Powerful Owl Assessment

55 Coonara Avenue West Pennant Hills The Hills LGA

For: Mirvac

REF: HiSC 15-770

17th September 2019



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mail:	PO Box 5095 Empire Bay NSW 2257	Cover photograph: Audio recording unit in
telephone:	(02) 4368 1106	gully habitat.
email:	office@keystone-ecological.com.au	Photo: E. Ashby, 4 th December 2018
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1 BACKGROUND

Keystone Ecological has been engaged by Mirvac to prepare an assessment of the biodiversity values at 55 Coonara Avenue, West Pennant Hills in The Hills Shire Local Government Area (LGA), with the view to the site's redevelopment from a Business Park to residential housing and low rise apartments, public open space and environmental conservation of the remnant bushland area.

Ecological investigations of the subject site have been undertaken by Keystone Ecological since 2015. An integral part of these investigations has been the consideration of the likelihood of the presence of threatened species, and the subsequent targeted survey and assessment of those species likely to occur.

Ninox strenua Powerful Owl was the subject of such consideration, as the site is part of an expanse of bushland known to support a breeding pair.

The proposed rezoning will facilitate redevelopment of the current buildings and landscaped gardens for residential purposes. The proposed development footprint shown in Masterplanning documents confine the redeveloped parts almost entirely to the existing footprint. A detailed discussion of the proposal is provided in companion documents such as the *Biodiversity Assessment* (Ashby 2018).

2 ECOLOGICAL PROFILE OF THE POWERFUL OWL

The Powerful Owl is listed as Vulnerable under Schedule 1 of 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 Australia Owls, with bold chevrons across its chest. This species is endemic to eastern and south-eastern Australia (OEH 2018a), recorded from most types of sclerophyll forest along the south east coast of Australia (Slater et al. 1995), 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 2018a). 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 2018a).

Habitat ranges from 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).

This species can be observed roosting in dense vegetation during the day, often clutching the remains of prey species in its talons. The Powerful Owl 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, but the Sugar Glider, Common Brushtail Possum and Greyheaded Flying-fox are also common prey species (DECCW 2010). Its diet is also supplemented by diurnal birds, particularly the Pied Currawong and many parrot species of a similar size including Rainbow Lorikeets (DECCW 2010). Scansorial and terrestrial mammals (particularly rats) are also recorded in Powerful Owl pellets, although rarely (DECCW 2010). Insects are also exploited, especially by, and for, fledglings (Mo and Waterhouse 2015).

Nests are located in large vertical hollows at least 0.5 metre deep (OEH 2018a) 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 located in a well vegetated gully (Kavanagh 1997). The large sizes of the trees preferred for nesting (DBH height of 80-240 centimetres) are offered only by old eucalypts e.g. 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 2018a).

The breeding season is from April to September (Australian Museum 2011). Clutches usually consist of two eggs and incubation lasts approximately 38 days (OEH 2018a). 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 around the nesting site may not be 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.

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 2018a). In good habitats a mere 400 hectares can support a pair; but where hollow trees and prey have been depleted, the owls may need up to 4,000 hectares (OEH 2018a).

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

The distribution and abundance of this species in the Sydney metropolitan area is now well known as a result of the Powerful Owl Project, a large citizen scientist project run by Birdlife Australia. This extensive survey of Powerful Owls across Sydney has established that the Sydney urban landscape and immediate bushland surrounds have probably reached carrying capacity. Prey species selection has also been expanding from the preferred arboreal Ringtail Possum to include the Brushtail Possum, which spends more time on the ground. It has been speculated that this may explain the increasing incidences of car strike (Dr Beth Mott, Birdlife Australia, personal communication).

3 SURVEY CONSIDERATIONS FOR THE POWERFUL OWL

The Powerful Owl can be detected in a number of ways:

- Direct observation in its diurnal roost;
- Heard calling, usually when it is establishing breeding territories;
- Calling or otherwise investigating in response to broadcast of calls;
- Direct observation around nest trees;
- White wash beneath roost trees or nest trees;
- Regurgitated pellets of undigested fur, feathers, and bones of prey dropped beneath feeding roosts;
- Dropped (usually headless) prey.

The Powerful Owl is a highly territorial species, but most particularly during breeding. They can be very skittish and are known to abandon early breeding activities (such as courting, mating, preparing the nest hollow, incubation of eggs, caring for new hatchlings) if disturbed. Best practice guidelines now recommend that no active survey (e.g. broadcasting calls, spotlighting, inspection of nest trees, flash photography) occurs early in the breeding season.

Thus, the type of survey to be undertaken is dictated by their life cycle stage as well as their daily behaviour, according to the following seasonal pattern:

- **Territory establishment.** During early autumn (March), males can be heard calling while they establish (or re-establish) their territories. They usually call in the early evening but are known to call intermittently throughout the night. In this season, it is therefore most easily detected at night through passive call recording. Adult males and females (and sometimes still dependent young) may be observed in day roosts;
- **Courting and mating** usually occurs throughout autumn, from late March to May. Males continue to call periodically through the night to their mate as well as to warn off other males. Survey must not interfere with this early breeding, and so they are again best detected at night through passive call recording, and otherwise observed in their day roosts;
- Incubation. The female is on the nest from early June to early September. She does not leave the nest tree during the 38-day incubation period, and is fed by the male. The male acts as both guard and provider during this period. His day roost is invariably near the nest tree, and usually from a vantage point with a good view of the entry to the hollow. Therefore, the male is best detected in his day roost, or observed entering and leaving the nest with prey items for his partner. Calls between the pair in this period are usually brief, so passive recording is not very effective;
- **Nestlings.** During early spring (September-October), newly-hatched nestlings can be heard in the nest. Both males and females forage and feed the young, but the females still spend most of their time in the nest with the vulnerable offspring. Therefore, in this

season, Powerful Owls are best detected by direct observation of males in their day roosts, or of observation of feeding activity around the nest tree entrance;

• **Fledglings.** The young are fledged 7 to 8 weeks after hatching, and by mid to late spring are escorted by the parents to another part of the territory away from the nest tree. Therefore, from late spring to mid-summer, both parents and fledgling juveniles are best detected in day roosts. Fledglings may still be with and dependent on their parents to some degree until the autumn, when courtship begins for the next breeding season. Broadcast of calls at night from late spring to summer is generally unlikely to interrupt their behaviour and so this, along with the observation of animals at their day roosts, are the best survey methods at this time of year.

4 SITE SURVEY

Biodiversity survey has been carried out on the site by Keystone Ecological from winter 2015 to spring 2019. Targeted survey activities for Powerful Owls were informed by the following desktop investigations:

- Literature searches, the most relevant being the Species Impact Statement prepared for the Tree Tops Adventure Trail in Cumberland State Forest (Couston 2013);
- Interrogation of wildlife databases (BioNet, Atlas of Living Australia, eBird);
- Consultation with the Site Manager of Cumberland State Forest Mr Tim Liston; and
- Consultation with experts and colleagues, particularly Dr Stephen Ambrose (Ambrose Ecological Services) and Dr Beth Mott (BirdLife Australia, convenor of the Powerful Owl Project).

These investigations identified 2 nest trees on the subject site and another 4 trees in the adjacent Cumberland State Forest. Birdlife Australia reported both successful and unsuccessful breeding attempts in 4 of these trees in 2000, 2004, 2007, 2008, 2014, 2015, 2016, and 2017.

This background information allowed for targeted survey on site to be confined to potential roosting habitat in the two gullies, and specifically around known nest trees. Supplementary survey was undertaken in Cumberland State Forest in winter and spring 2019.

In accordance with the sampling constraints detailed above, appropriate methodology has been employed in every sampling period, but comprehensive targeted survey was not implemented until spring 2017. Survey details are shown in Figure 1 and Table 1 overleaf.

Survey activities comprised:

- Continuous nocturnal audio recording in 4 locations on site (in roosting habitat along the central gully and beneath nest tree #2);
- Call broadcast from 2 locations in the northern and southern parts of the site. Calls were broadcast within 1 hour of nightfall, repeated several times interspersed with quiet listening;

• Assessment of habitat for preferred prey species (particularly Ringtail Possum) in 15 sample plots. The sampling was concentrated in the areas to be most impacted by the proposed development as shown in the Masterplan, being the car park and in the landscaped gardens. All habitat assessment plots were approximately 400 square metres in extent. 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;
- Regular and repeated daytime inspection of canopy and sub-canopy trees in the roosting habitat in the gullies;
- Intensive searching beneath planted trees in developed parts. These areas were targeted as they are the areas proposed for development as per the Masterplan;
- Spotlighting around the developed and planted areas, along trails in the southern bushland, and along trails in the southern end of Cumberland State Forest; and
- Regular and repeated inspections beneath nest trees #1 and #2 for signs of use (such as white wash or regurgitated pellets).



FIGURE 1: Survey activities for the Powerful Owl.

TABLE 1: Surve	TABLE 1: Survey activities on and near the site from 2015 to 2019. Unless otherwise stated, all activities are on site.											
			Survey r	nethod su	itable to det	ect:						
Life Cycle Stage	Data	Survey method	Male	Male	Female	Juvenile						
Life Cycle Stage	Date	Survey method	in day	night	in nest /	in nest /						
			roost	activity	day roost	day roost						
Incubation	20 June 2014	Direct observation of roosting habitat	\checkmark									
Nestlings	8 September 2015	• Direct observation of roosting habitat	\checkmark		\checkmark	\checkmark						
Nestlings	September 2017	• Direct observation of roosting habitat	\checkmark		\checkmark							
Fledglings	12 December 2017	• Direct observation of roosting habitat	\checkmark	✓	\checkmark	√						
Fledglings	29 December 2017	Passive audio recording	\checkmark	✓	\checkmark	√						
Fledglings	30 December 2017	Call broadcast	\checkmark	✓	\checkmark	\checkmark						
Fledglings	31 December 2017	Spotlighting	\checkmark	✓	\checkmark	✓						
Fledglings	2 February 2018	• Direct observation of roosting habitat	\checkmark		\checkmark	✓						
Fledglings	21 February 2018	• Direct observation of roosting habitat	✓		\checkmark	✓						
Courting and mating	14 March 2018	• Direct observation of roosting habitat	\checkmark		\checkmark	\checkmark						
Incubation	8 June 2018	Direct observation of roosting habitat	~									
Incubation	10 July 2018	Direct observation of roosting habitat	~									
Incubation	18 July 2018	• Direct observation of roosting habitat	\checkmark									
Incubation	8 August 2018	Direct observation of roosting habitat	\checkmark									
		• Direct observation of roosting habitat	1			1						
Fledglings	4 December 2018	Passive audio recording	V	~	V	V						
	5 D	Call broadcast			1	(
Fledglings	5 December 2018	Spotlighting	~	V	~	V						
Fledglings	31 January 2019	Direct observation of roosting habitat	~		\checkmark	✓						
Courting and mating	9 May 2019	• Direct observation of roosting habitat	\checkmark									
Courting and mating	28 May 2019	• Direct observation of roosting habitat	✓									
Incubation	12 June 2010	Direct observation of roosting habitat	~									
IIICUDALIOII	12 Julie 2017	Passive audio recording	·									

TABLE 1: Surve	y activities on and nea	r the site from 2015 to 2019. Unless otherw	vise stated	l, all activi	ties are on s	ite.
			Survey r	nethod su	itable to det	ect:
Life Cycle Stage	Data	Survey method	Male	Male	Female	Juvenile
Life Cycle Stage	Date	Survey memou	in day	night	in nest /	in nest /
			roost	activity	day roost	day roost
Incubation	2 - 9 July 2019	Passive audio recording	✓	✓		
		Direct observation of roosting habitat				
Incubation	2 July 2019	Nest tree watch	✓	✓		
		Spotlighting				
		• Direct observation of roosting habitat				
Incubation	9 July 2019	Nest tree watch	\checkmark	\checkmark		
		Spotlighting				
Incubation	18 -23 July 2019	Passive audio recording	~	✓		
		• Direct observation of roosting habitat				
Incubation	18 July 2019	Nest tree watch	\checkmark	✓		
		Spotlighting				
		• Direct observation of roosting habitat				
Incubation	23 July 2019	Nest tree watch	\checkmark	\checkmark		
		Spotlighting				
		In Cumberland State Forest and the				
		subject site:				
Incubation	22 July 2010	• Direct observation of roosting habitat		1	1	
Incubation	25 July 2019	Passive audio recording		•	·	
		Nest tree watch				
		Spotlighting				
		In Cumberland State Forest:				
Nectlings	6 September 2019	• Direct observation of roosting habitat		1	\checkmark	\checkmark
ivesuiligs		Passive audio recording			÷	÷
		Nest tree watch				

TABLE 1: Surve	TABLE 1: Survey activities on and near the site from 2015 to 2019. Unless otherwise stated, all activities are on site.								
			Survey method suitable to detect:						
Life Cuelo Stage	Data	Sumon method	Male	Male	Female	Juvenile			
Life Cycle Stage	Date	Survey method	in day	night	in nest /	in nest /			
			roost	activity	day roost	day roost			
		Spotlighting							
		In Cumberland State Forest:							
		• Direct observation of roosting habitat							
Nestlings	8 September 2019	8 September 2019 • Passive audio recording				\checkmark	\checkmark		
		Nest tree watch							
		Spotlighting							
		In Cumberland State Forest:							
		• Direct observation of roosting habitat							
Nestlings	9 September 2019	Passive audio recording		✓	\checkmark	\checkmark			
		Nest tree watch							
		Spotlighting							

5 **RESULTS**

5.1 The Powerful Owl

Birdlife Australia records indicate the following breeding activity in the 5 nest trees shown as yellow circles in Figure 1:

- Tree #1: used in 2007
- Tree #2: used in 2008, 2014, 2015
- Tree #3: used in 2016, 2017
- Tree #4a: used in 2004
- Tree #4b: used in 2000

There are no data available re the unnumbered nest tree reported by Forestry Corporation staff.

No individuals of the Powerful Owl were observed on site during any of the targeted survey activities from 2017 to 2019. However, calls were recorded by the passive audio recording equipment placed near tree number 2 in December 2017 and again in July 2019.

In 2017 two short, faint calls of the 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.

At this time of year, a successful breeding pair should have recently-fledged young with them away from the nest. However, no owlets were observed during survey, and there are no reports of such activity published by eBird or BirdLife Australia at that time in or near that location.

Roosting habitat on site was regularly inspected throughout 2018, but no animals were observed on site or evidence of their occupation found.

Forestry Corporation staff reported seeing 2 young birds in December 2018 in one of the gullies near the corporate buildings in the southern part of Cumberland State Forest (Mr Tim Liston, personal communication). It is not known which tree was used for nesting, but the absence of evidence of activity in trees and habitat within the subject site indicate that trees 1 and 2 were not used.

In the audio sampling period of 2-9 July 2019, short faint calls were again recorded by the audio equipment located near tree number 2. The calls all occurred within a few minutes either side of the end of astronomical twilight, which is when the sky is dark and most nocturnal species become active. At this time of year, the female should be on eggs in the nest, and it is likely that the recording was of the male calling softly to her as he woke and emerged from his roosting habitat, prior to his first foraging foray.

In order to determine whether these calls were of the pair using tree number 2, this tree was watched on 18 July 2019 from a half hour before the start to a half hour after the end of astronomical twilight. No animals were observed to enter or emerge from nest tree number 2, but faint calls were recorded at 6.04 p.m.

At the same time as tree number 2 was being watched, another observer quietly surveyed the gullies around the Forestry Corporation buildings, listening for calling birds during twilight. Calls of the Powerful Owl were heard at 6.04 p.m. and although they were not loud or persistent, they were clearly emanating from a gully in the southern part of Cumberland State Forest and not from the subject site. Animals were not observed, as the mid canopy in this part of the State Forest is very dense, but further investigations were not undertaken due to it being in a sensitive part of the breeding season.

Follow up survey was undertaken by bird specialist Dr Stephen Ambrose on 6, 8, and 9 September 2019, looking for likely nest trees in the gullies around the Forestry corporate buildings. No Powerful Owls were observed, and there were no obvious signs of current or recent Powerful Owl nesting activity at each of the previously known nest trees.

5.2 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 2 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, 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, 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 is located in landscaped habitat along the edge of the perimeter road and has a dense and mostly native understorey. This is unlike most of the landscaped area, but 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, 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.

Sample site	Habitat	Understorey	Hollows suitable for arboreal mammals	Total Habitat Value Score
1 Southern forest	STIF in habitat type 10	Mid dense, native (2)	Present (1)	3
2 Northern tip	BGHF in habitat type 8	Dense, exotic (3)	Absent (0)	3
3 North eastern corner	BGHF in habitat type 8	Dense, native (4)	Absent (0)	4
4 Riparian zone of unnamed tributary	BGHF in habitat type 10	Mid dense, native (2)	Present (1)	3
5 Riparian zone of unnamed tributary	BGHF in habitat type 10	Mid dense, native (2)	Present (1)	3
6 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

Table 2: Arboreal mammal habitat assessment plots, locations shown in Figure 1.

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 was observed foraging on the subject site and in Cumberland State Forest in December 2018. 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.

6 POTENTIAL IMPACTS ON THE 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).

Bain et al. (2014) developed a set of guidelines specifically aimed at avoiding and mitigating development impacts on the 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), the APZ works in the vegetated parts around the dams (0.11 hectares), and of the planted trees in the northern car park (up to 5.09 hectares).

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, where the resident pair has bred in 2018 and probably again in 2019. 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 and young have 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 tree number 2 is 66 metres from the existing building (see Figure 2 below). The proposed distance to the closest proposed buildings is between 84 and 113 metres.



Figure 2: Extract of surveyor's plan showing the distance of tree number 2 from existing and proposed buildings.

The conditions for tree number 1 will remain unchanged.

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 21 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.
- The timing of construction activity should be restricted in areas within 100 metres of the nest trees during breeding season: noisy works should be confined to 30 minutes after dawn to 60 minutes before dusk between September and February. This would allow time for the fledglings to move to and from potential foraging or roosting habitat near the subject site (Dr Stephen Ambrose, personal communication).
- Areas to be revegetated / landscaped in or near 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, retention of bushland and / or a bushland character is a priority. This feature has been incorporated into the proposal.
- Boost the prey population by habitat enrichment, most of which will occur in the retained bushland.
- 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 in areas adjacent to nesting and roosting habitat instead of hard surfaces (such as asphalt) where choices are available, 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.

7 IMPACT ASSESSMENT

As this rezoning proposal was originally submitted under the old planning provisions, an assessment of significance has been prepared. The definition of the local population is critical to this assessment.

7.1 Local Population

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 3. 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 3. 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 3 and the pair that occupy the subject site and Cumberland State Forest are classified as sub-location 1.



Figure 3: Powerful Owl local population. Simplified territories (purple, red, yellow 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/) (see Table 3) and Foggo (2015).

Territory / site name	Sub- location	Sub- Date				Activi	ty	Prev present	Iuveniles
rennery y site nume	code	Year	Month	Day	reported	Roosting	Calling	ricy present	juvennes
Cumberland State Forest	1	2011	Мау	2	2	roosting			
Cumberland State Forest	1	2007	January	17	2	roosting			
Cumberland State Forest	1	2007	January	7	2	roosting			
Cumberland State Forest	1	2007	January	7	2	roosting			present
Cumberland State Forest	1	2006	December	30	2	roosting			
Cumberland State Forest	1	2004	April	25	1	roosting			
George Thornton Reserve	2	2017	November	12	3	roosting			present
George Thornton Reserve	3	2016	Мау	20	1				
Northmead Gully	4	2015	June	19	2	roosting			
Northmead Gully	5	2017	Мау	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			

Table 3: Powerful Owl data used for local territory analysis - see Figure 3.

Territory / site name	Sub-		Date		Number	Activi	ty	Prev present	Iuveniles
rennery y site nume	code	Year	Month	Day	reported	Roosting	Calling	ricy present	juvennes
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	Мау	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
Vineyard Creek Reserve, Oatlands	8	2012	September	15	3	roosting			present
Carlingford	9	2017	July	1	1	roosting		Rainbow Lorikeet	
Carlingford	10	2019	August	17	1	roosting			
Carlingford	10	2019	July	24	1	roosting			
Carlingford	10	2019	July	3	1	roosting			
Carlingford	10	2019	June	30	1	roosting			
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			

Territory / site name	Sub- location	Date			Number	Activi	ty	Prev present	Iuveniles
rennory / site nume	code	Year	Month	Day	reported	Roosting	Calling	rey present	juvennes
Carlingford	10	2013	June	10	2	roosting			
Carlingford	10	2013	Мау	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	Мау	23	2	roosting			
Carlingford	10	2012	Мау	17	1	roosting			
Carlingford	10	2012	Мау	17	1	roosting			
Carlingford	10	2012	Мау	10	1	roosting		Ringtail Possum	

Territory / site name	Sub- location		Date		Number	Activi	ty	Prev present	Iuveniles
	code	Year	Month	Day	reported	Roosting	Calling	ricy present	juvennee
Carlingford	10	2012	Мау	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		

Territory / site name	Sub- location		Date		Number	Activi	ty	Prev present	Iuveniles
Territory / Site nume	code	Year	Month	Day	reported	Roosting	Calling	rey present	juvennes
Parklands along Terrys Creek, southern end	13	2013	Мау	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			
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

Territory / site name	Sub- location		Date		Number	Activi	ty	Prey present	Iuveniles
Territory / site name	code	Year	Month	Day	reported	Roosting	Calling	Trey present	Juvennes
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	15	2019	September	5	4	roosting			present
Parklands along Terrys Creek	15	2019	September	3	1	roosting			
Parklands along Terrys Creek	15	2019	September	2	4	roosting			present
Parklands along Terrys Creek	15	2019	September	1	5				
Parklands along Terrys Creek	15	2019	August	21	5				
Parklands along Terrys Creek	15	2019	August	5	1				
Parklands along Terrys Creek	15	2019	July	31	3				
Parklands along Terrys Creek	15	2019	July	22	2				
Parklands along Terrys Creek	15	2019	June	7	3				
Parklands along Terrys Creek	15	2019	Мау	15	1				
Parklands along Terrys Creek	15	2019	Мау	4	1				
Parklands along Terrys Creek	15	2019	April	17	1				
Parklands along Terrys Creek	15	2019	April	11	3				
Parklands along Terrys Creek, southern end	15	2018	January	8	1	roosting			
Parklands along Terrys Creek, southern end	15	2018	January	4	1	roosting			

Territory / site name	Sub- location		Date		Number		ty	Prev present	Iuveniles
	code	Year	Month	Day	reported	Roosting	Calling	ricy present	juvennee
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			
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			

Territory / site name	Sub-		Date		Number	Number Activity		Prev present	Iuveniles
rennory y site nume	code	Year	Month	Day	reported	Roosting	Calling	rey present	Juvennes
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	Мау	10	2	roosting			
Parklands along Terrys Creek, southern end	15	2017	Мау	8	2	roosting			
Parklands along Terrys Creek, southern end	15	2017	Мау	1	1	roosting			

Territory / site name	Sub-		Date		Number	Activity		Prev present	Iuveniles
Territory y site nume	code	Year	Month	Day	reported	Roosting	Calling	rey present	Juvennes
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	
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	

Territory / site name	Sub-		Date		Number	Number Activity		Prev present	Iuveniles
Territory y site nume	code	Year	Month	Day	reported	Roosting	Calling	rey present	juvennes
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			
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			

Territory / site name	Sub-		Date		Number	Number		Prev present	Iuveniles
rennory / site nume	code	Year	Month	Day	reported	Roosting	Calling	rey present	juvennes
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	Мау	27	1	roosting			
Parklands along Terrys Creek, southern end	15	2016	Мау	18	1	roosting			
Parklands along Terrys Creek, southern end	15	2016	Мау	9	1	roosting			
Parklands along Terrys Creek, southern end	15	2016	Мау	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			

Territory / site name	Sub-		Date		Number	Number		Prev present	Iuveniles
Territory y site nume	code	Year	Month	Day	reported	Roosting	Calling	rey present	juvennes
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			
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			

Territory / site name	Sub-		Date		Number	Activity		Prev present	Iuveniles
Territory / Site nume	code	Year	Month	Day	reported	Roosting	Calling	rey present	juvennes
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
Parklands along Terrys Creek, southern end	15	2015	January	15	1	roosting			

Territory / site name	Sub- location		Date		Number	Activity		Prev present	Iuveniles
	code	Year	Month	Day	reported	Roosting	Calling	rey present	juvennee
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	Х	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	Х	roosting			

Territory / site name	Sub-		Date		Number	Activity		Prev present	Iuveniles
Territory / Site nume	code	Year	Month	Day	reported	Roosting	Calling	rey present	juvennes
Parklands along Terrys Creek, southern end	15	2014	July	21	2	roosting			
Parklands along Terrys Creek, southern end	15	2014	Мау	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			
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	Х	roosting			

Territory / site name	Sub-		Date		Number	Activity		Prev present	Iuveniles
Territory / Site nume	code	Year	Month	Day	reported	Roosting	Calling	rey present	juvennes
Parklands along Terrys Creek, southern end	15	2013	November	12	3	roosting			
Parklands along Terrys Creek, southern end	15	2013	November	3	Х	roosting			
Parklands along Terrys Creek, southern end	15	2013	October	29	Х	roosting			
Parklands along Terrys Creek, southern end	15	2013	October	11	1	roosting			
Parklands along Terrys Creek, southern end	15	2013	September	30	Х	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	Х	roosting			
Parklands along Terrys Creek, southern end	15	2013	July	1	2	roosting			
Parklands along Terrys Creek, southern end	15	2013	Мау	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-		Date		Number		Prev present	Iuveniles	
Territory / Site nume	code	Year	Month	Day	reported	Roosting	Calling	Trey present	juvennes
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

Territory / site name	Sub-		Date		Number	Activity		Prev present	Iuveniles
Territory / Site nume	code	Year	Month	Day	reported	Roosting	Calling	rey present	juvennes
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	Мау	12	1	roosting			
Parklands along Terrys Creek, northern end	17	2017	Мау	10	1	roosting		Ringtail Possum	
Parklands along Terrys Creek, northern end	17	2017	Мау	1	2	roosting		Ringtail Possum	
Parklands along Terrys Creek, northern end	17	2017	April	30	2	roosting			
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

Territory / site name	Sub- location		Date		Number	Activi	ty	Prey present	Iuveniles
rennery y site nume	code	Year	Month	Day	reported	Roosting	Calling	rey present	juvennes
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

Territory / site name	Sub- location		Date		Number	Activi	ty	Prev nresent	Iuveniles
	code	Year	Month	Day	reported	Roosting	Calling	rey present	juvennee
Parklands along Terrys Creek, northern end	17	2016	August	11	1	roosting			
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	Х	roosting			
Parklands along Terrys Creek, northern end	17	2016	Мау	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			

Territory / site name	Sub-		Date		Number	Activi	ty	Prev present	Iuveniles
	code	Year	Month	Day	reported	Roosting	Calling	ricy present	juvennes
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	Х	roosting			
Parklands along Terrys Creek, northern end	17	2015	November	8	4	roosting			
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			

Territory / site name	Sub-		Date		Number	Activi	ty	Prev present	Juveniles
Territory y site nume	code	Year	Month	Day	reported	Roosting	Calling	rey present	
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	

Territory / site name	Sub-		Date		Number	Activi	ty	Prev present	Iuveniles
rennory y site nume	code	Year	Month	Day	reported	Roosting	Calling	rey present	juvennes
Parklands along Terrys Creek, northern end	17	2013	Мау	20	2	roosting			
Parklands along Terrys Creek, northern end	17	2013	Мау	8	2	roosting			
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			

Territory / site name	Sub-		Date		Number	Activi	ty	Prev present	Juveniles
Territory / Site nume	code	Year	Month	Day	reported	Roosting	Calling	rey present	juvennes
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		
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			

Territory / site name	Sub- location		Date		Number	Activi	ty	Prey present	Iuveniles
	code	Year	Month	Day	reported	Roosting	Calling	ricy present	juvennee
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	Мау	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	Мау	17					
Beecroft Reserve, Beecroft	25	2019	April	11	2	roosting			
Devlins Creek Reserve, Beecroft	25	2019	April	17	1				
Devlins Creek Reserve, Beecroft	25	2018	March	5					

Territory / site name	Sub- location		Date		Number	Activi	ty	Prev present	Iuveniles
rennery / site nume	code	Year	Month	Day	reported	Roosting	Calling	rey present	juvennes
Devlins Creek Reserve, Beecroft	25	2016	April	6	2				
Devlins Creek Reserve, Beecroft	25	2016	February	4	2				
Devlins Creek Reserve, Beecroft	25	2014	March	26	1				
Devlins Creek Reserve, Beecroft	25	2014	January	1	2				
Devlins Creek Reserve, Beecroft	25	2013	September	18	2				
Devlins Creek Reserve, Beecroft	25	2013	July	7	1				
Devlins Creek Reserve, Beecroft	25	2011	March	9	1				
Beecroft Reserve, Beecroft	25	2012	April	6	2				
Devlins Creek Reserve, Beecroft	25	2012	February	12		roosting			
Devlins Creek Reserve, Beecroft	25	2011	Мау	9		roosting			
Pennant Hills Golf Club	26	2013	July	1	1		calling		
Pennant Hills Golf Club	26	2014	March	2		roosting			
Pennant Hills Golf Club	26	2014	February	17		roosting			
Thornleigh	27	2010	March	19	2		calling		
Thornleigh	27	2009	March	29	1		calling		
Thornleigh	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		

Territory / site name	Sub-		Date		Number	Activi	ty	Prev present	Iuveniles
Territory y site nume	code	Year	Month	Day	reported	Roosting	Calling	rey present	juvennes
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		

Territory / site name	Sub- location		Date		Number	Activi	ty	Prey present	Iuveniles
Territory / Site nume	code	Year	Month	Day	reported	Roosting	Calling	i rey present	juvennes
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		
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		

Territory / site name	Sub- location		Date		Number	Activity		Prev present	Iuveniles
	code	Year	Month	Day	reported	Roosting	Calling		
West Turramurra	32	2008	December	11			calling		
West Turramurra	32	2008	November	27			calling		
West Turramurra	32	2008	September	23			calling		

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.

7.2 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, 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 4.23 hectares, which exceeds the threshold nominated by Bain et al. (2014).

However, investigation into the quality of that habitat for this assessment reveals that the landscaped areas generally provide very poor foraging habitat due to the absence of both hollowbearing 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 locallynative Blue Gum High Forest / Sydney Turpentine Ironbark Forest 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 conserved 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 or 6 known to be used in this remnant forest. Tree number 2 is currently within 66 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.

The nearest buildings in the proposed footprint will be in the order of 84 to 113 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 or 6 nest trees within their territory, and apparently now breeding in Cumberland State Forest. Thus, even if tree 2 was rendered unsuitable for one breeding season

due to construction noise, there are 4 or 5 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 such as strategic use f Ornilux or equivalent.

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 r to a State Government entity for conservation.

(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. [*Note that this buffer distance is at odds with recovery activities otherwise promulgated see point 6 below.*]
- 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 [*see above*];
- 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 natural 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.

8 CONCLUSION

The current development on the subject site is a result of long-standing clearing and significant excavation works when the IBM headquarters was constructed in the 1980s, which was concentrated in areas previously cleared for orchards. The ecological values of these parts of the site are therefore diminished. The Masterplan that is the subject of this Planning Proposal has been developed specifically with regard to the protection of the existing significant ecological features that occur outside of the footprint. The Planning Proposal provides a significant opportunity for conservation of areas that now have no environmental protection, being instead currently zoned for business park use.

The developed part of the site – while an aesthetically pleasing man-made landscape - is poor habitat for native flora and fauna. 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. The Planning Proposal also provides a protection mechanism not otherwise available, with the most valuable areas of habitat being captured by the E2 zoning.

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