatchers, and an improvement in owl survey techniques. However, it was also acknowledged that this may reflect a true population trend resulting from habitat changes that benefit the owl's favoured prey species, *Pseudocheirus peregrinus* Common Ringtail Possum.

A review of historical records and anecdotal reports from long term resident ornithologists across Sydney (McAllan and Larkins 2005) also indicate that this species was rarer pre-1980 and has been recently increasing in the urban environment.

Recent work has found this species in higher densities and more widespread in the sandstone reserves around Sydney than previously thought, and in the Greater Southern Sydney Region, this species is a common and stable resident (DECC 2007b).

This species can be observed roosting in dense vegetation during the day, often clutching the remains of prey species in its talons. Its diet is influenced by regional factors that influence prey availability, but in general it is a specialist predator of medium-sized arboreal marsupials, particularly the Common Ringtail Possum in coastal lowland areas and the Greater Glider in the tablelands (OEH 2017a). The Sugar Glider, Common Brushtail Possum and Grey-headed Flying-fox are also common prey species, and supplemented by diurnal birds, particularly the Pied Currawong and many parrot species (OEH 2017a). Scansorial and terrestrial mammals (particularly rats) are also recorded in Powerful Owl pellets, although rarely (personal observation, and Birds in Backyards 2016). Insects are also exploited, especially by, and for, fledglings (Mo and Waterhouse 2015).

It is thought that Powerful Owls in the Sydney area are now feeding more often on Brushtail Possums, perhaps due to a population decline of urban Ringtail Possums (personal communication, Dr Beth Mott, BirdLife Australia). This mooted population trend is not yet verified, and there is anecdotal evidence to the contrary reported by WIRES in the eastern suburbs of Sydney (Patterson 2016). A research project into population studies of urban Ringtail Possums is currently being considered by an academic at the University of Western Sydney (personal communication, Dr Beth Mott, BirdLife Australia).

Factors that produce the dense understorey favoured by Ringtail Possums are common in urban bushland, and include fewer fires, and nutrification from adjacent development. Coincidentally, these environmental factors also favour the development of preferred roosting habitat of the Powerful Owl, such as dense stands of exotic (e.g. Privet) or native (e.g. *Pittosporum undulatum*) vegetation in gullies. The Powerful Owl also preys on species of birds that have also increased in the urban landscape, such as the Rainbow Lorikeet.

The call of the Powerful Owl may be heard at any time of the year, but it is more vocal during the autumn breeding season. It has a slow, deep and resonant double hoot, with the female's being higher pitched and expressing an upward inflection on the second note (OEH 2017a).

Nests are located in large vertical hollows at least 0.5 metre deep (OEH 2017a) in large old trees (Australian Museum 2011), and with an entry of at least 30 centimetres. The nest is lined with decayed wood debris, often in a tree at the head of a well vegetated gully (Kavanagh 1997). The large sizes of the trees preferred for nesting (DBH height of 80-240 centimetres) are offered often only by old eucalypts: for example, Blackbutts in this size range are at least 150 years old (Mackowski 1984).

Powerful Owls are monogamous and mate for life, which may be 30 years (Australian Museum 2011). While the female and young are in the nest hollow, the male roosts nearby (from 10 to 200 metres away) guarding them, often choosing a dense "grove" of trees that provide concealment from other birds that harass him (OEH 2017a).

The NSW Recovery Plan reports that Powerful Owls first breed at 2 years in captivity, and probably 3-4 years in the wild. Further, Debus (2011) reports that a female bred successfully in the wild at one year. However, according to commentary from BirdLife Australia Powerful Owl Project, the age at which the owls of urban Sydney first breed may be around 10 years (https://www.facebook.com/ThePowerfulOwlProject/).

This late onset of breeding might be a response to competition for breeding territory and / or appropriate nesting trees, as it is thought that the Sydney urban habitat has reached carrying capacity (personal communication, Dr Beth Mott, BirdLife Australia).

The breeding season is from April to September (Australian Museum 2011). Clutches usually consist of two eggs and incubation lasts approximately 38 days (OEH 2017a). Young birds remain with the parents for several months after fledging and may stay within their parents' territory for over a year (Australian Museum 2011).

Human disturbance immediately around the nesting site is not well tolerated. There is evidence that a nesting pair observed over several seasons in a metropolitan Melbourne park ate its own young after a pathway was constructed during the breeding season that passed under the nest tree (Webster et al. 1999). Despite the closure of that pathway, the pair did not return to that hollow tree, relocating instead voluntarily to more secluded habitat within their home range.

This species is reportedly intolerant of artificial nest boxes, but McNabb and McNabb (2011) and McNabb (2008) reported on the successful use of a nest box in an environment where nest sites

were in short supply, but other habitat factors were satisfactory.

Home ranges for territorial pairs appear to range from 800 to 1,000 hectares (although much larger territories have been recorded) (Kavanagh 2002). Pairs of Powerful Owls demonstrate high fidelity to a large territory, the size of which varies with habitat quality and thus prey densities (OEH 2017a). In good habitats a mere 400 hectares can support a pair; where hollow trees and prey have been depleted, the owls may need up to 4,000 hectares (OEH 2017a).

Dispersal is not well understood, but McNabb and McNabb (2011) radio-tracked a juvenile in its natal territory. This individual moved consistently over about 90 hectares for many weeks until it suddenly started to double its range of movements, and moved in 3 different directions over 3 nights. On the third night the signal was lost after being tracked to a point 3 kilometres from the nest tree. Long-range dispersals of up to 18 kilometres have also been reported (McNabb and Greenwood 2011). Otherwise, this species is thought not to disperse very far – perhaps just outside of the natal territory.

Landscape-scale research on large forest owls in regional south east NSW found wholesale habitat removal has a greater impact on the Powerful Owl and their arboreal marsupial prey than logging (Kavanagh and Stanton 2002). The study also identified that habitat fragments smaller than 200 hectares do not provide significant reservoirs for the Powerful Owl populations studied. The applicability of these conclusions to the urban Powerful Owls of Sydney is unclear, as this species is breeding well, with all territories occupied, in a highly fragmented landscape dominated by habitat patches less than 200 hectares in area.

7.4.2 *Ninox strenua* Powerful Owl and the Subject Site

This species was recorded on the subject site during survey and is known from 473 records within the broader study area. Other than the record during this survey, the most recent record dates from October 2017, when it was recorded 7.8 kilometres south west of the subject site near North Parramatta. The closest record dates from May 2017, 600 metres south of the site along Bellamys Creek.

The site contains a known breeding pair of Powerful Owls that have been regularly monitored since at least 2004. Their territory includes the forested habitats on site, within the adjacent Cumberland State Forest, and beyond. The site contains 2 known nest trees, with a further 3 known nest trees and known roosting habitat in the gullies of the adjoining Cumberland State Forest.

In a letter to The Hills Shire Council (dated 11th December 2017), Birdlife Australia reported that the resident pair of Powerful Owls has a documented 18-year history of breeding on the subject site and in Cumberland State Forest, including in nest tree number 2 (last successfully used in 2015). Further, the resident pair has reportedly produced 12 chicks over this time, which represents 0.12% of the estimated 10,000 birds in the NSW population.

Photographs of birds in the local area (Terrys Creek Parklands) available on eBird (http://ebird.org/ebird/australia/map/), show preferred roosts as being within riparian

situations with a dense layer of trees, both native and exotic. Such roosting habitat is available in the gullies on site and in the adjacent State Forest.

The definition of the extent and size of the local population is critical to an assessment of potential impact on this species. Therefore, to aid in such assessments, Bain et al. (2014) have produced guidelines, wherein the local territory of a pair of Powerful Owls has been defined as the surrounding area within 2 kilometres of a nest tree. Moreover, the local population has been further defined as those animals inhabiting the surrounding area within 5 kilometres of the subject pair's territory.

Using this guideline, a simplified circular territory for the resident pair and the extent of the surrounding local population are shown in Figure 9. The shape and size of the territories will, in reality, reflect the shape of the available habitat (and therefore may be more linear for some pairs), but for the sake of this exercise, a circle was considered adequate.

In order to quantify the size of that local population, all available records from within that 7 kilometre radius circle were examined, using the following sources:

- The online data provided at the eBird web site (http://ebird.org/ebird/australia/map/). A summary of that data is provided in Table 6. Information that could identify the observers has been removed and the locations denatured. These data include roost locations, roost habitat, behavioural insights, information regarding breeding and the presence of juveniles, and prey species;
- Published maps of "centroids" of owl activity, as provided in Bain et al. (2014); and
- A map of nest sites, contemporaneously being used as at the 2015 breeding season, together with those nest trees known to be in use in the previous 2 seasons, from a talk given to the Avicultural Society of NSW by one of the BLAPOP team (Foggo 2015).

Analysis of the observational information and spatial analysis of the nest tree locations allowed the grouping of the eBird "hotspots" into 32 natural sub-localities. These are detailed in Table 6 and the pair that occupy the subject site and Cumberland State Forest are classified as sub-location 1.

The eBird data indicate that in this "local population":

- Of 371 records, 316 are of roosting birds;
- 48 roost sites have habitat information or a photograph from which habitat data could be inferred;
- Roosting habitat is often over a creek or other water body;
- Vegetation of a roost site is almost always dense canopy species, but not necessarily native (*Pittosporum undulatum*, Coachwood, Large-leaved Privet, Camphor Laurel, Coral Tree);
- Sometimes open canopy trees are also used for roosting (*Eucalyptus* sp. and *Angophora costata*); and
- Of 371 records, 167 are of family groups, 63 of which have sightings of juveniles, these being at 10 sub-locations (1,2,8,12,13,14,15,17,23,28).

These data were used to help define the location of the centre of each territory, and therefore the eventual size of the local population. It was determined that the local population of which the site's resident pair is a part probably comprises 16 pairs. Not all pairs will necessarily be successful at breeding in every year, and in 2015, only 12 of these had active nests (Foggo 2015).

Bain et al. (2014) determined that each pair of birds required 450 hectares of foraging habitat. Approximately 3,400 hectares of bushland patches occur within the 7 kilometre radius of the local population extent as mapped. If each pair needs 450 hectares of exclusive foraging habitat, then this area could only sustain 8 pairs or 16 birds, which is half the number indicated by the spatial analysis as occurring.

For the numbers of territories observed in this local population (16) to be maintained, then there must be significant overlap of foraging territory and / or the foraging habitat used is of very high quality. This hypothesis is partially supported by the territory overlap of 2 family groups at Terrys Creek Parklands; and that birds from adjoining territories are also known to forage on the subject site (personal communication, Dr Beth Mott, BirdLife Australia).

Using the number of active nests known in 2015, together with the estimate of 1.2 chicks fledged per year per pair (Bain et al. 2104), then 12 successful nests could expect to inject 14.4 additional owls into the population each year, totalling a local population of 46.4 birds (32 parents + 14.4 young). Assuming an annual mortality rate of 10%, this makes the population 41.76 (or 42) birds.

The BLAPOP data set indicate that the urban owl population is made up of 90% paired birds and 10% "floaters", those individuals not in a breeding pair but awaiting an opportunity to find a mate and establish a territory. This means that the 42 birds should comprise the 32 paired birds in stable territories, plus 3.6 floaters, with 6.4 birds able to disperse into territories outside of the local population area.

7.4.3 Assessment of Significance

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Response:

Threats to the life cycle stages and therefore viability of a local population include loss of foraging habitat, loss of roosting habitat, and loss of nesting habitat, as well as existential threats to bird survival through increased mortality (due to car strike, predation, or flying into glass panels).

Bain et al. (2014) have defined the removal of more than 1 hectare of **foraging habitat** as a threat to the owls exploiting that resource. The proposal will remove trees planted in the car park and in the landscaped parts of the building curtilage. While much of the landscaped curtilage of 2.92 hectares is occupied by trees (see Photographs 22 and 23), the open hard surfaces of the car park outnumber the area occupied by trees in the car park at a ratio of approximately 3:1. Thus planted vegetation (and therefore foraging habitat) occupies 2.92 hectares of Habitat Type 4, and

approximately 1.31 hectares of Habitat Type 2. The proposal exceeds the threshold nominated by Bain et al. (2014).

However, investigation into the quality of that habitat for this Biodiversity Assessment reveals that the landscaped areas generally provide very poor foraging habitat due to the absence of both hollow-bearing trees and a complex understorey required by the owl's preferred prey species Ringtail Possum. This is particularly so for the trees of the car park. It is assumed that this poor quality habitat provides little for the foraging owls and is probably restricted to birds (such as the Rainbow Lorikeet) and the Grey-headed Flying Fox.

Also, it is noted that the foraging habitat available to the resident pair and the two other pairs that use the subject site also includes the habitats in the adjacent territories in the Eric Mobbs Reserve / Bidjigal Reserve to the south west, and in Berowra Valley National Park to the north east. These additionally available areas are in large reserves and comprise well-connected natural bushland. They are likely to provide sufficient area of high value foraging habitat to account for the loss of the sub-optimal foraging habitats in the development footprint.

In addition to the potential for other external areas to accommodate the loss of sub-optimal foraging habitat, the loss is to be further ameliorated and offset by improvements in retained foraging habitats for their prey as detailed below, and reinstatement of habitat within the landscaped areas of the development.

The losses of the foraging habitats in the landscaped areas can be mitigated by the enhancement of the remainder of the site for prey species. This can be achieved by:

- Improving the composition and condition of foraging habitat for prey species through conservation management of the retained bushland and riparian habitats, using low impact bush regeneration and weed control
- Improving the structure of habitat for prey species through selective planting of understorey species in the retained bushland and riparian habitats, using local provenance material;
- Improving the sheltering and breeding habitat of prey species by the installation of appropriate nest boxes / salvaged hollows. These will enrich, replace, or provide (where absent) habitat features that are important for the life cycle of hollow-dependant prey;
- Enrich the terrestrial habitat by the re-use of felled timber, particularly those larger logs with hollow sections; and
- Implementation of a Landscape Plan that is informed by ecological advice. This will include such things as plant species selection (with an emphasis on locally-native BGHF / STIF species), the weed potential of other chosen plants, structural elements that will advantage target fauna, use of water features, and sensitive lighting design.

The potential **roosting habitat** all lies within that part of the site to be retained and dedicated as a Stewardship Site and also protected otherwise by riparian controls. Vegetation management for weed control can be staged and timed in order to maintain the dense structure preferred by this

species. This has been used effectively in management of similar riparian roosting habitats in weedy urban gullies in Victoria (McNabb and McNabb 2011)

Nesting habitat on site consists of the 2 nest trees of the 5 known to be used in this remnant forest. Tree number 2 is currently within 60 - 70 metres of the existing office building, adjacent to a road with no protections in place. Tree number 1 is located only 35 metres from houses in The Glade to the west of the site.

Neither of these trees will be removed but instead occur within bushland that is to be retained under a formal conservation agreement, and managed in perpetuity for conservation purposes per an Approved Management Plan.

The nearest buildings in the proposed footprint will be in the order of 78, 94 and 109 metres from tree number 2, with no change to the current distances from tree number 1. The intervening area between tree 2 and the footprint will be maintained as a bushland buffer, principally for protection of owl habitat.

Moreover, additional controls can be enforced in and near the buffer in order to minimise potential disruption during the breeding period. Such controls can include restriction on the timing of demolition and construction to avoid breeding season and / or to avoid vulnerable times of day (dawn and dusk).

Although the buffer distance of 100 metres nominated by Bain et al. (2014) in their guidelines is not achieved by all elements of the proposal none will be closer than existing buildings. It is important to note that nest tree number 2 has been successfully used in its current configuration, which is also less than the recommended 100 metres. Tree number 1 has also been successfully used for breeding, and it is very close to houses, being only 35 metres away.

Breeding in tree number 2 has not been attempted for the last 3 years, and the pair appear to cycle through the 5 trees within their territory. Thus, even if tree 2 was rendered unsuitable for one breeding season due to construction noise, there are 4 other trees that have been used previously by the resident pair, and many more potentially suitable hollow-bearing trees on site in the retained vegetation.

The risk of increased mortality can be addressed by management and minimisation of the recognised hazards:

- car strike - traffic calming devices, signage, and education of residents;
- predation - prohibition of free-ranging Cats and control of Dogs; and
- collisions with glass – imposition of an acceptable design solution.

However, for the sake of the analysis of a worst-case scenario, if all of the safeguards fail and the assumptions above prove to be wrong, and the resident pair abandon the nest tree(s), abandon the site and / or die, the likely impact on the viability of the local population has also been considered.

If the pair abandon the territory or die, one of two scenarios will ensue: either (i) existing

neighbouring birds will expand their territories to take up the newly-vacant habitats, or (ii) a new pair will move in and take over the newly-vacant territory.

The first scenario will result in a decrease of the local population by 1 breeding pair (from 16 to 15 pairs), as well as the offspring they might be expected to contribute (from 14.4 to 13.2) (note however, that this pair has not been breeding successfully for several years). This would result in a local population of 43.2 (down from 46.4). Accounting for 10% mortality and 10% floaters, the new population would be made up of 30 paired birds (down from 32), 3.3 floaters (down from 3.6), and 5.6 animals to disperse to the larger population (down from 6.4). This small decrease is unlikely to result in the demise of the local population, especially if the freeing up of foraging and breeding habitat allows for a reshuffling of territories, perhaps increasing the territory available to the remaining birds. This may increase their breeding success and make up for the small anticipated losses.

However, the second scenario is more likely, as it is thought that the Sydney urban owl habitat is fully occupied, having reached its carrying capacity. "Floaters" are quickly taken up by lone birds with established territories if a partner meets some misadventure or are otherwise rejected (personal communication, Dr Beth Mott, BirdLife Australia). This outcome may therefore result in no change to the local population, or even an increase, as the resident pair currently has a poor breeding record and a new pair may be more successful.

Whichever scenario comes to pass, the outcome is either no change, a small negative change, or a small positive change. None of these outcomes are likely to threaten the viability of the local population, which is the essence of the assessment of significance.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Response:

This question is not relevant to a threatened species.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Response:

This question is not relevant to a threatened species.

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Response:

This question is not relevant to a threatened species.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Response:

Potential foraging habitat of poor quality occurs in the trees across approximately 1.31 hectares in the car parks and 2.92 hectares of landscaped curtilage that will be redeveloped. A small area of regrowth STIF (199 square metres) may fall within the development footprint, and 0.95 hectares of BGHF will be impacted by APZ works. Some of the areas to be managed as APZ are already being so managed.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

Response:

This is a highly mobile species with large home ranges. The proposed redevelopment is concentrated within the already developed parts and the existing home range of the resident pair includes the core lands that will be retained and surrounding fragmented habitat in small urban patches and backyards. The proposal is not considered likely to isolate or fragment habitat for this species to any appreciable degree. Instead, it will result in permanent retention of habitat with the adjacent Cumberland State Forest, with the dedication of the remnant bushland as a Stewardship Site.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

Response:

The habitat that is to be removed or modified is of very poor quality sub-optimal foraging habitat. No areas of important habitat (roosting, nesting) preferred by this species will be removed. Only a set of small areas of STIF and BGHF will be modified for the APZ, and these are also poor habitat, being narrow weed-infested slivers along the edge of the existing development or squeezed between the existing development and adjacent houses.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

Response:

No critical habitat has been declared for this species.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

Response:

A number of objectives and strategies for this species have been detailed in the Recovery Plan for the Large Forest Owls (NSWDEC 2005). Of relevance to this proposal are the following objectives:

1. Manage and protect habitat off reserves and State forests - To minimise further loss and fragmentation of habitat outside conservation reserves and State forests by protection and management of significant owl habitat (including protection of individual nest sites);
2. Model and map owl habitat and validate with surveys - To assess the distribution and amount of high quality habitat for each owl species across public and private lands to get an estimate of the number and proportion of occupied territories of each species that are, and are not, protected; and
3. Monitor owl population parameters - To monitor trends in population parameters (numbers, distribution, territory fidelity and breeding success) across the range of the three species.

The first objective is served by this assessment process with survey conducted for this species and recommendations made for minimisation of potential impact and conservation of important habitat features. It is also directly addressed by the retention of the natural bushland and dedication as a Stewardship Site.

The second and third objectives are served by the conducting of survey for this assessment and the provision of data to the relevant authorities.

This species has also been assigned to the "landscape species" management stream by the NSW Office of Environment and Heritage. The recovery of this species will be achieved by the following actions (OEH 2017b):

1. Consolidate all available information, knowledge and assessment protocols to create a consensus of best practice guidelines, providing a single point source to advise land managers about powerful owl conservation. Update regularly. Seek novel educational frameworks that increase public interest in applying these guidelines.
2. Document and protect known nests. Ensure that no habitat degradation occurs within 100 metres (e.g. hazard reduction burns or tree felling). Facilitate the location of new nest sites through observer training and encouragement.
3. Negotiate with relevant landholders to enter into agreements, particularly in-perpetuity covenants or stewardship agreements, that promote the retention of large old trees, riparian habitat, owl roost sites and other high value habitat (as developed in the best practice guidelines).
4. In regions where high priority Powerful Owl populations can be increased and stabilised, improve habitat quality and reconstruct connectivity. Focus initially on restoration of

arboreal habitat that will foster populations of habitat-specific mammalian prey. Create wide corridors, especially in riparian habitat where prey are potentially more abundant due to better resources and soil fertility.

5. At sites where tree hollows are few or declining within high priority Powerful Owl populations, trial the installation of nest boxes to increase mammalian prey densities. Expand the program if demonstrated to be effective for owls and use as a tool to educate the public about the impact of hollow loss.
6. Encourage development of citizen science programs in urban areas where an increase in community engagement is likely to create broader conservation awareness of Powerful Owls.

The proposal will serve all of these objectives.

Recovery activities to assist this species have also been identified (OEH 2017a):

1. Apply low-intensity, mosaic pattern fuel reduction regimes;
2. Searches for the species should be conducted in suitable habitat in proposed development areas and proposed forest harvesting compartments;
3. Retain large stands of native vegetation, especially those containing hollow-bearing trees;
4. Protect riparian vegetation to preserve roosting areas;
5. Protect hollow-bearing trees for nest sites. Younger recruitment trees should also be retained to replace older trees in the long-term;
6. Retain at least a 200 metre buffer of native vegetation around known nesting sites;
7. Assess the importance of the site to the species' survival. Include the linkages the site provides for the species between ecological resources across the broader landscape; and
8. Minimise visits to nests and other disturbances, including surveys using call playback, when owls are breeding.

It is considered that the proposed ameliorative strategies, the improved buffers, the dedication and conservation management of the naturally forest areas, and protection of the riparian corridor are consistent with these strategies.

Further, a Management Plan will be prepared at the Development Application stage, which will include the fuel reduction regimes consistent with these strategies.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Response:
The proposed works for the development footprint and bushfire protection requirements contribute to the Key Threatening Process "Clearing of Native Vegetation". However, this loss is at a very small scale and is not considered to exacerbate this Key Threatening Process in any significant way.

In conclusion, the Planning Proposal is considered unlikely to threaten the viability of the local population of the Powerful Owl. Thus, a Species Impact Statement is not required.

8 CONCLUSIONS AND RECOMMENDATIONS

The current development on the subject site is a result of long-standing clearing and significant excavation works. The ecological values of these parts of the site are therefore diminished. By contrast, the site also contains many very important ecological features that are recognised and protected by both NSW and Commonwealth legislation, namely the large intact remnant of BGHF and STIF, and a central creek line. Removal of any part of the remnant forest in the southern part of the site is likely to result in a significant adverse impact and trigger a referral to the Commonwealth Department of the Environment and Energy.

The Masterplan that is the subject of this Planning Proposal has been developed specifically with regard to these significant ecological features that are both a constraint to development, and a significant opportunity for conservation of areas that currently have no environmental protection, being currently zoned for business park use.

Subsequent and additional flora and fauna survey for this Biodiversity Assessment have reinforced this interpretation of the site: the significant ecological features are restricted to the areas proposed for retention and dedication as a Stewardship Site. Conservation management actions are therefore to be implemented, in perpetuity.

The remainder of the site – while an aesthetically pleasing man-made landscape - is poor habitat for native flora and fauna. For example, the microbat activity in the forest habitats was markedly greater and used by a more diverse assemblage, than those recorded in the car park habitats.

The known locations of nesting trees and roosting habitat for the Powerful Owl will be retained and protected, and a number of specific ameliorative measures are proposed.

Impact assessment pursuant to the planning provisions in place at the time of submission has demonstrated that the proposed redevelopment is unlikely to place any listed entity at risk of extinction. Therefore, neither a Species Impact Statement or Referral are necessary.

The development areas within the Masterplan are overwhelmingly made up of existing development or otherwise cleared areas. Nevertheless, as part of the Development Application process, specific development proposals will eventually require a comprehensive assessment per the Biodiversity Assessment Methodology (2017) pursuant to the *Biodiversity Conservation Act 2016* and *Regulations 2017*.

A notional quantitative analysis of the proposed Masterplan provided in Ashby and McTackett (2017) using the Biodiversity Assessment Methodology Calculator, demonstrated that the potential offset ratio for the Stewardship Site would deliver a 'maintain or improve' result for biodiversity.

The proposal is considered to deliver a "maintain or improve" biodiversity outcome by locating the development in the existing developed area, introducing a protection mechanism for the remnant forest, with funding for the conservation management of the remnant forest in perpetuity. The proposed rezoning for partial residential development of the site is supported.

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FIGURES

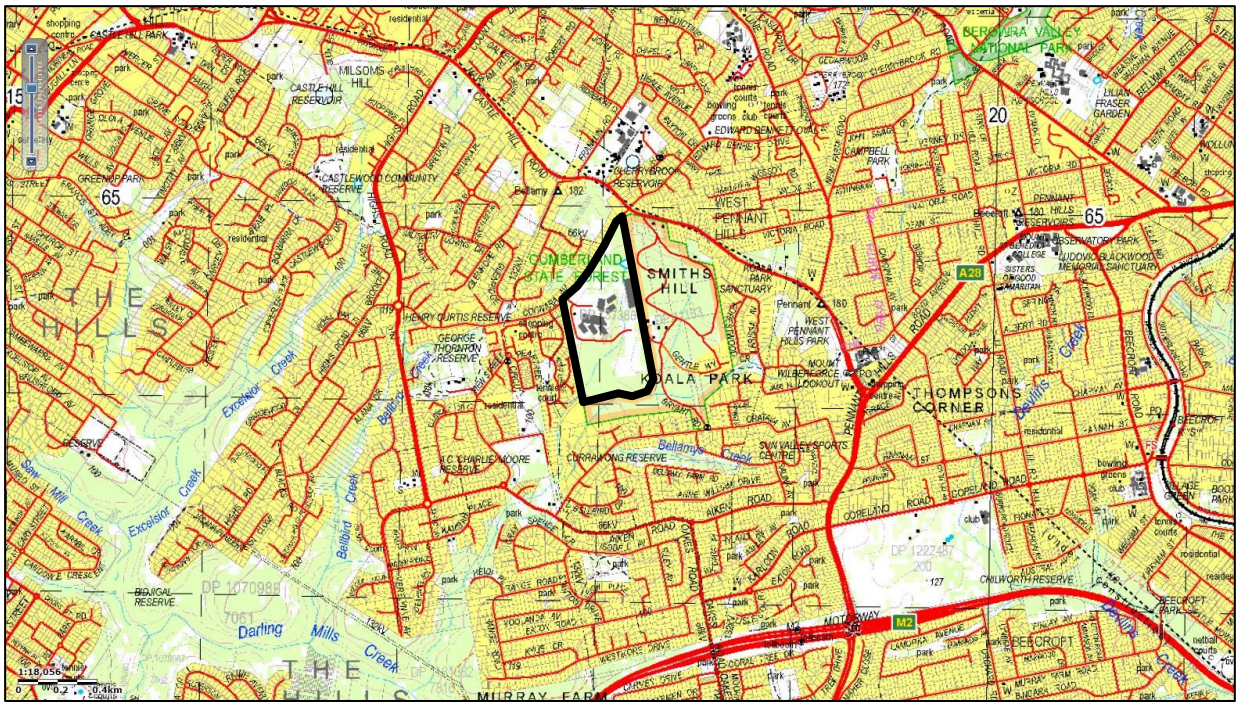

Figure 1: Location of the subject site (black outline) in relation to the local area. Source: SIXMaps aerial imagery (https://maps.six.nsw.gov.au/).

Figure 2: Aerial photography of the subject site (red outline) in relation to the local surrounds. Source: SIXMaps aerial imagery (https://maps.six.nsw.gov.au/).

Figure 3: Closer aerial imagery of the subject site (white outline) and the extent of the adjacent Cumberland State Forest (dashed white outline). Source: Nearmaps aerial imagery (http://maps.au.nearmap.com/)

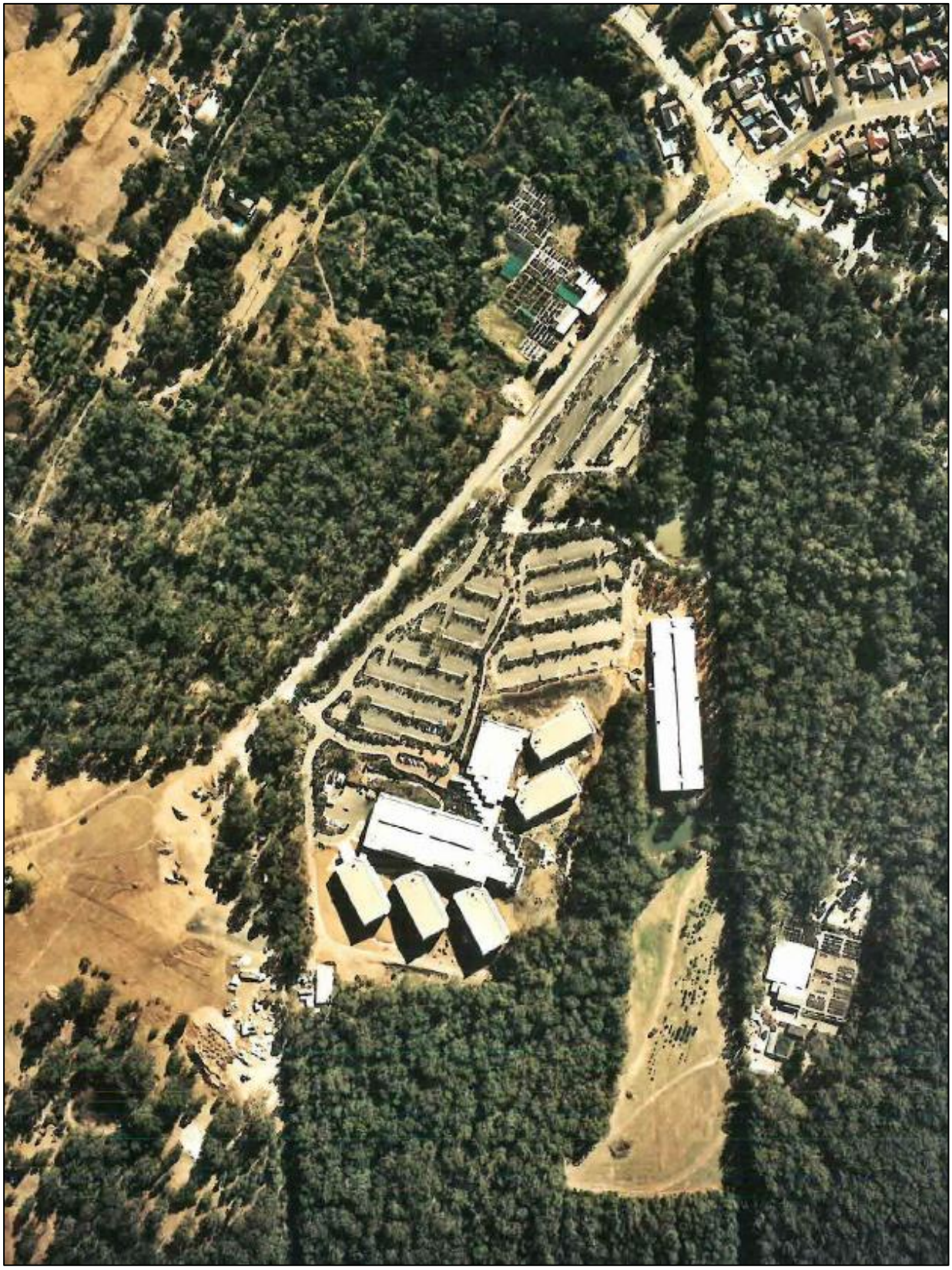

Figure 4: Development of the IBM headquarters on the subject site in 1985.

Figure 5a: The proposed development over the existing development footprint of the IBM site.

Figure 5b: The proposed development with the Asset Protection Zone (APZ) shown.

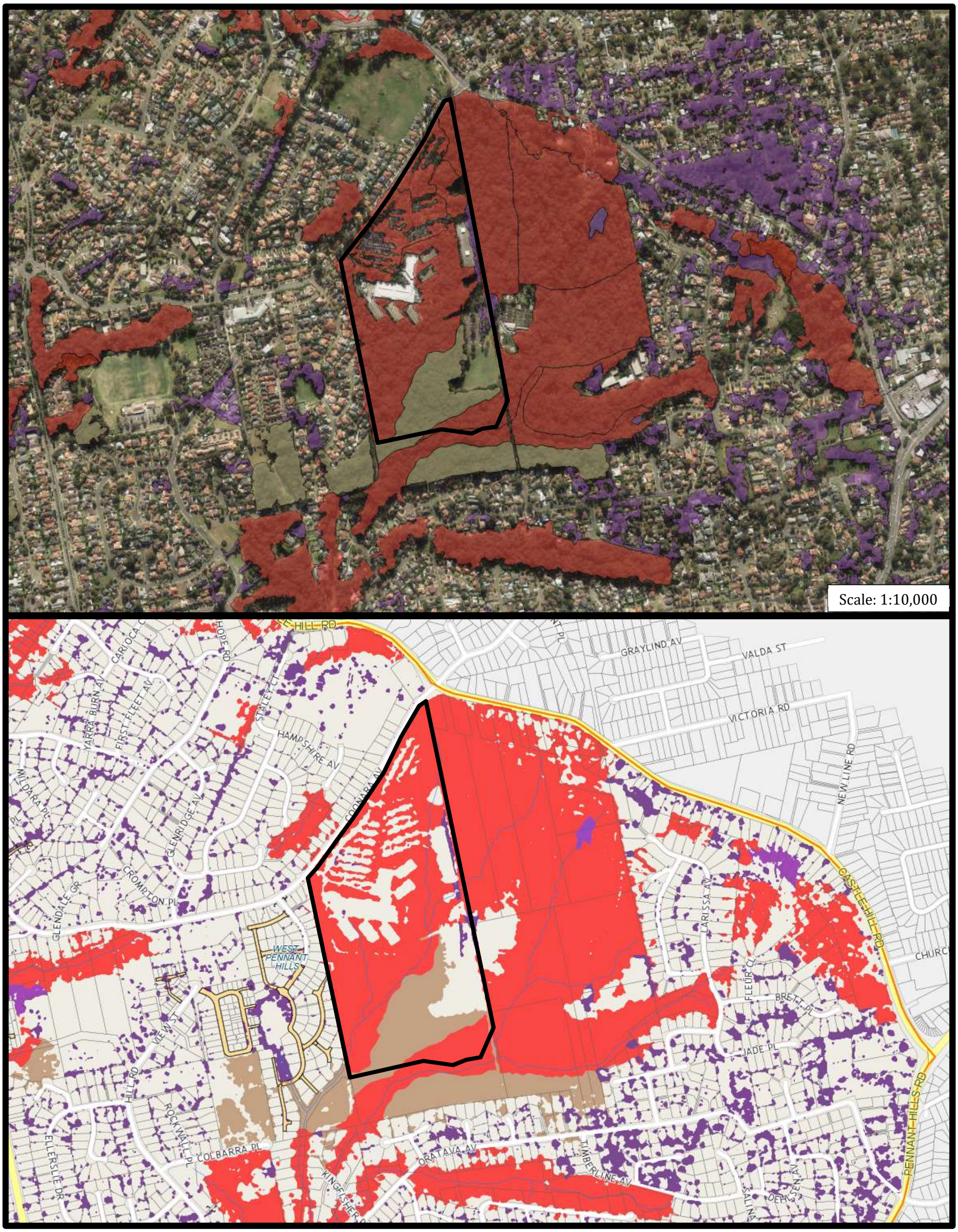

Figure 6: Vegetation mapping of the site and surrounds from two sources; top: OEH (2013), bottom: The Hills Shire Council (2008).
Red = Blue Gum High Forest (BGHF)(CEEC); Brown = Sydney Turpentine Ironbark Forest (STIF) (EEC/CEEC); Purple = Urban plantings (exotic/native) and plantations.

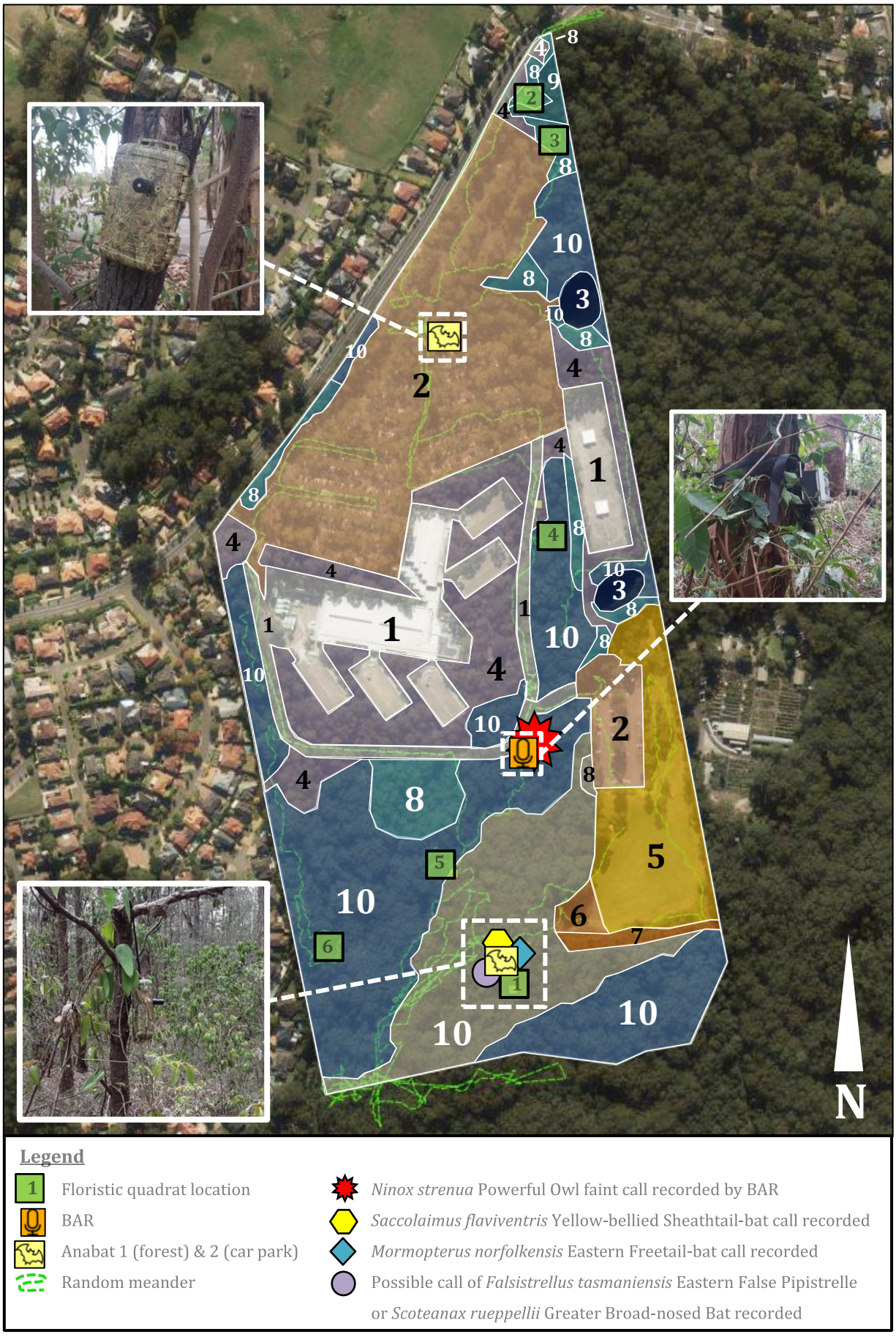

Figure 7: Flora and fauna survey and significant results.

Figure 8: Powerful Owl nest tree locations (Mott 2017) and the years of known use.

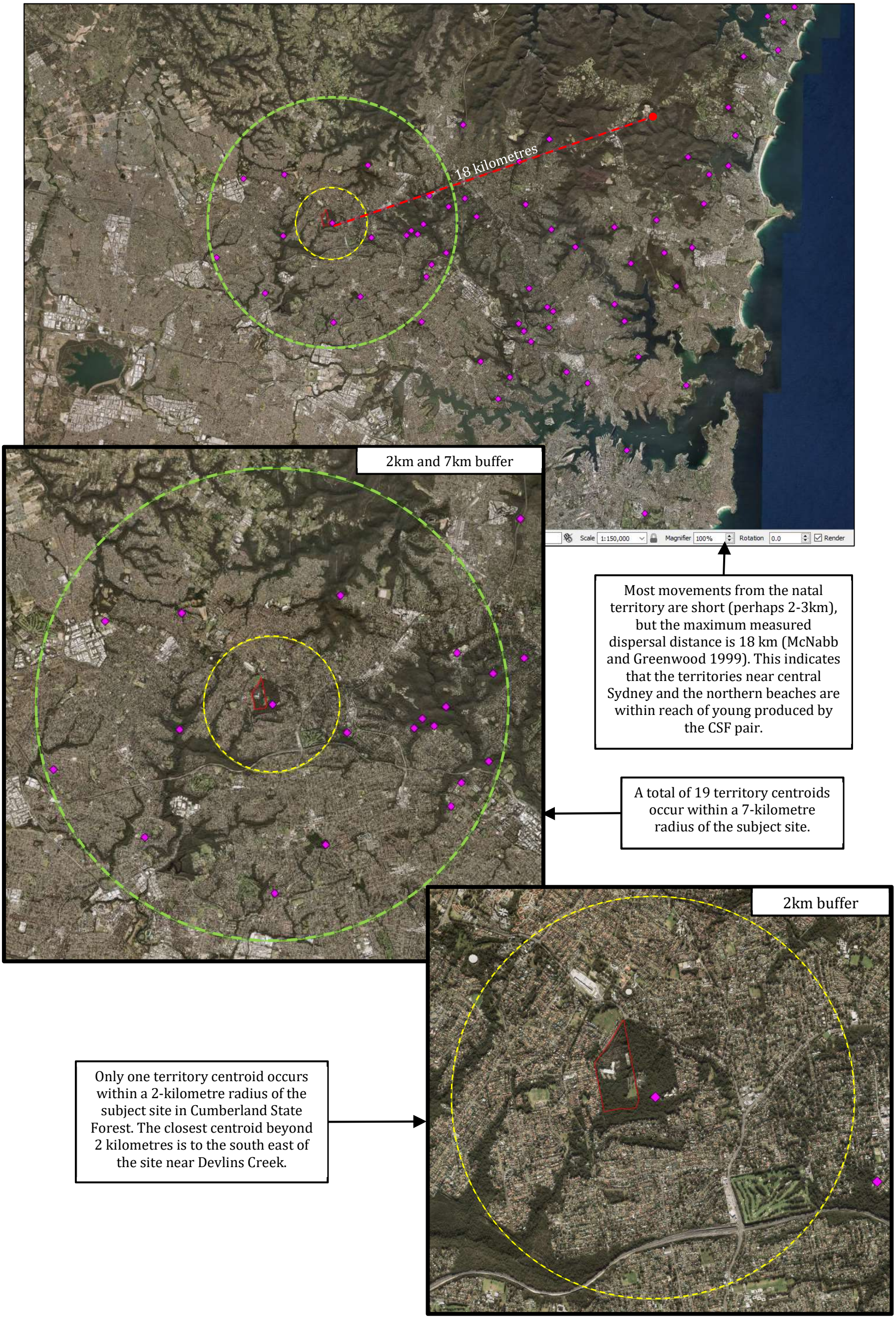

Figure 9: Centroids (pink) of *Ninox strenua* Powerful Owl activity in the local area. A total of 19 centroids occur within 7 kilometres (green circle) of the resident pair's simplified territory (yellow circle). Source: Bain et al. (2014).

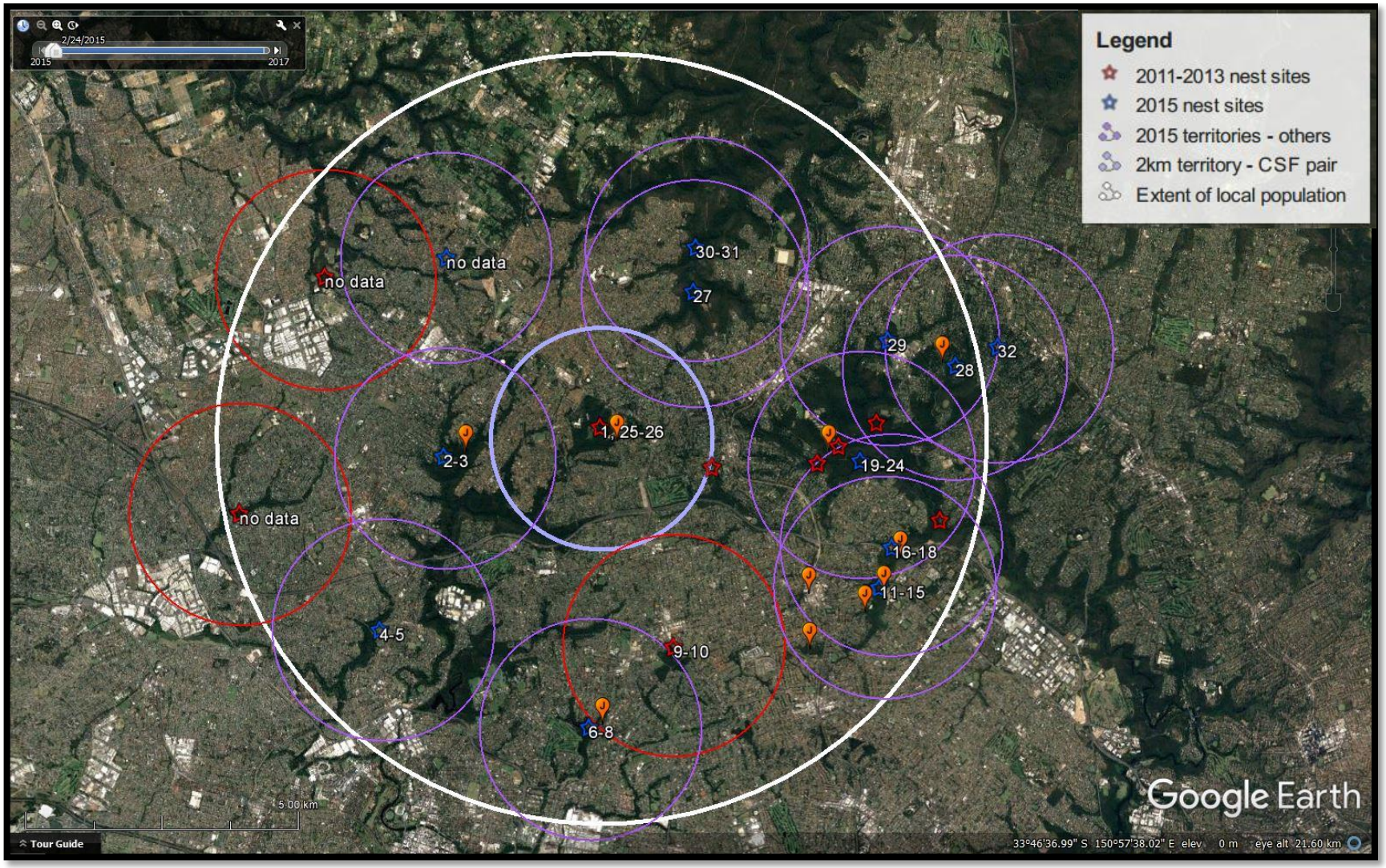

Figure 10: Powerful Owl local population. Simplified territories (purple and red circles), 32 hotspots of activity associated with each territory, recent nest sites (blue and red stars), and places where juveniles have been seen ("J"). Source: eBird (http://ebird.org/ebird/australia/map/) and Foggo (2015).

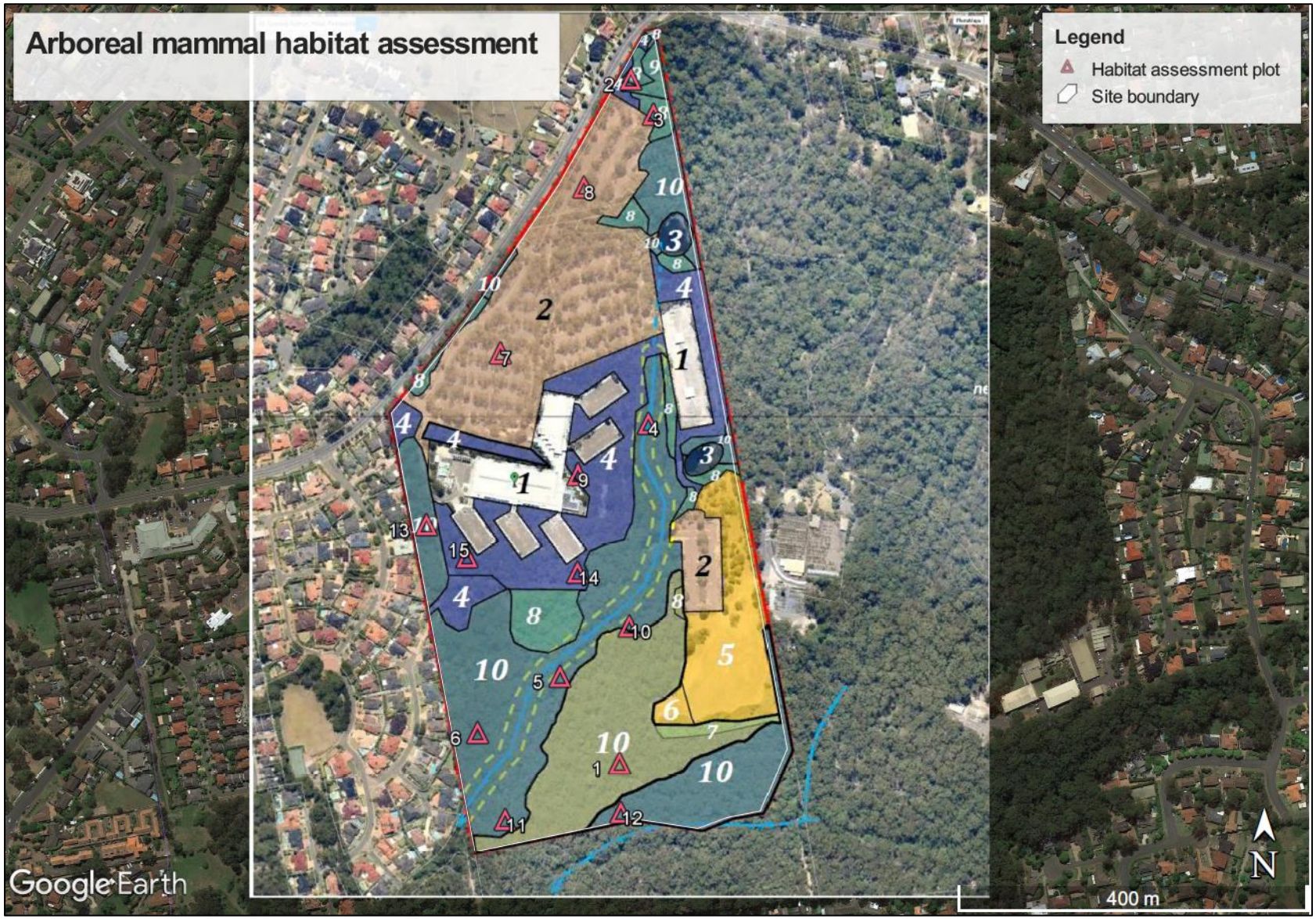

Figure 11: Arboreal mammal habitat assessment locations undertaken across the subject site.

PHOTOGRAPHS

Photograph 1: Quadrat 2.

Photograph 2: Quadrat 3.

Photograph 3: Quadrat 4.

Photograph 4: Carpark.

Photograph 5: Carpark.

Photograph 6: Dry Creek bed.

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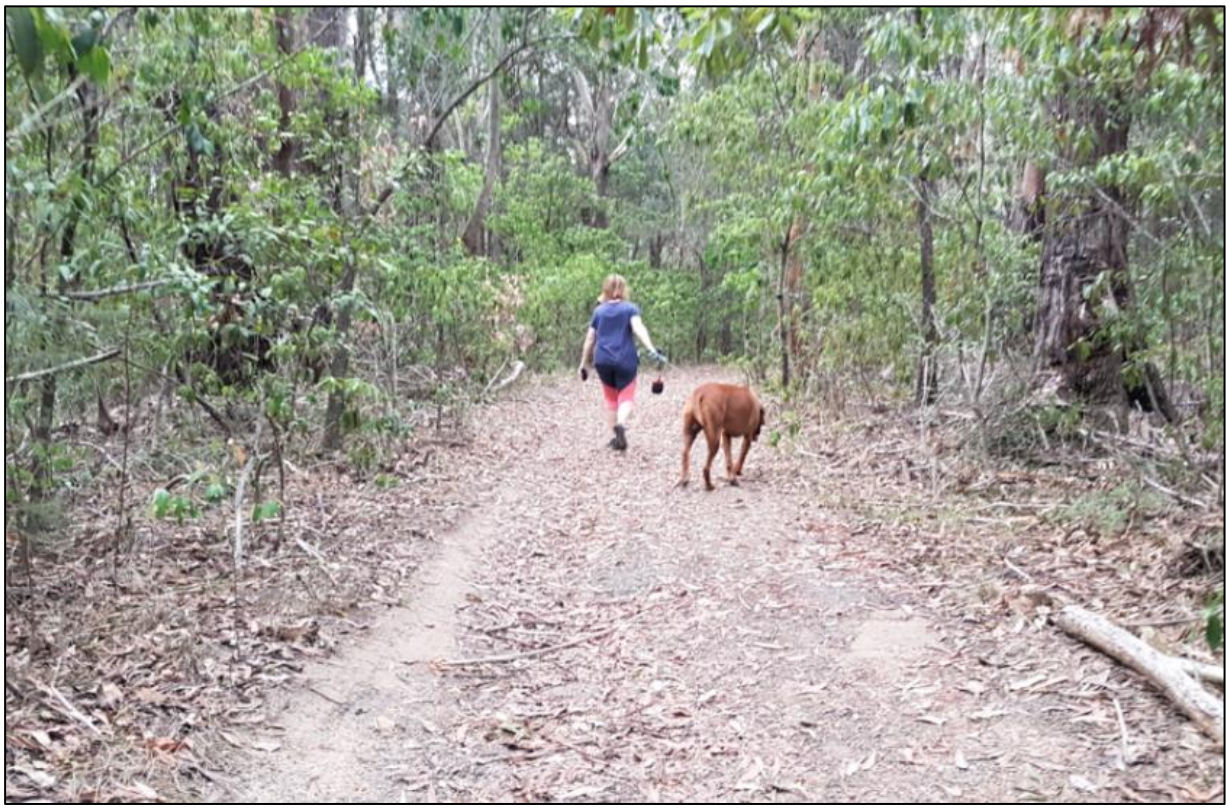
Photograph 7: Dry Creek bed.

Photograph 8: Looking towards Quadrat 6 near nest tree 1.

Photograph 9: Lantana thicket at the interface of the mown grass and forest.

Photograph 10: One of the many tracks through the subject site that are regularly used by local residents.



Photograph 11: Local resident walking their dog along one of the many tracks through the subject site. This large dog was off the lead until its owner realised that she was not alone.

Photograph 12: basal hollow with signs of use.

Photograph 13: Nest tree 1, *Angophora costata* Smooth-barked Apple.

Photograph 14: Large hollow potentially suitable for Powerful Owls, near the site's southern boundary.

Photograph 15: Small tree hollow. Smooth entry indicates likely use.

Photograph 16: Smooth branch hollow suitable for medium birds and mammals.

Photograph 17: Fallen limb with previous use evident from feathers inside the hollow.

Photograph 18: Upward facing branch hollow suitable for a range of urban species.

Photograph 19: Culvert over central creek, suitable for microbats.

Photograph 20: Remnant bushland along the site's western boundary, currently managed for bushfire mitigation, mainly through removal of Lantana and other weeds in the understorey.

Photograph 21: Habitat sample site 15.

Photograph 22: Landscaped area at the north eastern corner of the existing buildings.

Photograph 23: Landscaped area on the northern side of the existing buildings.

TABLES

Table 1: Flora species of conservation significance recorded within 10 kilometres of the subject site. E = Endangered; EPop=Endangered Population, Ext=Extinct, V=Vulnerable. Source: OEH BioNet Atlas 2018.

Family	Scientific Name	Common Name	Status		Number of Records	Likelihood to occur
			NSW	Commonwealth		
Campanulaceae	*Wahlenbergia multicaulis*	Tadgell's Bluebell	EPop	-	1	Low
Convolvulaceae	*Wilsonia backhousei*	Narrow-leafed Wilsonia	V	-	65	Low
Dilleniaceae	*Hibbertia superans*	-	E	-	105	Low
Elaeocarpaceae	*Tetratheca glandulosa*	-	V	-	239	Moderate BioNet record of one individual collected from Cumberland SF in 1976 from near the south western corner of the subject site. This location is an error: the Royal Botanic Gardens records show it was collected from Hill Road Reserve, 430 m to the south west.
Ericaceae	*Epacris purpurascens* var. *purpurascens*	-	V	-	299	Moderate
Ericaceae	*Leucopogon fletcheri* subsp. *fletcheri*	-	E	-	25	Moderate
Fabaceae (Faboideae)	*Dillwynia tenuifolia*	-	V	-	2	Low
Fabaceae (Mimosoideae)	*Acacia bynoeana*	Bynoe's Wattle	E	V	19	Low
Fabaceae (Mimosoideae)	*Acacia clunies-rossiae*	Kanangra Wattle	V	-	1	Low
Fabaceae (Mimosoideae)	*Acacia gordonii*	-	E	E	3	Low
Fabaceae (Mimosoideae)	*Acacia pubescens*	Downy Wattle	V	V	21	Low
Grammitidaceae	*Grammitis stenophylla*	Narrow-leaf Finger Fern	E	-	7	Low

Family	Scientific Name	Common Name	Status		Number of Records	Likelihood to occur
			NSW	Commonwealth		
Haloragaceae	*Haloragodendron lucasii*	-	E	E	4	Low
Lamiaceae	*Prostanthera marifolia*	Seaforth Mintbush	CE	CE	2	Low
Lobeliaceae	*Hypsela sessiliflora*			Ext	1	Low
Malvaceae	*Lasiopetalum joyceae*		V	V	26	Low
Myrtaceae	*Callistemon linearifolius*	Netted Bottle Brush	V	-	13	Low
Myrtaceae	*Darwinia biflora*	-	V	V	632	Low
Myrtaceae	*Darwinia peduncularis*	-	V	-	25	Low
Myrtaceae	*Eucalyptus camfieldii*	Camfield's Stringybark	V	V	37	Low
Myrtaceae	*Eucalyptus nicholii*	Narrow-leaved Black Peppermint	V	V	7	Low
Myrtaceae	*Eucalyptus scoparia*	Wallangarra White Gum	E	V	3	Low
Myrtaceae	*Eucalyptus sp. Cattai*	-	CE	-	38	Low
Myrtaceae	*Kunzea rupestris*	-	V	V	1	Low
Myrtaceae	*Leptospermum deanei*	-	V	V	21	Low
Myrtaceae	*Melaleuca biconvexa*	Biconvex Paperbark	V	V	2	Low
Myrtaceae	*Melaleuca deanei*	Deane's Paperbark	V	V	80	Low
Myrtaceae	*Syzygium paniculatum*	Magenta Lilly Pilly	E	V	22	Low
Myrtaceae	*Triplarina imbricata*	Creek Triplarina	E	E	4	Low
Orchidaceae	*Caladenia tessellata*	Thick Lip Spider Orchid	E	V	1	Low
Orchidaceae	*Genoplesium baueri*	Bauer's Midge Orchid	E	E	23	Low

Family	Scientific Name	Common Name	Status		Number of Records	Likelihood to occur
			NSW	Commonwealth		
Orchidaceae	*Genoplesium plumosum*	Tallong Midge Orchid	CE	E	2	Low
Orchidaceae	*Pterostylis nigricans*	Dark Greenhood	V	-	1	Low
Orchidaceae	*Pterostylis saxicola*	Sydney Plains Greenhood	E	E	1	Low
Proteaceae	*Grevillea caleyi*	Caley's Grevillea	CE	E	1	Low
Proteaceae	*Persoonia hirsuta*	Hairy Geebung	E	E	26	Low
Proteaceae	*Persoonia mollis* subsp. *maxima*		E	E	283	Low
Proteaceae	*Persoonia nutans*	Nodding Geebung	E	E	2	Low
Rhamnaceae	*Pomaderris brunnea*	Brown Pomaderris	E	V	1	Low
Rhamnaceae	*Pomaderris prunifolia*	-	EPop		5	Low
Rubiaceae	*Galium australe*	Tangled Bedstraw	E		7	Low
Thymelaeaceae	*Pimelea curviflora* var. *curviflora*	-	V	V	35	Low
Thymelaeaceae	*Pimelea spicata*	Spiked Rice-flower	E	E	9	Low
Zannichelliaceae	*Zannichellia palustris*	-	E		1	Low

Table 2: Fauna species of conservation significance recorded within 10 kilometres of the subject site. E=Endangered, EPop=Endangered Population, Ext=Extinct, V=Vulnerable. Source: OEH BioNet Atlas 2018 (http://www.bionet.nsw.gov.au/).

Fauna type	Scientific Name	Common Name	Status		Number of Records	Likelihood to occur
			NSW	Commonwealth		
Amphibia	*Heleioporus australiacus*	Giant Burrowing Frog	V	V	20	Low
Amphibia	*Pseudophryne australis*	Red-crowned Toadlet	V	-	179	Low
Amphibia	*Litoria aurea*	Green and Golden Bell Frog	E	V	6027	Low
Reptile	*Varanus rosenbergi*	Rosenberg's Goanna	V	-	3	Low
Aves	*Stictonetta naevosa*	Freckled Duck	V	-	1	Low
Aves	*Ptilinopus superbus*	Superb Fruit-Dove	V	-	5	Moderate
Aves	*Apus pacificus*	Fork-tailed Swift	-	M	9	High One record from Cumberland State Forest, however terrestrial habitat is largely irrelevant to this species.
Aves	*Hirundapus caudacutus*	White-throated Needletail	-	M	45	High One record from Cumberland State Forest, however terrestrial habitat is largely irrelevant to this species.
Aves	*Ardea ibis*	Cattle Egret	-	M	44	Low
Aves	*Botaurus poiciloptilus*	Australasian Bittern	E	E	7	Low
Aves	*Ixobrychus flavicollis*	Black Bittern	V	-	8	Low
Aves	*Plegadis falcinellus*	Glossy Ibis	-	C	29	Low
Aves	*Circus assimilis*	Spotted Harrier	V	-	1	Low

Fauna type	Scientific Name	Common Name	Status		Number of Records	Likelihood to occur
			NSW	Commonwealth		
Aves	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	V	C	219	Low
Aves	*Hieraaetus morphnoides*	Little Eagle	V	-	15	High
Aves	*Lophoictinia isura*	Square-tailed Kite	V	-	11	High One record from Cumberland State Forest.
Aves	*Pandion cristatus*	Eastern Osprey	V	-	2	Low
Aves	*Falco hypoleucos*	Grey Falcon	E	-	1	Low
Aves	*Falco subniger*	Black Falcon	V	-	1	Low
Aves	*Haematopus fuliginosus*	Sooty Oystercatcher	V	-	3	Low
Aves	*Pluvialis fulva*	Pacific Golden Plover	-	M	277	Low
Aves	*Rostratula australis*	Australian Painted Snipe	E	E	3	Low
Aves	*Actitis hypoleucos*	Common Sandpiper	-	M	59	Low
Aves	*Arenaria interpres*	Ruddy Turnstone	-	M	5	Low
Aves	*Calidris acuminata*	Sharp-tailed Sandpiper	-	M	395	Low
Aves	*Calidris canutus*	Red Knot	-	E,M	14	Low
Aves	*Calidris ferruginea*	Curlew Sandpiper	E	CE,M	255	Low
Aves	*Calidris mauri*	Western Sandpiper	-	M	1	Low
Aves	*Calidris melanotos*	Pectoral Sandpiper	-	M	27	Low
Aves	*Calidris ruficollis*	Red-necked Stint	-	M	25	Low
Aves	*Calidris tenuirostris*	Great Knot	E	CE,M	2	Low
Aves	*Gallinago hardwickii*	Latham's Snipe	-	M	537	Low

Fauna type	Scientific Name	Common Name	Status		Number of Records	Likelihood to occur
			NSW	Commonwealth		
Aves	*Limicola falcinellus*	Broad-billed Sandpiper	V	M	3	Low
Aves	*Limosa lapponica*	Bar-tailed Godwit	-	M	614	Low
Aves	*Limosa limosa*	Black-tailed Godwit	V	M	9	Low
Aves	*Numenius madagascariensis*	Eastern Curlew	-	CE,M	23	Low
Aves	*Numenius phaeopus*	Whimbrel	-	M	1	Low
Aves	*Tringa glareola*	Wood Sandpiper	-	M	3	Low
Aves	*Tringa nebularia*	Common Greenshank	-	M	150	Low
Aves	*Tringa stagnatilis*	Marsh Sandpiper	-	M	27	Low
Aves	*Xenus cinereus*	Terek Sandpiper	V	M	1	Low
Aves	*Chlidonias leucopterus*	White-winged Black Tern	-	M	1	Low
Aves	*Gelochelidon nilotica*	Gull-billed Tern	-	M	4	Low
Aves	*Hydroprogne caspia*	Caspian Tern	-	M	2	Low
Aves	*Sterna hirundo*	Common Tern	-	M	9	Low
Aves	*Sternula albifrons*	Little Tern	E	M	3	Low
Aves	*Callocephalon fimbriatum*	Gang-gang Cockatoo	V	-	65	High
Aves	*Calyptorhynchus lathami*	Glossy Black-Cockatoo	V	-	37	High
Aves	*Glossopsitta pusilla*	Little Lorikeet	V	-	18	High BioNet has one record from Cumberland State Forest (2012), but there are many more records held by eBird from 1998 to 2015.

Fauna type	Scientific Name	Common Name	Status		Number of Records	Likelihood to occur
			NSW	Commonwealth		
Aves	*Lathamus discolor*	Swift Parrot	E	CE	20	Moderate In 1982, one record of a flock of 40 birds attributed to Cumberland State Forest, but this record has an accuracy of +/- 10km. All of the more recent records from the broader study area are restricted to winter-flowering trees. The site provides potential foraging habitat in Blackbutt canopy that may have lerps.
Aves	*Polytelis swainsonii*	Superb Parrot	V	V	2	Low
Aves	*Ninox connivens*	Barking Owl	V	-	10	High Recent records from similar habitats in surrounding areas such as Blue Gum Reserve, Chatswood (2007), Galaringi Reserve Carlingford (2011) and Lake Parramatta Reserve (2012).
Aves	*Ninox strenua*	Powerful Owl	V	-	473	High Call recorded on site during this survey. Past records include 2 nest trees on site plus 3 in Cumberland State Forest.
Aves	*Tyto longimembris*	Eastern Grass Owl	V	-	2	Low
Aves	*Tyto novaehollandiae*	Masked Owl	V	-	9	Low
Aves	*Tyto tenebricosa*	Sooty Owl	V	-	3	Low

Fauna type	Scientific Name	Common Name	Status		Number of Records	Likelihood to occur
			NSW	Commonwealth		
Aves	*Merops ornatus*	Rainbow Bee-eater	-	M	2	Moderate
Aves	*Climacteris picumnus victoriae*	Brown Treecreeper	V	-	1	Low
Aves	*Anthochaera phrygia*	Regent Honeyeater	CE	CE	9	Low
Aves	*Epthianura albifrons*	White-fronted Chat	EPop, V	-	228	Low
Aves	*Melithreptus gularis gularis*	Black-chinned Honeyeater (eastern subspecies)	V	-	1	Low
Aves	*Daphoenositta chrysoptera*	Varied Sittella	V	-	10	Moderate Reported from Cumberland SF in 1985 and 1992 but not since, despite regular surveys by CBOC. Nearest recent record from Lake Parramatta (2017) but is a sedentary species.
Aves	*Artamus cyanopterus cyanopterus*	Dusky Woodswallow	V	-	38	High Regularly recorded in Cumberland State Forest in 1970s-1980s as part of a banding scheme.. Again incidentally recorded in CSF in 2012 and 2014.
Aves	*Melanodryas cucullata cucullata*	Hooded Robin	V	-	1	Low
Aves	*Petroica boodang*	Scarlet Robin	V	-	8	Moderate
Aves	*Petroica phoenicea*	Flame Robin	V	-	3	Moderate One record from Cumberland State Forest.
Aves	*Petroica rodinogaster*	Pink Robin	V	-	1	Low
Aves	*Stagonopleura guttata*	Diamond Firetail	V	-	1	Low
Mammalia	*Dasyurus maculatus*	Spotted-tailed Quoll	V	E	11	Moderate

Fauna type	Scientific Name	Common Name	Status		Number of Records	Likelihood to occur
			NSW	Commonwealth		
						Records from the broader study area are almost all from areas adjacent to extensive expanses of bushland, such as large national parks, and none are very recent.
Mammalia	*Phascolarctos cinereus*	Koala	V	V	9	Low
Mammalia	*Cercartetus nanus*	Eastern Pygmy-possum	V	-	17	Low
Mammalia	*Petaurus australis*	Yellow-bellied Glider	V	-	2	Low
Mammalia	*Petauroides volans*	Greater Glider	-	V	3	Low
Mammalia	*Pteropus poliocephalus*	Grey-headed Flying-fox	V	V	241	High Previously recorded in Cumberland State Forest.
Mammalia	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat	V	-	27	High Probable call recorded on site and previously recorded in Cumberland State Forest.
Mammalia	*Mormopterus norfolkensis*	Eastern Freetail-bat	V	-	49	High Possible call recorded on site and previously recorded in Cumberland State Forest.
Mammalia	*Chalinolobus dwyeri*	Large-eared Pied Bat	V	V	2	Low
Mammalia	*Falsistrellus tasmaniensis*	Eastern False Pipistrelle	V	-	27	High Possible call recorded on site and previously recorded in Cumberland State Forest.
Mammalia	*Miniopterus australis*	Little Bentwing-bat	V	-	20	High
Mammalia	*Miniopterus orianae oceanensis*	Eastern Bentwing-bat	V	-	179	High

Fauna type	Scientific Name	Common Name	Status		Number of Records	Likelihood to occur
			NSW	Commonwealth		
Mammalia	*Myotis macropus*	Southern Myotis	V	-	41	Low
Mammalia	*Scoteanax rueppellii*	Greater Broad-nosed Bat	V	-	27	High Possible call recorded on site and previously recorded in Cumberland State Forest.
Mammalia	*Pseudomys gracilicaudatus*	Eastern Chestnut Mouse	V	-	2	Low
Gastropoda	*Meridolum corneovirens*	Cumberland Plain Land Snail	E	-	24	Low
Gastropoda	*Pommerhelix duralensis*	Dural Woodland Snail	E	E	33	High

Table 3: Times of passive recording survey and target fauna groups. A = ultrasonic recording using 2 Anabat Express units; B = Audio recording of birds, mammals, and megachiroptera using by a BAR unit.

Date	Recording times	Passive recording survey periods (minutes)					
		Microbats[A]	Diurnal birds[B]	Nocturnal birds[B]	Amphibians[B]	Arboreal mammals[B]	Flying-foxes[B]
29/12/2017	7.30-8 pm	30	30				
	8pm-8:30pm	30					
	8.30-9 pm	30	30				
	9pm-9:30pm	30					
	9.30-10 pm	30		30	30	30	30
	10pm-10:30pm	30					
	10.30-11 pm	30		30	30	30	30
	11pm-11:30pm	30					
	11.30-12 midnight pm	30		30	30	30	30
30/12/2017	12 midnight-12.30 am	30		30	30	30	30
	12:30am-1am	30					
	1-1.30 am	30		30	30	30	30
	1:30am-2am	30					
	2-2.30 am	30		30	30	30	30
	2:30am-3am	30					
	3-3.30 am	30		30	30	30	30
	3:30am-4am	30					
	4-4.30 am	30		30	30	30	30
	4:30am-5am	30					
	5-5.30 am	30	30				
	5:30am-6am	30					
	6-6.30 am		30				
	6:30am-7am						
	7-7.30 am		30				
	7.30-8 pm	30	30				

Date	Recording times	Passive recording survey periods (minutes)					
		Microbats[A]	Diurnal birds[B]	Nocturnal birds[B]	Amphibians[B]	Arboreal mammals[B]	Flying-foxes[B]
	8pm-8:30pm	30					
	8.30-9 pm	30	30				
	9pm-9:30pm	30					
	9.30-10 pm	30		30	30	30	30
	10pm-10:30pm	30					
	10.30-11 pm	30		30	30	30	30
	11pm-11:30pm	30					
	11.30-12 midnight pm	30		30	30	30	30
31/12/2017	12 midnight-12.30 am	30		30	30	30	30
	12:30am-1am	30					
	1-1.30 am	30		30	30	30	30
	1:30am-2am	30					
	2-2.30 am	30		30	30	30	30
	2:30am-3am	30					
	3-3.30 am	30		30	30	30	30
	3:30am-4am	30					
	4-4.30 am	30		30	30	30	30
	4:30am-5am	30					
	5-5.30 am	30	30				
	5:30am-6am	30					
	6-6.30 am		30				
	6:30am-7am						
	7-7.30 am		30				
	7:30am-8am						
	8-8.30 am		30				
Total minutes recorded and analysed		**1,260**	**660**	**480**	**480**	**480**	**480**
Total hours recorded and analysed		**21**	**11**	**8**	**8**	**8**	**8**

Table 4: Flora species recorded on site during survey and otherwise within Cumberland State Forest. * = exotic or not locally native.
Affinity of each species with BGHF or STIF is also indicated, according to the characteristic species listed in the Final Determination of each community.

Family	Scientific Name	Common Name	BGHF	STIF	RM	Q1	Q2	Q3	Q4	Q5	Q6	Cumberland SF
Adiantaceae	*Adiantum aethiopicum*	Common Maidenhair	C			x				x	x	
Adiantaceae	*Cheilanthes distans*	Bristly Cloak Fern										x
Adiantaceae	*Cheilanthes sieberi* subsp. *sieberi*	Poison Rock Fern										x
Apocynaceae	*Parsonsia straminea*	Common Silkpod				x					x	
Araliaceae	*Hedera helix**	English Ivy							x			
Araliaceae	*Polyscias sambucifolia* subsp. *long leaflets*	Elderberry Panax		C		x		x		x		
Arecaceae	*Livistona australis*	Cabbage Tree Palm			x							
Asparagaceae	*Asparagus aethiopicus**	Ground Asparagus					x					
Aspleniaceae	*Asplenium australasicum*	Birds Nest Fern							x			
Asteliaceae	*Cordyline stricta*	Narrow-leaf Palm Lily							x	x		
Asteraceae	*Ozothamnus diosmifolius*	Rive Flower			x							
Bignoniaceae	*Pandorea jasminoides*	Bower Vine			x							
Bignoniaceae	*Pandorea pandorana*	Wonga Vine	C	C		x				x	x	
Blechnaceae	*Blechnum cartilagineum*	Gristle Fern	C		x							
Caprifoliaceae	*Lonicera japonica**	Japanese Honeysuckle					x					
Casuarinaceae	*Allocasuarina torulosa*	Forest Oak	C	C		x						
Celastraceae	*Denhamia silvestris*	-	C							x		
Cunoniaceae	*Ceratopetalum gummiferum*	Christmas Bush			x							
Cyatheaceae	*Cyathea australis*	Rough Tree-fern			x							
Ericaceae	*Leucopogon juniperinus*	Prickly Beard-heath	C	C		x					x	
Euphorbiaceae	*Breynia oblongifolia*	Coffee Bush	C	C	x	x						x
Euphorbiaceae	*Glochidion ferdinandi* var. *ferdinandi*	Cheese Tree	C				x			x	x	x
Euphorbiaceae	*Poranthera microphylla*			C	x							x
Iridaceae	*Dietes bicolor**	Spanish Iris			x							
Lamiaceae	*Clerodendrum tomentosum*	Hairy Clerodendrum	C	C							x	
Lomandraceae	*Lomandra longifolia*	Spiky-headed Mat-rush	C	C					x	x		
Lomariopsidaceae	*Nephrolepis cordifolia*	Fish-bone Fern							x			
Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry	C		x	x						
Menispermiaceae	*Sarcopetalum harveyanum*	Pearl Vine								x		
Menispermiaceae	*Stephania japonica* var. *discolor*	Snake Vine						x				
Mimosaceae	*Acacia elata*	Cedar Wattle					x					
Mimosaceae	*Acacia floribunda*	Sally Wattle			x							
Mimosaceae	*Acacia longissima*	Long-leaf Wattle				x						
Moraceae	*Ficus coronata*	Sandpaper Fig	C		x							
Myrsinaceae	*Myrsine variabilis*	Muttonwood	C			x						

Family	Scientific Name	Common Name	BGHF	STIF	RM	Q1	Q2	Q3	Q4	Q5	Q6	Cumberland SF
Myrtaceae	*Angophora costata*	Smooth-barked Apple	C	C		x			x	x	x	
Myrtaceae	*Corymbia citriodora**	Lemon-scented Gum			x							
Myrtaceae	*Eucalyptus paniculata* subsp. *paniculata*	Grey Ironbark	C	C			x					
Myrtaceae	*Eucalyptus pilularis*	Blackbutt	C			x			x	x	x	x
Myrtaceae	*Eucalyptus punctata*	Grey Gum			x							
Myrtaceae	*Eucalyptus resinifera* subsp. *resinifera*	Red Mahogany										x
Myrtaceae	*Eucalyptus saligna*	Sydney Blue Gum	C				x	x	x	nearby		x
Myrtaceae	*Eucalyptus tereticornis*	Forest Red Gum			x							x
Myrtaceae	*Leptospermum polygalifolium* subsp. *polygalifolium*	Lemon Scented Tea Tree										x
Myrtaceae	*Leptospermum trinervium*	Flaky-barked Tea Tree										x
Myrtaceae	*Syncarpia glomulifera*	Turpentine		C		x				x	x	x
Ochnaceae	*Ochna serrulata**	Mickey Mouse Plant					x					x
Oleaceae	*Ligustrum lucidum**	Large-leaved Privet					x	x	x			x
Oleaceae	*Ligustrum sinense**	Small-leaved Privet					x			x	x	x
Oleaceae	*Notelaea longifolia*	Mock Olive	C	C		x					x	x
Oleaceae	*Olea europaea* subsp. *cuspidata**	African Olive			x							
Orchidaceae	*Acianthus* sp.	Orchid			x							x
Orchidaceae	*Calochilus campestris*	Copper Beard Orchid										x
Orchidaceae	*Calochilus paludosus*	Red Beard Orchid										x
Orchidaceae	*Calochilus robertsonii*	Purplish Beard Orchid										x
Orchidaceae	*Cryptostylis subulata*	Large Tongue Orchid									x	
Orchidaceae	*Dipodium variegatum*	-			x							
Orchidaceae	*Microtis unifolia*	Common Onion Orchid										x
Oxalidaceae	*Oxalis perennans*	-										x
Oxalidaceae	*Oxalis pes-caprae**	Soursob										x
Passifloraceae	*Passiflora edulis**	Common Passionfruit										x
Passifloraceae	*Passiflora herbertiana*	Native Passionfruit										x
Passifloraceae	*Passiflora subpeltata**	White Passionflower										x
Passifloraceae	*Passiflora tarminiana**	Banana Passionfruit						x				
Phormiaceae	*Dianella caerulea*	Flax Lily	C	C		x				x	x	x
Phormiaceae	*Dianella caerulea* var. *producta*	Blue Flax Lily										x
Phormiaceae	*Dianella longifolia*	-										x
Phormiaceae	*Dianella prunina*	-										x
Phormiaceae	*Dianella revoluta* var. *revoluta*	Spreading Flax Lily										x
Phytolaccaceae	*Phytolacca octandra**	Inkweed										x
Pittosporaceae	*Billardiera scandens*	Hairy Apple Berry										x
Pittosporaceae	*Bursaria spinosa* var. *spinosa*	Blackthorn		C		x					x	x

Family	Scientific Name	Common Name	BGHF	STIF	RM	Q1	Q2	Q3	Q4	Q5	Q6	Cumberland SF
Pittosporaceae	*Pittosporum revolutum*	Yellow Pittosporum										x
Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum	C	C		x	x	x	x	x	x	x
Plantaginaceae	*Plantago debilis*	Slender Plantain										x
Plantaginaceae	*Plantago lanceolata**	Ribwort										x
Plantaginaceae	*Veronica plebeia*	Creeping Speedwell										x
Poaceae	*Andropogon virginicus**	Whisky Grass										x
Poaceae	*Aristida vagans*	Three-awn Speargrass										x
Poaceae	*Briza maxima**	Quaking Grass										x
Poaceae	*Briza minor**	Shivery Grass										x
Poaceae	*Briza subaristata**	-										x
Poaceae	*Bromus catharticus**	Prairie Grass										x
Poaceae	*Dichelachne micrantha*	Short-hair Plume Grass										x
Poaceae	*Dichelachne rara*	-										x
Poaceae	*Digitaria parviflora*	Small-flowered Finger Grass										x
Poaceae	*Echinopogon caespitosus* var. *caespitosus*	Tufted Hedgehog Grass										x
Poaceae	*Echinopogon ovatus*	Forest Hedgehog Grass										x
Poaceae	*Ehrharta erecta**	Panic Veldtgrass						x				x
Poaceae	*Entolasia marginata*	Bordered Panic	C	C		x			x			x
Poaceae	*Entolasia stricta*	Wiry Panic										x
Poaceae	*Imperata cylindrica* var. *major*	Blady Grass										x
Poaceae	*Microlaena stipoides* var. *stipoides*	Weeping Rice Grass		C	x							x
Poaceae	*Oplismenus aemulus*	Basket Grass	C	C	x							x
Poaceae	*Oplismenus imbecillis*	-										x
Poaceae	*Paspalidium* sp.	-										x
Poaceae	*Poa affinis*	-										x
Poaceae	*Poa labillardieri* var. *labillardieri*	Tussock Grass										x
Poaceae	*Sporobolus africanus**	Parramatta Grass										x
Poaceae	*Themeda triandra*	Kangaroo Grass		C	x							x
Podocarpaceae	*Podocarpus spinulosus*	-										x
Polygalaceae	*Comesperma ericinum*	Matchheads										x
Proteaceae	*Grevillea linearifolia*	White Spider Flower										x
Proteaceae	*Grevillea sericea*	Pink Spider Flower										x
Proteaceae	*Hakea laevipes* subsp. *laevipes*	-										x
Proteaceae	*Hakea salicifolia*	Willow Hakea										x
Proteaceae	*Hakea sericea*	Needlebush										x
Proteaceae	*Isopogon anemonifolius*	Flat-leaved Drumsticks										x
Proteaceae	*Lomatia silaifolia*	Crinkle Bush				x						x

Family	Scientific Name	Common Name	BGHF	STIF	RM	Q1	Q2	Q3	Q4	Q5	Q6	Cumberland SF
Proteaceae	*Macadamia integrifolia**	Macadamia Nut										x
Proteaceae	*Persoonia laurina*	Laurel Geebung										x
Proteaceae	*Persoonia levis*	Broad-leaved Geebung										x
Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung	C		x							
Proteaceae	*Petrophile pulchella*	Conesticks										x
Proteaceae	*Telopea speciosissima*	Waratah										x
Proteaceae	*Xylomelum pyriforme*	Woody Pear										x
Pteridaceae	*Pteris tremula*	Tender Brake										x
Ranunculaceae	*Clematis aristata*	Old Man's Beard	C	C		x		x			x	x
Ranunculaceae	*Clematis glycinoides* var. *glycinoides*	Clematis										x
Rhamnaceae	*Alphitonia excelsa*	Red Ash	C			x						x
Rhamnaceae	*Cryptandra amara*	-										x
Rhamnaceae	*Cryptandra ericoides*	-										x
Rosaceae	*Rubus fruticosis* sp. *agg.**	Blackberry										x
Rosaceae	*Rubus parvifolius*	Native Raspberry										x
Rubiaceae	*Galium binifolium*	-										x
Rubiaceae	*Galium propinquum*	Bedstraw										x
Rubiaceae	*Morinda jasminoides*	-	C			x		x	x	x	x	x
Rubiaceae	*Opercularia aspera*	Common Stinkweed										x
Rubiaceae	*Pomax umbellata*	Pomax										x
Rutaceae	*Eriostemon australasius* subsp. *australasius*	Pink Wax Flower										x
Rutaceae	*Zieria smithii*	Sandfly Zieria		C	x							x
Santalaceae	*Exocarpos cupressiformis*	Native Cherry										x
Sapindaceae	*Dodonaea triquetra*	Hop Bush										x
Schizaeaceae	*Schizaea bifida*	Forked Comb-fern										x
Smilacaceae	*Smilax australis*	Lawyer Vine										x
Smilacaceae	*Smilax glyciphylla*	Sarsparilla	C	C						x		x
Solanaceae	*Duboisia myoporoides*	Corkwood			x							x
Solanaceae	*Solanum mauritianum**	Wild Tobacco Bush			x							
Solanaceae	*Solanum prinophyllum*	Forest Nightshade										x
Solanaceae	*Solanum pseudocapsicum**	-										x
Solanaceae	*Solanum seaforthianum**	Brazilian Nightshade						x				
Thelypteridaceae	*Christella dentata*	-			x							x
Thymelaeaceae	*Pimelea linifolia* subsp. *linifolia*	Slender Rice Flower										x
Ulmaceae	*Trema tomentosa* var. *aspera*	Native Peach										x
Verbenaceae	*Lantana camara**	Lantana					x	x		x	x	
Verbenaceae	*Verbena officinalis**	Common Verbena										x

Family	Scientific Name	Common Name	BGHF	STIF	RM	Q1	Q2	Q3	Q4	Q5	Q6	Cumberland SF
Vitaceae	*Cayratia clematidea*	Slender Grape					x					x
Xanthorrhoeaceae	*Xanthorrhoea media*	-				x						

Table 5: Fauna recorded on and near the subject site, detailing the type of observation on the subject site during survey, and the numbers of all species reported as occurring in Cumberland State Forest as detailed in OEH BioNet Atlas 2018 (http://www.bionet.nsw.gov.au/). Listed species of conservation significance are shown in bold type.

Group	Scientific Name	Common Name	Subject site (record type)	Cumberland SF (number)	Status	
					BC Act (2016)	EPBC Act (1999)
Amphibians	*Crinia signifera*	Common Eastern Froglet		3		
	Limnodynastes peronii	Brown-striped Frog		8		
	Litoria dentata	Bleating Tree Frog		2		
	Litoria peronii	Peron's Tree Frog	Call recorded	2		
Reptiles	*Phyllurus platurus*	Broad-tailed Gecko		2		
	Pygopus lepidopodus	Common Scaly-foot		1		
	Eulamprus quoyii	Eastern Water-skink		3		
	Lampropholis guichenoti	Pale-flecked Garden Sunskink	Observed	1		
	Tiliqua scincoides	Eastern Blue-tongue		1		
	Cacophis squamulosus	Golden-crowned Snake		1		
	Pseudechis porphyriacus	Red-bellied Black Snake		1		
Birds	*Alectura lathami*	Australian Brush-turkey	Observed	1		
	Anas superciliosa	Pacific Black Duck		1		
	Columba leucomela	White-headed Pigeon		1		
	Macropygia amboinensis	Brown Cuckoo-Dove		1		
	Ocyphaps lophotes	Crested Pigeon		1		
	*Streptopelia chinensis**	Spotted Turtle-Dove		3		
	Podargus strigoides	Tawny Frogmouth	Call recorded	6		
	Hirundapus caudacutus	**White-throated Needletail**		**1**		**Migratory**
	Phalacrocorax varius	Pied Cormorant		1		
	Egretta novaehollandiae	White-faced Heron		1		
	Accipiter cirrocephalus	Collared Sparrowhawk		1		
	Accipiter fasciatus	Brown Goshawk		1		

Group	Scientific Name	Common Name	Subject site (record type)	Cumberland SF (number)	Status	
					BC Act (2016)	EPBC Act (1999)
Birds	*Accipiter novaehollandiae*	Grey Goshawk		5		
	Aviceda subcristata	Pacific Baza		1		
	Elanus axillaris	Black-shouldered Kite		1		
	Lophoictinia isura	**Square-tailed Kite**		**1**	**Vulnerable**	
	Gallinula tenebrosa	Dusky Moorhen		1		
	Vanellus miles	Masked Lapwing	Call recorded	1		
	Cacatua galerita	Sulphur-crested Cockatoo	Observed	14		
	Cacatua sanguinea	Little Corella		4		
	Cacatua tenuirostris	Long-billed Corella		1		
	Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo		1		
	Eolophus roseicapillus	Galah		2		
	Eolophus roseicapillus albiceps			1		
	Alisterus scapularis	Australian King-Parrot	Observed	7		
	Barnardius zonarius	Australian Ringneck		1		
	Barnardius zonarius barnardi	[Mallee Ringneck]		1		
	Glossopsitta concinna	Musk Lorikeet		6		
	Glossopsitta pusilla	**Little Lorikeet**		**1**	**Vulnerable**	
	Lathamus discolor	**Swift Parrot**		**1**	**Endangered**	**Critically Endangered**
	Platycercus elegans	Crimson Rosella		25		
	Platycercus eximius	Eastern Rosella	Observed	7		
	Trichoglossus chlorolepidotus	Scaly-breasted Lorikeet		1		
	Trichoglossus haematodus	Rainbow Lorikeet	Observed	11		
	Cacomantis flabelliformis	Fan-tailed Cuckoo		9		
	Cacomantis pallidus	Pallid Cuckoo		1		
	Chalcites basalis	Horsfield's Bronze-Cuckoo		1		
	Chalcites lucidus	Shining Bronze-Cuckoo		1		

Group	Scientific Name	Common Name	Subject site (record type)	Cumberland SF (number)	Status	
					BC Act (2016)	EPBC Act (1999)
Birds	*Eudynamys orientalis*	Eastern Koel	Call recorded	3		
	Scythrops novaehollandiae	Channel-billed Cuckoo		1		
	Ninox novaeseelandiae	Southern Boobook	Call recorded	3		
	Ninox strenua	**Powerful Owl**	**Call recorded, and 2 nest trees**	**2**	**Vulnerable**	
	Tyto javanica	Eastern Barn Owl		1		
	Dacelo novaeguineae	Laughing Kookaburra	Observed	21		
	Todiramphus sanctus	Sacred Kingfisher		8		
	Eurystomus orientalis	Dollarbird		3		
	Cormobates leucophaea	White-throated Treecreeper	Call recorded	40		
	Ptilonorhynchus violaceus	Satin Bowerbird		48		
	Malurus cyaneus	Superb Fairy-wren	Observed	111		
	Malurus lamberti	Variegated Fairy-wren		37		
	Malurus lamberti lamberti			1		
	Acanthiza lineata	Striated Thornbill		11		
	Acanthiza nana	Yellow Thornbill		2		
	Acanthiza pusilla	Brown Thornbill	Call recorded	24		
	Acanthiza pusilla pusilla			1		
	Gerygone mouki	Brown Gerygone		37		
	Sericornis frontalis	White-browed Scrubwren	Call recorded	231		
	Pardalotus punctatus	Spotted Pardalote	Call recorded	28		
	Pardalotus striatus	Striated Pardalote		1		
	Acanthorhynchus tenuirostris	Eastern Spinebill		120		
	Anthochaera carunculata	Red Wattlebird	Call recorded	7		
	Anthochaera chrysoptera	Little Wattlebird		7		
	Caligavis chrysops	Yellow-faced Honeyeater		46		
	Lichenostomus melanops	Yellow-tufted Honeyeater		186		

Group	Scientific Name	Common Name	Subject site (record type)	Cumberland SF (number)	Status	
					BC Act (2016)	EPBC Act (1999)
Birds	*Manorina melanocephala*	Noisy Miner	Call recorded	14		
	Manorina melanophrys	Bell Miner	Call recorded	314		
	Meliphaga lewinii	Lewin's Honeyeater	Call recorded	60		
	Melithreptus lunatus	White-naped Honeyeater		36		
	Myzomela sanguinolenta	Scarlet Honeyeater		1		
	Nesoptilotis leucotis	White-eared Honeyeater		1		
	Phylidonyris niger	White-cheeked Honeyeater		20		
	Phylidonyris novaehollandiae	New Holland Honeyeater		14		
	Ptilotula fuscus	Fuscous Honeyeater		5		
	Psophodes olivaceus	Eastern Whipbird	Call recorded	39		
	Coracina novaehollandiae	Black-faced Cuckoo-shrike	Heard	3		
	Coracina papuensis	White-bellied Cuckoo-shrike		1		
	Colluricincla harmonica	Grey Shrike-thrush		43		
	Falcunculus frontatus frontatus	Eastern Shrike-tit		4		
	Pachycephala pectoralis	Golden Whistler		80		
	Pachycephala rufiventris	Rufous Whistler		5		
	Oriolus sagittatus	Olive-backed Oriole	Call recorded	11		
	Artamus cyanopterus cyanopterus	**Dusky Woodswallow**		**14**	**Vulnerable**	
	Artamus superciliosus	White-browed Woodswallow		1		
	Cracticus tibicen	Australian Magpie	Call recorded	11		
	Cracticus torquatus	Grey Butcherbird	Observed	15		
	Cracticus nigrogularis	Pied Butcherbird	Call recorded			
	Strepera graculina	Pied Currawong	Observed	18		
	Rhipidura albiscapa	Grey Fantail		29		
	Rhipidura leucophrys	Willie Wagtail		14		
	Rhipidura rufifrons	Rufous Fantail		15		

Group	Scientific Name	Common Name	Subject site (record type)	Cumberland SF (number)	Status	
					BC Act (2016)	EPBC Act (1999)
Birds	*Corvus coronoides*	Australian Raven	Observed	10		
	Grallina cyanoleuca	Magpie-lark		2		
	Monarcha melanopsis	Black-faced Monarch		1		
	Myiagra alecto	Shining Flycatcher		1		
	Myiagra inquieta	Restless Flycatcher		1		
	Myiagra rubecula	Leaden Flycatcher		2		
	Symposiachrus trivirgatus	Spectacled Monarch		1		
	Eopsaltria australis	Eastern Yellow Robin	Observed	334		
	Petroica goodenovii	Red-capped Robin		1		
	Petroica phoenicea	**Flame Robin**		**1**	**Vulnerable**	
	Petroica rosea	Rose Robin		4		
	Zosterops lateralis	Silvereye		213		
	Hirundo neoxena	Welcome Swallow		22		
	*Pycnonotus jocosus**	Red-whiskered Bulbul		48		
	*Turdus merula**	Eurasian Blackbird		18		
	Zoothera sp.	unidentified ground thrush		1		
	*Sturnus tristis**	Common Myna	Call recorded	2		
	*Sturnus vulgaris**	Common Starling		1		
	Dicaeum hirundinaceum	Mistletoebird		1		
	Neochmia temporalis	Red-browed Finch		278		
	*Passer domesticus**	House Sparrow		26		
	*Carduelis carduelis**	European Goldfinch		1		
Mammals	*Tachyglossus aculeatus*	Short-beaked Echidna		1		
	Perameles nasuta	Long-nosed Bandicoot		1		
	Petaurus breviceps	Sugar Glider	Call recorded	4		
	Pseudocheirus peregrinus	Common Ringtail Possum		12		

Group	Scientific Name	Common Name	Subject site (record type)	Cumberland SF (number)	Status	
					BC Act (2016)	EPBC Act (1999)
Mammals	*Acrobates pygmaeus*	Feathertail Glider		1		
	Trichosurus vulpecula	Common Brushtail Possum		8		
	Pteropus poliocephalus	**Grey-headed Flying-fox**		**2**	**Vulnerable**	**Vulnerable**
	Saccolaimus flaviventris	**Yellow-bellied Sheathtail-bat**	**Call recorded - probable**	**2**	**Vulnerable**	
	Austronomus australis	White-striped Freetail-bat	Call recorded - definite	4		
	Mormopterus norfolkensis	**Eastern Freetail-bat**	**Call recorded - possible**	**2**	**Vulnerable**	
	Mormopterus ridei	Eastern Free-tailed Bat		4		
	Mormopterus sp.	Freetail-bat	Call recorded - probable	1		
	Chalinolobus gouldii	Gould's Wattled Bat	Call recorded - probable	8		
	Falsistrellus tasmaniensis	**Eastern False Pipistrelle**	**Call recorded - possible**	**1**	**Vulnerable**	
	Nyctophilus geoffroyi	Lesser Long-eared Bat		4		
	Nyctophilus gouldi	Gould's Long-eared Bat		9		
	Nyctophilus sp.	long-eared bat	Call recorded - probable	2		
	Scotorepens orion	Eastern Broad-nosed Bat	Call recorded - possible	3		
	Scoteanax rueppellii	**Greater Broad-nosed Bat**	**Call recorded - possible**		**Vulnerable**	
	Vespadelus vulturnus	Little Forest Bat	Call recorded - possible	8		
	*Mus musculus**	House Mouse		1		
	*Rattus rattus**	Black Rat		1		
	*Canis lupus familiaris**	Dog		1		
	*Vulpes vulpes**	Fox		1		

Table 6: Powerful Owl data used for local territory analysis. Sub-location codes as per Figure 10. Source: eBird Australia.

Territory / site name	Sub-location code	Date			Number reported	Activity		Prey present	Juveniles
		Year	Month	Day		Roosting	Calling		
Cumberland State Fores	1	2011	May	2	2	roosting			
Cumberland State Fores	1	2007	January	17	2	roosting			
Cumberland State Fores	1	2007	January	7	2	roosting			
Cumberland State Fores	1	2007	January	7	2	roosting			present
Cumberland State Fores	1	2006	December	30	2	roosting			
Cumberland State Fores	1	2004	April	25	1	roosting			
George Thornton Reserve	2	2017	November	12	3	roosting			present
George Thornton Reserve	3	2016	May	20	1				
Northmead Gully	4	2015	June	19	2	roosting			
Northmead Gully	5	2017	May	11	1		calling		
Northmead Gully	5	2017	April	17	1		calling		
Northmead Gully	5	2017	August	28	1		calling		
Vineyard Creek Reserve, Oatlands	6	2012	November	15	1				present
Vineyard Creek Reserve, Oatlands	7	2017	November	19	1	roosting			
Vineyard Creek Reserve, Oatlands	8	2017	December	3	2	roosting			
Vineyard Creek Reserve, Oatlands	8	2017	April	17	1	roosting			
Vineyard Creek Reserve, Oatlands	8	2017	February	26	2	roosting			
Vineyard Creek Reserve, Oatlands	8	2016	June	16	2	roosting			
Vineyard Creek Reserve, Oatlands	8	2015	September	28	2	roosting			
Vineyard Creek Reserve, Oatlands	8	2014	November	27	2	roosting			
Vineyard Creek Reserve, Oatlands	8	2013	July	29	1	roosting		Rainbow Lorikeet	
Vineyard Creek Reserve, Oatlands	8	2013	May	16	1	roosting			
Vineyard Creek Reserve, Oatlands	8	2013	April	29	2	roosting			
Vineyard Creek Reserve, Oatlands	8	2013	January	30	2	roosting			present
Vineyard Creek Reserve, Oatlands	8	2012	December	29	1		calling		present
Vineyard Creek Reserve, Oatlands	8	2012	October	13	3	roosting			present

Territory / site name	Sub-location code	Date			Number reported	Activity		Prey present	Juveniles
		Year	Month	Day		Roosting	Calling		
Vineyard Creek Reserve, Oatlands	8	2012	September	15	3	roosting			present
Carlingford	9	2017	July	1	1	roosting		Rainbow Lorikeet	
Carlingford	10	2014	March	12	2	roosting			
Carlingford	10	2013	December	31	2	roosting			
Carlingford	10	2013	October	30	1	roosting			
Carlingford	10	2013	September	18	1	roosting			
Carlingford	10	2013	June	28	1	roosting			
Carlingford	10	2013	June	17	2	roosting			
Carlingford	10	2013	June	10	2	roosting			
Carlingford	10	2013	May	24	1	roosting			
Carlingford	10	2013	April	26	2	roosting			
Carlingford	10	2013	April	17	2	roosting			
Carlingford	10	2013	March	6	1	roosting			
Carlingford	10	2013	February	21	1	roosting			
Carlingford	10	2012	December	12	2	roosting			
Carlingford	10	2012	November	5	1	roosting			
Carlingford	10	2012	October	26	1	roosting			
Carlingford	10	2012	October	20	1	roosting			
Carlingford	10	2012	October	19	2	roosting			
Carlingford	10	2012	October	14	1	roosting			
Carlingford	10	2012	October	2	2	roosting			
Carlingford	10	2012	September	28	1	roosting			
Carlingford	10	2012	September	27	2	roosting			
Carlingford	10	2012	June	1	1	roosting			
Carlingford	10	2012	May	23	2	roosting			
Carlingford	10	2012	May	17	1	roosting			
Carlingford	10	2012	May	17	1	roosting			
Carlingford	10	2012	May	10	1	roosting		Ringtail Possum	

Territory / site name	Sub-location code	Date			Number reported	Activity		Prey present	Juveniles
		Year	Month	Day		Roosting	Calling		
Carlingford	10	2012	May	2	1	roosting			
Carlingford	10	2012	April	22	1	roosting			
Carlingford	10	2012	April	15	2	roosting			
Carlingford	10	2012	April	3	1	roosting			
Parklands along Terrys Creek, southern end	11	2014	April	6	1	roosting			
Parklands along Terrys Creek, southern end	12	2017	August	26	3	roosting			present
Parklands along Terrys Creek, southern end	12	2017	July	1	1	roosting			
Parklands along Terrys Creek, southern end	12	2017	June	1	1	roosting			
Parklands along Terrys Creek, southern end	13	2015	August	23	1		calling		
Parklands along Terrys Creek, southern end	13	2014	February	12	1		calling		
Parklands along Terrys Creek, southern end	13	2013	October	13	3	roosting			
Parklands along Terrys Creek, southern end	13	2013	September	5	1		calling		
Parklands along Terrys Creek, southern end	13	2013	August	27	4	roosting			present
Parklands along Terrys Creek, southern end	13	2013	August	25	1		calling		
Parklands along Terrys Creek, southern end	13	2013	May	16	1				
Parklands along Terrys Creek, southern end	13	2013	April	16	1		calling		
Parklands along Terrys Creek, southern end	13	2013	January	12	2	roosting			
Parklands along Terrys Creek, southern end	13	2011	August	27	1		calling		
Parklands along Terrys Creek, southern end	14	2017	April	6	2	roosting			
Parklands along Terrys Creek, southern end	14	2016	October	6	1	roosting			
Parklands along Terrys Creek, southern end	14	2016	February	12	1	roosting			

Territory / site name	Sub-location code	Date			Number reported	Activity		Prey present	Juveniles
		Year	Month	Day		Roosting	Calling		
Parklands along Terrys Creek, southern end	14	2013	August	30	3	roosting			present
Parklands along Terrys Creek, southern end	14	2011	November	13	1	roosting			present
Parklands along Terrys Creek, southern end	14	2011	October	15	2	roosting			
Parklands along Terrys Creek, southern end	14	2011	September	1	1	roosting			
Parklands along Terrys Creek, southern end	14	2009	December	31	1	roosting		Ringtail Possum	present
Parklands along Terrys Creek, southern end	14	2008	October	26	3	roosting			present
Parklands along Terrys Creek, southern end	14	2008	January	28	1	roosting		Ringtail Possum	
Parklands along Terrys Creek, southern end	14	2007	November	16	4	roosting			present
Parklands along Terrys Creek, southern end	15	2018	January	8	1	roosting			
Parklands along Terrys Creek, southern end	15	2018	January	4	1	roosting			
Parklands along Terrys Creek, southern end	15	2018	January	1	3	roosting			
Parklands along Terrys Creek, southern end	15	2018	January	1	3	roosting			present
Parklands along Terrys Creek, southern end	15	2017	December	11	2	roosting			present
Parklands along Terrys Creek, southern end	15	2017	December	8	2	roosting			
Parklands along Terrys Creek, southern end	15	2017	November	27	4	roosting			
Parklands along Terrys Creek, southern end	15	2017	November	7	3	roosting			
Parklands along Terrys Creek, southern end	15	2017	November	1	2	roosting		Possum	
Parklands along Terrys Creek, southern end	15	2017	October	25	1	roosting			
Parklands along Terrys Creek, southern end	15	2017	October	21	2	roosting		Ringtail Possum	
Parklands along Terrys Creek, southern end	15	2017	October	12	1	roosting			

Territory / site name	Sub-location code	Date			Number reported	Activity		Prey present	Juveniles
		Year	Month	Day		Roosting	Calling		
Parklands along Terrys Creek, southern end	15	2017	September	18	2	roosting		Mammal	
Parklands along Terrys Creek, southern end	15	2017	September	15	1	roosting			
Parklands along Terrys Creek, southern end	15	2017	September	7	1	roosting			
Parklands along Terrys Creek, southern end	15	2017	September	4	2	roosting			
Parklands along Terrys Creek, southern end	15	2017	August	17	2	roosting			
Parklands along Terrys Creek, southern end	15	2017	August	2	1	roosting			
Parklands along Terrys Creek, southern end	15	2017	July	24	2	roosting			
Parklands along Terrys Creek, southern end	15	2017	July	17	1	roosting			
Parklands along Terrys Creek, southern end	15	2017	July	12	1	roosting			
Parklands along Terrys Creek, southern end	15	2017	July	9	1	roosting			
Parklands along Terrys Creek, southern end	15	2017	July	1	1	roosting			
Parklands along Terrys Creek, southern end	15	2017	June	25	1	roosting			
Parklands along Terrys Creek, southern end	15	2017	June	18	1	roosting			
Parklands along Terrys Creek, southern end	15	2017	May	10	2	roosting			
Parklands along Terrys Creek, southern end	15	2017	May	8	2	roosting			
Parklands along Terrys Creek, southern end	15	2017	May	1	1	roosting			
Parklands along Terrys Creek, southern end	15	2017	April	24	3	roosting			
Parklands along Terrys Creek, southern end	15	2017	April	16	1	roosting		Ringtail Possum	
Parklands along Terrys Creek, southern end	15	2017	April	13	3	roosting		Ringtail Possum and Grey-headed Flying-fox	

Territory / site name	Sub-location code	Date			Number reported	Activity		Prey present	Juveniles
		Year	Month	Day		Roosting	Calling		
Parklands along Terrys Creek, southern end	15	2017	April	7	3	roosting			
Parklands along Terrys Creek, southern end	15	2017	April	6	3	roosting		Ringtail Possum	
Parklands along Terrys Creek, southern end	15	2017	April	5	3	roosting		Ringtail Possum and mammal	
Parklands along Terrys Creek, southern end	15	2017	March	27	1	roosting			
Parklands along Terrys Creek, southern end	15	2017	March	2	2	roosting			
Parklands along Terrys Creek, southern end	15	2017	February	22	3	roosting			
Parklands along Terrys Creek, southern end	15	2017	February	20	3	roosting			
Parklands along Terrys Creek, southern end	15	2017	February	16	2	roosting		Ringtail Possum	
Parklands along Terrys Creek, southern end	15	2017	January	17	2	roosting		Ringtail Possum	
Parklands along Terrys Creek, southern end	15	2017	January	10	2	roosting		Ringtail Possum	
Parklands along Terrys Creek, southern end	15	2017	January	1	2	roosting			
Parklands along Terrys Creek, southern end	15	2016	December	22	1	roosting			
Parklands along Terrys Creek, southern end	15	2016	December	8	1	roosting			
Parklands along Terrys Creek, southern end	15	2016	November	30	1	roosting		Ringtail Possum	
Parklands along Terrys Creek, southern end	15	2016	November	4	2	roosting		Bird	
Parklands along Terrys Creek, southern end	15	2016	October	24	1	roosting			
Parklands along Terrys Creek, southern end	15	2016	October	14	2	roosting			
Parklands along Terrys Creek, southern end	15	2016	October	5	1	roosting			
Parklands along Terrys Creek, southern end	15	2016	September	6	1	roosting			
Parklands along Terrys Creek, southern end	15	2016	August	31	1	roosting			

Territory / site name	Sub-location code	Date			Number reported	Activity		Prey present	Juveniles
		Year	Month	Day		Roosting	Calling		
Parklands along Terrys Creek, southern end	15	2016	August	22	2	roosting		Ringtail Possum	
Parklands along Terrys Creek, southern end	15	2016	August	11	1	roosting			
Parklands along Terrys Creek, southern end	15	2016	August	1	1	roosting			
Parklands along Terrys Creek, southern end	15	2016	July	9	2	roosting			
Parklands along Terrys Creek, southern end	15	2016	July	4	3	roosting		Ringtail Possum	
Parklands along Terrys Creek, southern end	15	2016	June	30	3	roosting			
Parklands along Terrys Creek, southern end	15	2016	June	30	1	roosting			
Parklands along Terrys Creek, southern end	15	2016	June	20	1	roosting			
Parklands along Terrys Creek, southern end	15	2016	June	1	3	roosting		Ringtail Possum	
Parklands along Terrys Creek, southern end	15	2016	May	27	1	roosting			
Parklands along Terrys Creek, southern end	15	2016	May	18	1	roosting			
Parklands along Terrys Creek, southern end	15	2016	May	9	1	roosting			
Parklands along Terrys Creek, southern end	15	2016	May	4	2	roosting		Ringtail Possum	
Parklands along Terrys Creek, southern end	15	2016	April	20	1	roosting			
Parklands along Terrys Creek, southern end	15	2016	April	13	3	roosting			
Parklands along Terrys Creek, southern end	15	2016	April	12	1	roosting		Bird	
Parklands along Terrys Creek, southern end	15	2016	March	30	1	roosting			
Parklands along Terrys Creek, southern end	15	2016	March	18	2	roosting			
Parklands along Terrys Creek, southern end	15	2016	March	14	1	roosting			
Parklands along Terrys Creek, southern end	15	2016	March	7	2	roosting			

Territory / site name	Sub-location code	Date			Number reported	Activity		Prey present	Juveniles
		Year	Month	Day		Roosting	Calling		
Parklands along Terrys Creek, southern end	15	2016	February	29	1	roosting		Ringtail Possum	
Parklands along Terrys Creek, southern end	15	2016	February	19	1	roosting			
Parklands along Terrys Creek, southern end	15	2016	February	17	2	roosting		Possum and possum	
Parklands along Terrys Creek, southern end	15	2016	February	12	1	roosting			
Parklands along Terrys Creek, southern end	15	2016	January	24	1	roosting			
Parklands along Terrys Creek, southern end	15	2016	January	18	2	roosting			
Parklands along Terrys Creek, southern end	15	2016	January	3	1	roosting			present
Parklands along Terrys Creek, southern end	15	2015	December	29	1	roosting			
Parklands along Terrys Creek, southern end	15	2015	December	15	2	roosting			present
Parklands along Terrys Creek, southern end	15	2015	November	21	1	roosting			
Parklands along Terrys Creek, southern end	15	2015	September	30	3	roosting			present
Parklands along Terrys Creek, southern end	15	2015	September	14	3	roosting			present
Parklands along Terrys Creek, southern end	15	2015	September	7	1	roosting			present
Parklands along Terrys Creek, southern end	15	2015	August	19	2	roosting			
Parklands along Terrys Creek, southern end	15	2015	August	17	2	roosting			
Parklands along Terrys Creek, southern end	15	2015	July	24	1	roosting			
Parklands along Terrys Creek, southern end	15	2015	July	20	1	roosting			
Parklands along Terrys Creek, southern end	15	2015	June	30	1	roosting			
Parklands along Terrys Creek, southern end	15	2015	April	27	1	roosting			
Parklands along Terrys Creek, southern end	15	2015	February	7	6	roosting			present

Territory / site name	Sub-location code	Date			Number reported	Activity		Prey present	Juveniles
		Year	Month	Day		Roosting	Calling		
Parklands along Terrys Creek, southern end	15	2015	January	15	1	roosting			
Parklands along Terrys Creek, southern end	15	2015	January	12	2	roosting			
Parklands along Terrys Creek, southern end	15	2015	January	4	3	roosting			
Parklands along Terrys Creek, southern end	15	2014	December	16	1	roosting			
Parklands along Terrys Creek, southern end	15	2014	November	24	2	roosting			present
Parklands along Terrys Creek, southern end	15	2014	November	10	3	roosting			
Parklands along Terrys Creek, southern end	15	2014	October	20	4	roosting			present
Parklands along Terrys Creek, southern end	15	2014	October	13	4	roosting			present
Parklands along Terrys Creek, southern end	15	2014	September	22	4	roosting			
Parklands along Terrys Creek, southern end	15	2014	September	12	4	roosting			present
Parklands along Terrys Creek, southern end	15	2014	September	11	X	roosting			
Parklands along Terrys Creek, southern end	15	2014	September	1	5	roosting			present
Parklands along Terrys Creek, southern end	15	2014	August	22	1	roosting			
Parklands along Terrys Creek, southern end	15	2014	August	14	X	roosting			
Parklands along Terrys Creek, southern end	15	2014	July	21	2	roosting			
Parklands along Terrys Creek, southern end	15	2014	May	30	1	roosting			
Parklands along Terrys Creek, southern end	15	2014	March	10	2	roosting			
Parklands along Terrys Creek, southern end	15	2014	February	17	1	roosting			
Parklands along Terrys Creek, southern end	15	2014	February	10	1	roosting			
Parklands along Terrys Creek, southern end	15	2014	February	6	1	roosting			

Territory / site name	Sub-location code	Date			Number reported	Activity		Prey present	Juveniles
		Year	Month	Day		Roosting	Calling		
Parklands along Terrys Creek, southern end	15	2014	February	1	2	roosting			
Parklands along Terrys Creek, southern end	15	2014	January	15	3	roosting			
Parklands along Terrys Creek, southern end	15	2014	January	7	4	roosting			present
Parklands along Terrys Creek, southern end	15	2013	December	16	1	roosting			
Parklands along Terrys Creek, southern end	15	2013	December	12	2	roosting			present
Parklands along Terrys Creek, southern end	15	2013	December	9	2	roosting			
Parklands along Terrys Creek, southern end	15	2013	November	21	X	roosting			
Parklands along Terrys Creek, southern end	15	2013	November	12	3	roosting			
Parklands along Terrys Creek, southern end	15	2013	November	3	X	roosting			
Parklands along Terrys Creek, southern end	15	2013	October	29	X	roosting			
Parklands along Terrys Creek, southern end	15	2013	October	11	1	roosting			
Parklands along Terrys Creek, southern end	15	2013	September	30	X	roosting			
Parklands along Terrys Creek, southern end	15	2013	September	6	4	roosting			present
Parklands along Terrys Creek, southern end	15	2013	September	5	4	roosting			present
Parklands along Terrys Creek, southern end	15	2013	August	12	X	roosting			
Parklands along Terrys Creek, southern end	15	2013	July	1	2	roosting			
Parklands along Terrys Creek, southern end	15	2013	May	8	2	roosting			
Parklands along Terrys Creek, southern end	15	2013	April	30	1	roosting			
Parklands along Terrys Creek, southern end	15	2013	April	12	2	roosting			
Parklands along Terrys Creek, southern end	15	2013	April	5	1	roosting			

Territory / site name	Sub-location code	Date			Number reported	Activity		Prey present	Juveniles
		Year	Month	Day		Roosting	Calling		
Parklands along Terrys Creek, southern end	15	2013	March	2	2	roosting			
Parklands along Terrys Creek, southern end	15	2013	February	8	1	roosting			
Parklands along Terrys Creek, southern end	15	2013	February	1	1	roosting			
Parklands along Terrys Creek, southern end	15	2013	January	11	2	roosting			
Parklands along Terrys Creek, southern end	15	2013	January	2	2	roosting			
Parklands along Terrys Creek, southern end	15	2012	October	29	1	roosting			
Parklands along Terrys Creek, southern end	15	2012	October	3	1	roosting			
Parklands along Terrys Creek, southern end	16	2017	September	3	1		calling		
Parklands along Terrys Creek, southern end	16	2017	September	3	1		calling		
Parklands along Terrys Creek, southern end	16	2017	March	1	1				
Parklands along Terrys Creek, southern end	16	2013	January	4	1		calling	Channel-billed Cuckoo (x2)	
Parklands along Terrys Creek, northern end	17	2017	December	8	1	roosting			present
Parklands along Terrys Creek, northern end	17	2017	November	7	3	roosting			present
Parklands along Terrys Creek, northern end	17	2017	October	29	3	roosting			present
Parklands along Terrys Creek, northern end	17	2017	October	25	3	roosting			present
Parklands along Terrys Creek, northern end	17	2017	July	10	1	roosting		Ringtail Possum	
Parklands along Terrys Creek, northern end	17	2017	May	12	1	roosting			
Parklands along Terrys Creek, northern end	17	2017	May	10	1	roosting		Ringtail Possum	
Parklands along Terrys Creek, northern end	17	2017	May	1	2	roosting		Ringtail Possum	
Parklands along Terrys Creek, northern end	17	2017	April	30	2	roosting			

Territory / site name	Sub-location code	Date			Number reported	Activity		Prey present	Juveniles
		Year	Month	Day		Roosting	Calling		
Parklands along Terrys Creek, northern end	17	2017	April	5	2	roosting			
Parklands along Terrys Creek, northern end	17	2017	March	27	1	roosting			
Parklands along Terrys Creek, northern end	17	2017	February	20	1	roosting			
Parklands along Terrys Creek, northern end	17	2017	January	15	1	roosting			present
Parklands along Terrys Creek, northern end	17	2017	January	4	1	roosting			
Parklands along Terrys Creek, northern end	17	2016	December	12	1	roosting			present
Parklands along Terrys Creek, northern end	17	2016	December	8	1	roosting			present
Parklands along Terrys Creek, northern end	17	2016	November	28	2	roosting			present
Parklands along Terrys Creek, northern end	17	2016	November	10	3	roosting			present
Parklands along Terrys Creek, northern end	17	2016	November	6	3	roosting			present
Parklands along Terrys Creek, northern end	17	2016	November	1	2	roosting			present
Parklands along Terrys Creek, northern end	17	2016	October	30	2	roosting		Ringtail Possum	
Parklands along Terrys Creek, northern end	17	2016	October	27	3	roosting			present
Parklands along Terrys Creek, northern end	17	2016	October	14	4	roosting			present
Parklands along Terrys Creek, northern end	17	2016	October	9	4	roosting			present
Parklands along Terrys Creek, northern end	17	2016	September	28	4	roosting			present
Parklands along Terrys Creek, northern end	17	2016	September	17	4	roosting			present
Parklands along Terrys Creek, northern end	17	2016	August	25	4	roosting			present
Parklands along Terrys Creek, northern end	17	2016	August	23	4	roosting			present
Parklands along Terrys Creek, northern end	17	2016	August	11	1	roosting			

Territory / site name	Sub-location code	Date			Number reported	Activity		Prey present	Juveniles
		Year	Month	Day		Roosting	Calling		
Parklands along Terrys Creek, northern end	17	2016	August	1	1	roosting			
Parklands along Terrys Creek, northern end	17	2016	June	15	1	roosting		Ringtail Possum	
Parklands along Terrys Creek, northern end	17	2016	June	12	X	roosting			
Parklands along Terrys Creek, northern end	17	2016	May	4	2	roosting			
Parklands along Terrys Creek, northern end	17	2016	April	27	2	roosting			
Parklands along Terrys Creek, northern end	17	2016	April	20	2	roosting		Bird	
Parklands along Terrys Creek, northern end	17	2016	April	13	1	roosting			
Parklands along Terrys Creek, northern end	17	2016	April	1	1	roosting			
Parklands along Terrys Creek, northern end	17	2016	March	30	2	roosting			
Parklands along Terrys Creek, northern end	17	2016	March	18	1	roosting		Grey-headed Flying-fox	
Parklands along Terrys Creek, northern end	17	2016	March	14	2	roosting			
Parklands along Terrys Creek, northern end	17	2016	February	29	1	roosting			
Parklands along Terrys Creek, northern end	17	2016	February	21	1	roosting			
Parklands along Terrys Creek, northern end	17	2016	February	19	1	roosting			present
Parklands along Terrys Creek, northern end	17	2016	February	8	2	roosting			
Parklands along Terrys Creek, northern end	17	2016	January	18	2	roosting			present
Parklands along Terrys Creek, northern end	17	2015	December	29	3	roosting			present
Parklands along Terrys Creek, northern end	17	2015	December	15	1	roosting			
Parklands along Terrys Creek, northern end	17	2015	November	22	X	roosting			
Parklands along Terrys Creek, northern end	17	2015	November	8	4	roosting			

Territory / site name	Sub-location code	Date			Number reported	Activity		Prey present	Juveniles
		Year	Month	Day		Roosting	Calling		
Parklands along Terrys Creek, northern end	17	2015	October	23	1	roosting			
Parklands along Terrys Creek, northern end	17	2015	September	30	4	roosting			present
Parklands along Terrys Creek, northern end	17	2015	September	27	4	roosting			present
Parklands along Terrys Creek, northern end	17	2015	September	7	3	roosting			present
Parklands along Terrys Creek, northern end	17	2015	April	5	2	roosting			
Parklands along Terrys Creek, northern end	17	2014	December	16	1	roosting			present
Parklands along Terrys Creek, northern end	17	2014	November	13	1	roosting			
Parklands along Terrys Creek, northern end	17	2014	October	13	3	roosting			present
Parklands along Terrys Creek, northern end	17	2014	September	12	3	roosting			present
Parklands along Terrys Creek, northern end	17	2014	April	14	2	roosting			
Parklands along Terrys Creek, northern end	17	2014	February	21	1	roosting			
Parklands along Terrys Creek, northern end	17	2014	February	10	2	roosting			
Parklands along Terrys Creek, northern end	17	2014	February	7	1	roosting			present
Parklands along Terrys Creek, northern end	17	2014	January	7	2	roosting			
Parklands along Terrys Creek, northern end	17	2013	October	29	3	roosting			
Parklands along Terrys Creek, northern end	17	2013	October	11	3	roosting			
Parklands along Terrys Creek, northern end	17	2013	September	13	1	roosting			
Parklands along Terrys Creek, northern end	17	2013	August	12	1	roosting		Ringtail Possum	
Parklands along Terrys Creek, northern end	17	2013	May	20	2	roosting			
Parklands along Terrys Creek, northern end	17	2013	May	8	2	roosting			

Territory / site name	Sub-location code	Date			Number reported	Activity		Prey present	Juveniles
		Year	Month	Day		Roosting	Calling		
Parklands along Terrys Creek, northern end	17	2013	April	30	1	roosting			
Parklands along Terrys Creek, northern end	17	2013	April	12	2	roosting			
Parklands along Terrys Creek, northern end	17	2013	April	8	2	roosting		Brushtail Possum	
Parklands along Terrys Creek, southern end	18	2017	January	4	1	roosting			
Parklands along Terrys Creek, southern end	18	2013	April	6	3	roosting			
Lane Cove National Park, Pennant Hills	19	2015	October	4	2	roosting			
Lane Cove National Park, Pennant Hills	19	2014	October	14	2	roosting			
Lane Cove National Park, Pennant Hills	19	2013	August	4	1	roosting			
Lane Cove National Park, Pennant Hills	19	2013	March	20	1	roosting			
Lane Cove National Park, Pennant Hills	19	2012	April	23	1	roosting			
Lane Cove National Park, Pennant Hills	19	1996	March	2	1	roosting			
Lane Cove National Park, Pennant Hills	19	1996	March	1	2	roosting			
Lane Cove National Park, Pennant Hills	19	1992	April	18	1	roosting			
Lane Cove National Park, Pennant Hills	20	2014	March	14	2	roosting			
Lane Cove National Park, Pennant Hills	21	2015	October	9	1	roosting			
Lane Cove National Park, Pennant Hills	22	2017	December	11	3	roosting			
Lane Cove National Park, Pennant Hills	22	2017	December	10	1	roosting			
Lane Cove National Park, Pennant Hills	22	2014	March	14	2	roosting			
Lane Cove National Park, Pennant Hills	23	2009	December	31	1	roosting			
Lane Cove National Park, Pennant Hills	23	2007	December	30	1		calling		

Territory / site name	Sub-location code	Date			Number reported	Activity		Prey present	Juveniles
		Year	Month	Day		Roosting	Calling		
Lane Cove National Park, Pennant Hills	23	2007	November	20	1 (up to 3)	roosting			present
Lane Cove National Park, Pennant Hills	23	2007	September	6	1	roosting			
Lane Cove National Park, Pennant Hills	23	2007	September	4	1	roosting			
Lane Cove National Park, Pennant Hills	23	2007	September	1	2	roosting			
Lane Cove National Park, Pennant Hills	23	2007	August	18	3 (maybe 4)	roosting			present
Lane Cove National Park, Pennant Hills	23	2007	June	25	2		calling		
Lane Cove National Park, Pennant Hills	23	2006	October	28	3	roosting			present
Lane Cove National Park, Pennant Hills	24	2013	October	20		roosting			
Lane Cove National Park, Pennant Hills	24	2012	August	13		roosting			
Lane Cove National Park, Pennant Hills	24	2011	May	16	1				
Lane Cove National Park, Pennant Hills	24	2011	January	5	1	roosting			
Lane Cove National Park, Pennant Hills	24	2009	December	8	3	roosting			
Lane Cove National Park, Pennant Hills	24	2007	September	28	2	roosting		Possum	
Lane Cove National Park, Pennant Hills	24	2000	November	9	2	roosting			
Lane Cove National Park, Pennant Hills	24	1992	May	17					
Cumberland State Forest	25	2012	February	12		roosting			
Cumberland State Forest	25	2011	May	9		roosting			
Cumberland State Forest	26	2013	July	1	1		calling		
Cumberland State Forest	26	2014	March	2		roosting			
Cumberland State Forest	26	2014	February	17		roosting			
Cumberland State Forest	27	2010	March	19	2		calling		
Cumberland State Forest	27	2009	March	29	1		calling		

Territory / site name	Sub-location code	Date			Number reported	Activity		Prey present	Juveniles
		Year	Month	Day		Roosting	Calling		
Cumberland State Forest	27	2004	September	26	1		calling		
Wahroonga	28	2009	November	6	3	roosting			present
West Wahroonga	29	2015	February	10	1		calling		
Berowra Valley Regional Park, Westleigh	30	2015	October	13	1		calling		
Berowra Valley Regional Park, Westleigh	30	2015	February	20	1				
Berowra Valley Regional Park, Westleigh	30	2015	February	15	1				
Berowra Valley Regional Park, Westleigh	30	2015	February	3	1		calling		
Berowra Valley Regional Park, Westleigh	30	2015	January	4	1		calling		
Berowra Valley Regional Park, Westleigh	30	2014	July	9					
Berowra Valley Regional Park, Westleigh	30	2014	July	4					
Berowra Valley Regional Park, Westleigh	30	2009	March	29					
Berowra Valley Regional Park, Westleigh	31	2018	January	7	1		calling		
Berowra Valley Regional Park, Westleigh	31	2017	April	17	1		calling		
Berowra Valley Regional Park, Westleigh	31	2017	April	4	1		calling		
Berowra Valley Regional Park, Westleigh	31	2017	March	28	1		calling		
Berowra Valley Regional Park, Westleigh	31	2016	April	20	1		calling		
Berowra Valley Regional Park, Westleigh	31	2016	February	14	1		calling		
Berowra Valley Regional Park, Westleigh	31	2015	August	6	1		calling		
Berowra Valley Regional Park, Westleigh	31	2015	April	26	1		calling		
Berowra Valley Regional Park, Westleigh	31	2015	March	28	1		calling		
Berowra Valley Regional Park, Westleigh	31	2015	March	17	1		calling		

Territory / site name	Sub-location code	Date			Number reported	Activity		Prey present	Juveniles
		Year	Month	Day		Roosting	Calling		
Berowra Valley Regional Park, Westleigh	31	2015	March	5	2		calling		
Berowra Valley Regional Park, Westleigh	31	2015	February	20	1	roosting			
Berowra Valley Regional Park, Westleigh	31	2015	February	3	1		calling		
Berowra Valley Regional Park, Westleigh	31	2015	January	14	1		calling		
West Turramurra	32	2013	November	3	1	roosting			
West Turramurra	32	2011	June	1	1		calling		
West Turramurra	32	2009	September	12			calling		
West Turramurra	32	2009	August	9			calling		
West Turramurra	32	2009	April	8		roosting	calling		
West Turramurra	32	2009	January	9			calling		
West Turramurra	32	2008	December	27			calling		
West Turramurra	32	2008	December	11			calling		
West Turramurra	32	2008	November	27			calling		
West Turramurra	32	2008	September	23			calling		

Table 7: Arboreal mammal habitat assessment plots.

Sample site	Habitat	Understorey	Hollows suitable for arboreal mammals	Total Habitat Value Score
1 (Q1) Southern forest	STIF in habitat type 10	Mid dense, native (2)	Present (1)	3
2 (Q2) Northern tip	BGHF in habitat type 8	Dense, exotic (3)	Absent (0)	3
3 (Q3) North eastern corner	BGHF in habitat type 8	Dense, native (4)	Absent (0)	4
4 (Q4) Riparian zone of unnamed tributary	BGHF in habitat type 10	Mid dense, native (2)	Present (1)	3
5 (Q5) Riparian zone of unnamed tributary	BGHF in habitat type 10	Mid dense, native (2)	Present (1)	3
6 (Q6) Near nest tree 1	BGHF in habitat type 10	Dense, native (4)	Present (1)	5
7 Northern car park	Habitat type 2	Absent (0)	Absent (0)	0
8 Northern car park	Habitat type 2	Absent (0)	Absent (0)	0
9 Landscaped garden	Habitat type 4	Absent (0)	Absent (0)	0
10 Near nest tree 2	BGHF in habitat type 10	Mid dense, native (2)	Present (1)	3
11 South western corner	STIF in habitat type 10	Dense, native (4)	Present (1)	5
12 Southern boundary	BGHF in habitat type 10	Mid dense, native (2)	Present (1)	3
13 Western APZ	BGHF in habitat type 10	Absent (0)	Absent (0)	0
14 Landscaped garden	Habitat type 4	Absent (0)	Absent (0)	0
15 Landscaped garden	Habitat type 4	Dense and native (4)	Absent	4