



University of Wollongong Molecular and Life Science Building

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Document history and status

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1. Introduction

An Environmental Impact Statement (EIS) has been prepared for a State Significant Development Application (SSDA) for a new Molecular and Life Sciences Building (MLS Building) at the University of Wollongong (UOW) Campus. The MLS Building would replace an existing at grade car park within the Science, Medicine and Health (SMAH) faculty at campus east precinct of UOW. The proposed development comprises a new five storey MLS Building.

The removal of planted trees will be required within the development footprint prior to the construction works for the MLS Building. Secretary's Environmental Assessment Requirements (SEARs) for the MLS Building SSDA were received on 12 December 2016. The SEARs outlined that 'flora and fauna impacts related to the proposed development are to be assessed'. The purpose of this report is to present the findings of an Ecological Impact Assessment undertaken within the study area (refer to Figure 1.1) to assess the potential impacts of the UOW MLS Building on flora and fauna and address the SEARs.

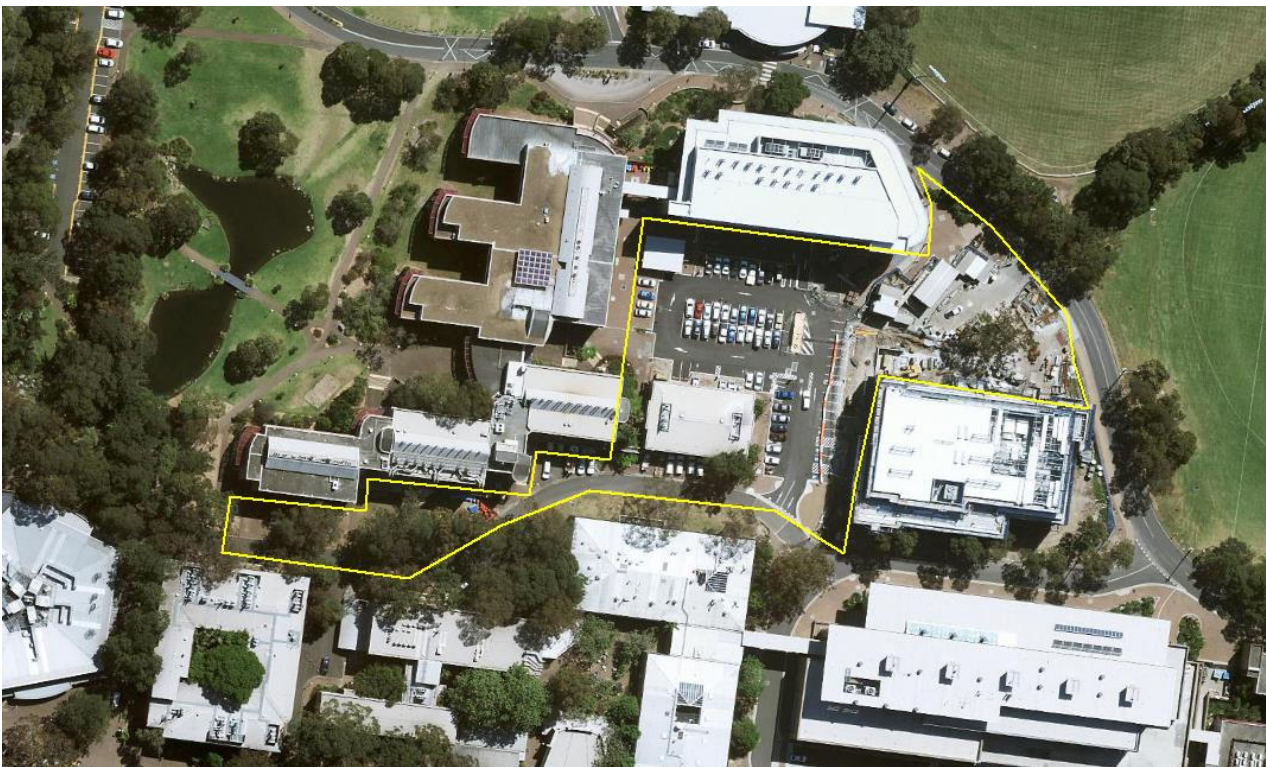


Figure 1.1 : Location of the study area (outlined in yellow)

1.1 Assessment aims

This Ecological Impact Assessment report aims to:

- identify the occurrence, or likelihood of occurrence of threatened species, populations and communities listed under the *Threatened Species Conservation Act 1995* (TSC Act) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) within the area subject to the activity.
- present baseline data in sufficient detail to allow the potential impact of works at the study area to be quantified.
- assess the significance of potential impacts to threatened biodiversity.
- ensure the biodiversity values of the study area are protected from the effects of works (as much as is practicable).
- outline a mitigation strategy to minimise impacts to biodiversity as required.

2. Methodology

2.1 Personnel

A site inspection was undertaken in the study area on 2 May 2017 by Lukas Clews, a Jacobs Senior Ecologist. Jacobs ecologists are licensed to conduct field surveys under the *National Parks and Wildlife Act 1974* (Scientific Research Permit SL100044) and hold ethical approval to conduct research by the Department of Primary Industries Animal Care and Ethics Committee (Animal Research Authority (09/1895)).

2.2 Desktop review

Prior to the commencement of fieldwork, a database search and literature review was completed. Relevant and available documents were reviewed for information on past land uses and presence of vegetation communities and flora and fauna. Relevant databases were searched for records of threatened species within a ten kilometre radius search area around the study area. This review was used to prepare a list of threatened species and communities likely to occur in the study area and locality. The following sources of information were consulted:

- EPBC Act Protected Matters Search Tool (PMST) (five kilometre radius around study area) - Department of Environment and Energy (DoEE)
- DoEE Species Profile and Threats (SPRAT) database
- NSW Office of Environment and Heritage (OEH) Atlas of NSW Wildlife
- Aerial photographs (current and historic) and topographic maps
- Available vegetation mapping for the Wollongong area.

The review focused on identifying and listing the threatened flora and fauna species, populations and ecological communities previously recorded near the study area. Following collation of database records and species and community profiles a 'likelihood of occurrence' assessment was prepared with reference to the broad habitats contained within the study area. This was further refined following field surveys and assessment of habitat present.

2.3 Field assessment

A site inspection was undertaken to identify flora and fauna species present in the study area, determine if native vegetation communities and habitats are present, and the likely impact of the works on biodiversity values. The site inspection focused on the identified study area with opportunistic sightings of flora and fauna made to verify the ecological values and facilitate habitat condition assessments. The purpose of the field assessment was to:

- identify flora species, populations and ecological communities, detailing suitability of habitat to support threatened fauna species.
- identify and provide mapping of potential threatened and migratory species, populations and ecological communities listed under TSC Act, and EPBC Act, if present.
- assess and document important fauna habitat (including hollow bearing trees, nectar producing plants, logs, etc.), to be retained, mitigated or avoided, where present.
- assess if native vegetation occurs and if so determine the vegetation structure and floristics.
- map the distribution and condition of native vegetation communities, where present, with particular regard to identifying threatened ecological communities in the study area.

The likely presence of threatened species was determined through habitat assessment, taking a precautionary approach likely to include species that are difficult to detect (i.e. cryptic species). A species was assumed to be present if suitable habitat was observed in the study area, and if that species was known to occur regionally. No detailed floristic surveys or fauna surveys were undertaken.

2.4 Determining the likelihood of occurrence of threatened species

State and nationally listed threatened species identified from the background review were considered in terms of their likelihood to occur in the habitats present within the study area based on their identified habitat requirements. The results of this review are provided in Appendix B. The likelihood of occurrence for threatened species was classified according to the criteria described in Table 2.1.

Table 2.1 : Criteria used in the likelihood of occurrence assessment

Likelihood of occurrence	Criteria
Unlikely	Species not recorded during field surveys and fit one or more of the following criteria: - species highly restricted to certain geographical areas not within the works footprint - specific habitat requirements are not present in the study area
Low	Species not recorded during field surveys and fit one or more of the following criteria: - have not been recorded previously in the study area/surrounds and for which the study area is beyond the current distribution range - use specific habitats or resources not present in the study area - are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded
Moderate	Species not recorded during the field surveys that fit one or more of the following criteria: - have infrequently been recorded previously in the study area/surrounds - use specific habitats or resources present in the study area but in a poor or modified condition - are unlikely to maintain sedentary populations, however may seasonally use resources within the study area opportunistically or during migration - are cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded
High	Species recorded during the field surveys or species not recorded that fit one or more of the following criteria: - have frequently been recorded previously in the study area/surrounds - use habitat types or resources that are present in the study area that are abundance and/or in good condition within the study area - are known or likely to maintain resident populations surrounding the study area - are known or likely to visit the site during regular seasonal movements or migration

2.5 Significance assessments

Significance assessments were conducted for species, populations and communities that have been positively identified or that have a moderate or high potential to occur in the study area based on the above assessment criteria.

The SEARs do not identify the need for assessment according to the Framework for Biodiversity Assessment (FBA), therefore the threatened biodiversity listed under the TSC Act the threatened species assessment was undertaken as outlined under Section 5A of the EP&A Act (known as the 7-part test). The document *Threatened Species Assessment Guidelines: The Assessment of Significance* (Department of Environment and Climate Change, 2007) outlines a set of guidelines to help applicants/proponents of a development or activity with interpreting and applying the factors of assessment in the 7-part test. The guidance provided by the Department of Environment and Climate Change (2007) has been used in this report.

For threatened biodiversity listed under the EPBC Act a significance assessment have been completed in accordance with the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (Department of the Environment, 2013).

2.6 Limitations

The list of flora and fauna species recorded from this study should not be seen to be fully comprehensive, but rather an indication of the species present at the time of the survey. A period of several seasons or years is often needed to identify all the species present in an area, especially as some species are only apparent at certain times of the year e.g. orchids or migratory birds and require specific weather conditions for optimum detection e.g. frogs. The conclusions of this report are therefore based upon available data and the field surveys and are therefore merely indicative of the environmental condition of the site at the time of the survey. It should be recognised that site conditions, including the presence of threatened species, can change with time. A precautionary approach was used with regards to presence of threatened species in areas of suitable habitat where there is insufficient evidence to discount the presence of the species due to seasonal limitations or other constraints.

3. Existing environment

The study area does not possess any naturally occurring native vegetation. As such, there are no Plant Community Types present within the study area as recognised by the NSW Vegetation Information System database. All vegetation within the study area has been planted and is maintained as garden beds and roadside plantings.

The garden beds predominantly contain species native to NSW including *Casuarina glauca*, *Melaleuca styphelioides*, *Acmena smithii*, *Melia azedarach*, *Eucalyptus microcorys*, *Eucalyptus saligna* x *botryoides*, *Eucalyptus crebra*, *Corymbia citriodora*, *Elaeocarpus reticulatus*, *Homolanthus populifolius*, *Acacia floribunda*, *Cordyline* sp., and *Livistona australis*. Species commonly used in horticulture are also present including *Murraya paniculata*, *Howea fosteriana*, *Cyathea australis*, *Dypsis decaryi*, and horticultural varieties of *Callistemon* sp. and *Grevillea* sp. particularly around the edges of the existing carpark. *Brachychiton acerifolius* trees are present in planter boxes along the footpath adjacent to the carpark. *Syzygium paniculatum* is present in the garden bed at the edge of the carpark outside of the Ihmri Gerard Sutton Building. The groundcover in the garden beds was generally sparse and consisted of *Commelina cyanea*, *Dianella caerulea*, *Lomandra longifolia*, *Hibbertia scandens* and exotic grasses and herbs including *Ehrharta erecta* and *Sonchus oleraceus*. Exotic vines including *Araujia sericifera* were also common along with native vine *Cayratia clematidea*. Photos of the gardens beds are provided in Appendix A.

The habitat that the vegetation within the study area provides for fauna is limited (photos are provided in Appendix A). There are no very large remnant trees or any hollow-bearing trees in the study area. As such, there is limited roosting habitat and no habitat for those species that rely on tree hollows. The habitat lacks important features for shelter such as a dense litter layer, or woody debris. The gardens beds provide habitat for common species of small reptile found in urban environments such as Garden Skinks and common invertebrates. Native arboreal mammals such as possums may utilise the habitat on occasion but it is unlikely to be used on a permanent basis as the vegetation lacks enough structure to provide shelter. The vegetation in the study area does not provide any significant habitat for fauna but may provide limited foraging opportunities for common urban adapted birds (e.g. Australian Magpie, Magpie Lark, Noisy Miner, and Australian White Ibis). The eucalypt trees and palms may provide some limited foraging habitat for threatened species such as the Grey-headed Flying-fox and Swift Parrot but the contribution of these trees to the regional foraging resource would be negligible. Overall, the habitat quality within the study area is poor as it is a maintained garden adjacent to a heavily used carpark and roadway subject to extensive vehicular and pedestrian traffic.

3.1 Threatened species

The background review identified 26 threatened flora and 60 threatened fauna species (listed under the TSC Act and EPBC Act) with a potential to occur in the locality. Based on the assessment of habitat features in the study area and a review of local literature, no threatened flora species and two threatened fauna species were considered to have a moderate to high likelihood of occurring based on the presence of suitable habitat and recent records from the locality (see Appendix B).

One threatened flora species, *Syzygium paniculatum*, was recorded in the study area in the garden bed at the edge of the carpark outside of the Ihmri Gerard Sutton Building. These plants are planted horticultural specimens and are not naturally occurring. Therefore, significance assessments have not been undertaken for this species.

Two threatened fauna species, the Grey-headed Flying-fox and the Swift Parrot are considered moderately likely to utilise the habitat within the study area on occasion. The planted eucalypt trees may provide some seasonal foraging habitat for these species. There is also a nearby Grey-headed Flying-fox camp at Figtree which increases the likelihood of this species using the trees in the study area as a foraging resource. These two species are highly mobile flyers and may utilise some of the trees and shrubs within the study area occasionally for foraging or resting. Importantly, no suitable breeding habitat for either of these species is present in the study area. The fauna habitats in the study area are considered to be of poor quality (see photos in Appendix A).

3.2 Migratory species

Thirty seven migratory species are predicted to occur in the locality based on the PMST (see Appendix B). Of these, the White-throated Needletail (*Hirundapus caudacutus*) and the Fork-tailed Swift (*Apus pacificus*) are considered moderately likely to occur in the air space above the study area during their annual migration.

While migratory bird species do use the study area and locality, the study area would not be classed as an 'important habitat' as defined under the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (Department of the Environment 2013), in that the study area does not contain:

- habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species
- habitat utilised by a migratory species which is at the limit of the species range
- habitat within an area where the species is declining.

As such, it is unlikely that the works would significantly affect migratory species and this group is not considered any further in this report.

4. Potential impacts

Direct biodiversity impacts of the works are predicted to be minimal due to the nature of the vegetation and habitats in the study area. Vegetation and habitat clearing would be minimal and no impacts to remnant native vegetation or high quality fauna habitat are predicted.

The trees in the study area add to the local amenity and provide other benefits besides contributing to biodiversity but their removal (if required) is considered unlikely to result in any detrimental ecological impacts. According to the arborist report for the project, there are 23 trees within the work area that would need to be removed. Three of these trees are *Corymbia maculata* trees that may provide some marginal foraging habitat for the Grey-headed Flying-fox and Swift Parrot.

Direct trauma to native fauna is expected to be minimal as no high quality habitats would be removed. Noise, dust, light and contaminant pollution is predicted to be minimal due to the lack of adjacent high quality habitats. Proliferation of weeds or introduction or spread of pathogens is not considered likely to be an issue with a project of this nature. The mitigation measures outlined below in Section 5 would ensure that indirect impacts would be minimised.

There are no predicted significant impacts to threatened biodiversity from the works. While the threatened Grey-headed Flying-fox and Swift Parrot may utilise the study area as foraging habitat on occasion, the area of available foraging habitat is very small and is considered low quality. The project is considered unlikely to have a significant impact on the Grey-headed Flying-fox or Swift Parrot (see Section 4.1 below). The project would not impact on any significant habitat features (i.e. suitable for roosting or breeding) for these species and the project is considered unlikely to interfere with the lifecycle of the local population. As such, no significant impacts to threatened biodiversity are predicted.

4.1 Significance assessment

A significance assessment was conducted for the Grey-headed Flying-fox (vulnerable TSC Act and EPBC Act) and Swift Parrot (endangered TSC Act and critically endangered EPBC Act) as these species are considered to have a moderate likelihood of occurring in the study area with the presence of some limited suitable foraging habitat (i.e. eucalypts and palm trees) and (for the Grey-headed Flying-fox) close proximity of a known roost camp at Figtree.

The EP&A Act requires that a 7-part test is undertaken to assess the likelihood of a significant impact occurring. As these species is also listed under the EPBC Act, a significance assessment has also been completed in accordance with the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (Department of the Environment, 2013).

The significance assessments undertaken for the Grey-headed Flying-fox and Swift Parrot are provided in Appendix D. The outcome of the assessments was that there is unlikely to be a significant impact to the Grey-headed Flying-fox or Swift Parrot due to the minimal impacts predicted from the works. While some trees suitable as foraging habitat may need to be removed, the works would not result in the removal of any significant quantity of food resources or impact on an area of foraging or breeding habitat considered critical to the survival of these species. The works would have little effect on the populations of Grey-headed Flying-fox or Swift Parrot and the potential for these species to occur in the study area is expected to continue after the works have been completed.

5. Avoidance and mitigation measures

The proposed measures to mitigate and minimise ecological impacts are outlined in Table 5.1.

Table 5.1 : Recommended mitigation measures during pre-construction and construction

Potential impact	Mitigation measure
Impact to trees to be retained	Materials, plant, equipment, work vehicles and stockpiles will be placed to avoid damage to surrounding vegetation, and will be outside tree drip-lines.
	Trees will be protected in accordance with the requirements of the Australian Standard 4970-2009 for the Protection of Trees on Development Sites.
	If any damage occurs to vegetation outside of the nominated work area (as shown in the EMP), the Environmental Representative will be notified so that appropriate remediation strategies can be developed.
	Erosion and sediment controls will remain in place until all restoration has been completed.
	Accurately and clearly mark out the limits of the work zone, areas for parking and turning of vehicles and plant equipment prior to commencement of works. These areas shall be located so that vegetation disturbance is minimised and the drip-line of trees avoided.
Impact to native flora and fauna including threatened species	Construction crews will be made aware that any native fauna species encountered must be allowed to leave site without being harassed and WIRES must be called for assistance where necessary.
	If any threatened or native species (flora or fauna) are discovered during the works, all work will stop immediately and the Environmental Representative will be notified. Work will only recommence once the impact on the species has been assessed and appropriate control measures provided. A Construction Site Plan will be prepared to show the: • No go areas and boundaries of the work area/disturbance corridor. • Locations of parking, lay-down and storage areas for materials, plant and stockpiles. • Location and full extent of any lopping, trimming, clearing or other vegetation disturbance required for the works.

6. Conclusions

The key findings of the biodiversity assessment are that there are no native vegetation communities present in the study area and the fauna habitat that is present is generally only suitable only for common urban adapted species. There would be no impact to any native vegetation communities. The vegetation within the study area is planted and opportunistic vegetation (predominately exotic species). There are no high quality areas of native vegetation or any high quality fauna habitats present within the study area.

Direct biodiversity impacts of the works are predicted to be minimal due to the lack of native vegetation. Vegetation and habitat clearing would be minimal and no impacts to remnant native vegetation or high quality fauna habitat are predicted. The trees in the study area add to the local amenity and provide other benefits besides contributing to biodiversity but their removal (if required) is considered unlikely to result in any detrimental ecological impacts. According to the arborist report for the project, there are 23 trees within the work area that would need to be removed.

The eucalypt trees and palms may provide some limited foraging habitat for threatened species such as the Grey-headed Flying-fox and Swift Parrot but the contribution of these trees to the regional foraging resource would be negligible. No significant impact to the Grey-headed Flying-fox or Swift Parrot is anticipated from the works.

While negligible impacts to native biodiversity are predicted, the mitigation measures detailed in Section 5 would ensure that any impacts that do occur are minimised. Trees that are to be retained would be protected by implementation of the *Australian Standard 4970-2009 for the Protection of Trees on Development Sites*.

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Appendix A. Site photos



Photo 1 : The stand of *Casuarina glauca* with *Livistona australis* and *Melia azedarach* outside the Sciences building and opposite the Halpern building



Photo 2 : *Casuarina glauca*, *Melaleuca styphelioides* and eucalypts outside the Sciences building opposite the Austin Keane building



Photo 3 : stand of *Casuarina glauca* and eucalypts outside the Sciences building opposite the Austin Keane building



Photo 4 : *Howea fosteriana*, *Syagrus romanzoffiana*, *Cyathea australis*, and *Shefflera actinophylla* to the west of the Science Annexe building



Photo 5 : The row of *Brachychiton acerifolius* trees in planter boxes adjacent to the car park



Photo 6 : A garden bed in the carpark adjacent building 32 (IHMRI)



Photo 7 : A garden bed in the carpark adjacent to building 32 (IHMRI building)



Photo 8 : Eucalypts in the garden bed outside of the Science Teaching Facility (building 43)

Appendix B. Likelihood of occurrence assessment

Habitat assessment table - Flora

Common Name (<i>Scientific Name</i>)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
White-flowered Wax Plant (<i>Cynanchum elegans</i>)	E	E	Occurs from the Gloucester district to the Wollongong area and inland to Mt Dangar where it grows in rainforest gullies, scrub and scree slopes (Harden, 1992). This species typically occurs at the ecotone between dry subtropical forest/woodland communities.	48 OEH Atlas of NSW Wildlife	Low. Occurs on university land to the west on a rocky slope with rainforest vegetation however, associated habitat is absent from site and the species was not detected during targeted surveys.
Illawarra Irene (<i>Irenepharsus trypherus</i>)	E	E	Occurs between Wollongong and the Shoalhaven River where it grows in gullies on the coast and escarpment (Harden, 2000). Specifically it is known to occur within Moist Box-Red foothills forest (NSW National Parks and Wildlife Service, 2003b). It has highly specialised habitat requirements with surveyed sites occupying steep slopes and cliff lines at the ecotone of sclerophyll forest and rainforest.	0 Predicted by BBCC	Low. No suitable steep slopes or cliff lines are present in the study area.
Lesser Creeping Fern (<i>Arthropteris palisotii</i>)	E	-	Occurs in north-eastern NSW, north from the Comboyne plateau and also in Queensland. This species may be extinct in NSW. It grows in rainforest, mainly on tree trunks (Department of Environment and Conservation, 2005b).	1 OEH Atlas of NSW Wildlife	Low. Associated warm temperate rainforest habitat is absent from the study area.
Rainforest Cassia	E	-	Occurs in coastal districts and adjacent tablelands of NSW from the Illawarra to Queensland. It grows in or on the edges of subtropical and dry rainforest (Department of Environment and Conservation, 2005b,	2 OEH Atlas	Low. Associated warm temperate rainforest

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
(<i>Senna acclinis</i>)			NSW National Parks and Wildlife Service, 2002c).	of NSW Wildlife	habitat is absent from the study area.
Bearded Bush Pea (<i>Pultenaea aristata</i>)	V	V	Occurs from Helensburgh to Mt Keira where it grows in moist dry sclerophyll woodland to heath on sandstone (Harden, 2002). Also grows within upland swamps on the Illawarra Plateau.	99 OEH Atlas of NSW Wildlife	None. Species frequently recorded in the locality, however, associated vegetation types are absent from the site.
Bynoe's Wattle (<i>Acacia bynoeana</i>)	E	V	Occurs south of Dora Creek-Morriset area to Berrima and the Illawarra region and west to the Blue Mountains. It grows mainly in heath and dry sclerophyll forest on sandy soils (Harden, 2002). Seems to prefer open, sometimes disturbed sites such as trail margins and recently burnt areas. Typically occurs in association with <i>Corymbia gummifera</i> , <i>Eucalyptus haemastoma</i> , <i>E. gummifera</i> , <i>E. parramattensis</i> , <i>E. sclerophylla</i> , <i>Banksia serrata</i> and <i>Angophora bakeri</i> (NSW National Parks and Wildlife Service, 1999a).	1 OEH Atlas of NSW Wildlife PMST	None. Rarely recorded in the locality and associated vegetation types are absent from the site.
<i>Allocasuarina glareicola</i>	E	E	Primarily restricted to the Richmond (NW Cumberland Plain) district, but with an outlier population found at Voyager Point, Liverpool. Grows in Castlereagh woodland on lateritic soil.	PMST	None. Rarely recorded in the locality and associated vegetation types are absent from the site.
<i>Caladenia tessellata</i> (Thick-lipped Spider-orchid)	E	V	The Thick Lip Spider Orchid is known from the Sydney area (old records), Wyong, Ulladulla and Braidwood in NSW. Populations in Kiama and Queanbeyan are presumed extinct. It was also recorded in the Huskisson area in the 1930s. The species occurs on the coast in Victoria from east of Melbourne to almost the NSW border. Generally found in grassy sclerophyll woodland on clay loam or sandy soils, though the population near Braidwood is in low woodland with stony	PMST	None. Rarely recorded in the locality and associated vegetation types are absent from the site.

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
			soil.		
Leafless Tongue-orchid (<i>Cryptostylis hunteriana</i>)		V	The Leafless Tongue Orchid has been recorded from as far north as Gibraltar Range National Park south into Victoria around the coast as far as Orbost. It is known historically from a number of localities on the NSW south coast and has been observed in recent years at many sites between Batemans Bay and Nowra (although it is uncommon at all sites). Also recorded at Munmorah State Conservation Area, Nelson Bay, Wyee, Washpool National Park, Nowendoc State Forest, Ku-Ring-Gai Chase National Park and Ben Boyd National Park. Does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland.	PMST	None. Rarely recorded in the locality and associated vegetation types are absent from the site.
Illawarra Socketwood (<i>Daphnandra johnsonii</i>)	E	-	Confined to the Illawarra (below 150 m alt) where it is usually found in subtropical Rainforest mostly on rocky sites along gullies and creeks. Sometimes found in disturbed areas (Harden, 2000) or in moist Eucalypt forest in association with Eucalyptus tereticornis, E. pilularis, E. quadrangulata or Casuarina cunninghamiana (Department of Environment and Conservation, 2004a).	0 Predicted by BBCC	None. Rarely recorded in the locality and associated vegetation types are absent from the site.
Yellow Gnat-orchid (<i>Genoplesium baueri</i>)	E	E	The species has been recorded from locations between Ulladulla and Port Stephens. About half the records were made before 1960 with most of the older records being from Sydney suburbs including Asquith, Cowan, Gladesville, Longueville and Wahroonga. No collections have been made from those sites in recent years. Currently the species is known from just over 200 plants across 13 sites. The species has been recorded at locations now likely to be within the following conservation reserves: Berowra Valley Regional Park, Royal National Park and Lane Cove National Park. May occur in the Woronora, O'Hares, Metropolitan and Warragamba Catchments. Grows in dry sclerophyll forest and	PMST	None. Rarely recorded in the locality and associated vegetation types are absent from the site.

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
			moss gardens over sandstone.		
<i>Gossia acmenoides</i> population in the Sydney Basin Bioregion south of the Georges River	EP	-	Known from Shellharbour, Wollongong and Kiama LGAs and encompasses all occurrences south of the Georges River. This population is the southernmost occurrence of the species and is approximately 175 km from the nearest population to the north in the Hunter region of NSW. Found in subtropical and dry rainforest on the ranges and coastal plain of eastern Australia. Estimated less than 100 mature plants, through approximately 30 sites. Occurring often as a single individual or small group.	2 OEH Atlas of NSW Wildlife	Low. Rarely recorded in the locality and associated vegetation types are absent from the site.
Magenta Lilly Pilly (<i>Syzygium paniculatum</i>)	E	V	Occurs between Bulahdelah and St Georges Basin where it grows in subtropical and littoral rainforest on sandy soils or stabilized dunes near the sea (Harden, 2002). On the south coast the Magenta Lilly Pilly occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest. On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities.	2 OEH Atlas of NSW Wildlife	Recorded Three planted horticultural <i>Syzygium paniculatum</i> plants are found in the study area in the garden bed opposite the IHMRI building
Hairy Geebung (<i>Persoonia hirsuta</i>)	E	E	Occurs in central coast and central tableland districts where it grows in woodland to dry sclerophyll forest on sandstone (Harden, 2002) and rarely shale (NSW Scientific Committee, 1998). Often occurs in areas with clay influence, in the ecotone between shale and sandstone (James, 1997).	1 OEH Atlas of NSW Wildlife	None. Rarely recorded in the locality and associated vegetation types are absent from the site.
Illawarra Zieria (<i>Zieria granulata</i>)	E	E	Occurs in the Kiama district from Bass Point to Foxground and west to near Albion Park where it grows on dry rocky ridges in sclerophyll forest to rainforest margins (Harden, 2002). Typically it occurs on dry ridge tops and rocky outcrops with shallow volcanic soils. Less frequently found on the moist slopes of the Illawarra escarpment and in low-lying	2 OEH Atlas of NSW Wildlife	None. Rarely recorded in the locality and associated vegetation types are absent from the site.

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
			areas on Quaternary sediments. Occurs in a range of communities including Melaleuca armillaris Tall Shrubland, Illawarra Subtropical Rainforest and Illawarra Lowlands Grassy Woodland (Department of Environment and Conservation, 2004c).		
<i>Solanum celatum</i>	E	-	Restricted to an area from Wollongong to just south of Nowra, and west to Bungonia. Majority of records are prior to 1960 and the majority of populations are likely to have been lost to clearing (Department of Environment and Conservation, 2005b). Grows on hills and slopes in eucalypt woodland; commonly found after fire or disturbance.	0 Predicted by BBCC	None. Rarely recorded in the locality and associated vegetation types are absent from the site.
Wingless Raspwort (<i>Haloragis exalata</i> subsp. <i>exalata</i>)	V	V	Square Raspwort occurs in 4 widely scattered localities in eastern NSW. It is disjunctly distributed in the Central Coast, South Coast and North Western Slopes botanical subdivisions of NSW. Square Raspwort appears to require protected and shaded damp situations in riparian habitats. Flowering specimens in NSW are recorded from November to January.	PMST	None. Rarely recorded in the locality and associated vegetation types are absent from the site.
Biconvex Paperbark (<i>Melaleuca biconvexa</i>)	V	V	Found only in NSW, with scattered and dispersed populations found in the Jervis Bay area in the south and the Gosford-Wyong area in the north. Generally grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects.	PMST	None. Rarely recorded in the locality and associated vegetation types are absent from the site.
Deane's Paperbark (<i>Melaleuca deanei</i>)	V	V	Deane's Paperbark occurs in two distinct areas, in the Ku-ring-gai, Berowra, Holsworthy and Wedderburn areas, and there are also more isolated occurrences at Springwood, Wollemi National Park, Yalwal and the Central Coast areas. The species grows in heath on sandstone.	PMST	None. Rarely recorded in the locality and associated vegetation types are absent from the site.

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Omeo Storksbill (<i>Pelargonium</i> sp. Striatellum G.W. Carr 10345)	E	E	Known from only 3 locations in NSW, with two on lake-beds on the basalt plains of the Monaro and one at Lake Bathurst. A population at a fourth known site on the Monaro has not been seen in recent years. The only other known population is at Lake Omeo, Victoria. It occurs at altitudes between 680 to 1030 m. It is known to occur in the local government areas of Goulburn-Mulwaree, Cooma-Monaro, and Snowy River, but may occur in other areas with suitable habitat; these may include Bombala, Eurobodalla, Palerang, Tumbarumba, Tumut, Upper Lachlan, and Yass Valley local government areas. It has a narrow habitat that is usually just above the high-water level of irregularly inundated or ephemeral lakes, in the transition zone between surrounding grasslands or pasture and the wetland or aquatic communities. It sometimes colonises exposed lake beds during dry periods.	PMST	None. Rarely recorded in the locality and associated vegetation types are absent from the site.
Needle Geebung (<i>Persoonia acerosa</i>)	V	V	The Needle Geebung has been recorded only on the central coast and in the Blue Mountains, from Mt Tomah in the north to as far south as Hill Top where it is now believed to be extinct. Mainly in the Katoomba/ Wentworth Falls/ Springwood area. The Needle Geebung occurs in dry sclerophyll forest, scrubby low-woodland and heath on low fertility soils.	PMST	None. Rarely recorded in the locality and associated vegetation types are absent from the site.
Spiked Rice-flower (<i>Pimelea spicata</i>)	E	E	The Spiked Rice-flower occurs in two disjunct areas; the Cumberland Plain (Marayong and Prospect Reservoir south to Narellan and Douglas Park) and the Illawarra (Landsdowne to Shellharbour to northern Kiama). Found on well-structured clay soils.	PMST	None. Rarely recorded in the locality and associated vegetation types are absent from the site.
Illawarra Greenhood	E	E	Known from a small number of populations in the Hunter region (Milbrodale), the Illawarra region (Albion Park and Yallah) and the Shoalhaven region (near Nowra). It is apparently extinct in western	PMST	None. Rarely recorded in the locality and

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
(<i>Pterostylis gibbosa</i>)			Sydney which is the area where it was first collected (1803). All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage. In the Illawarra region, the species grows in woodland dominated by Forest Red Gum <i>Eucalyptus tereticornis</i> , Woollybutt <i>E. longifolia</i> and White Feather Honey-myrtle <i>Melaleuca decora</i> .		associated vegetation types are absent from the site.
Sydney Plains Greenhood (<i>Pterostylis saxicola</i>)	E	E	Restricted to western Sydney between Freemans Reach in the north and Picton in the south. There are very few known populations and they are all very small and isolated. Only one population occurs within a conservation reserve (Georges River National Park). Most commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines. The vegetation communities above the shelves where <i>Pterostylis saxicola</i> occurs are sclerophyll forest or woodland on shale/sandstone transition soils or shale soils.	PMST	None. Rarely recorded in the locality and associated vegetation types are absent from the site.
Smooth Bush-pea (<i>Pultenaea glabra</i>)	V	V	Restricted to the higher Blue Mountains and has been recorded from the Katoomba-Hazelbrook and Mount Victoria areas, with unconfirmed sightings in the Mount Wilson and Mount Irvine areas. All known populations occur within the Blue Mountains Local Government Area. This species is primarily associated with riparian or swamp habitat areas in the mid to upper altitudes of the central Blue Mountains on sandstone derived soils. Grows in swamp margins, hillslopes, gullies and creekbanks and occurs within dry sclerophyll forest and tall damp heath on sandstone.	PMST	None. Rarely recorded in the locality and associated vegetation types are absent from the site.
Kangaloon Sun Orchid (<i>Thelymitra kangaloonica</i>)	CE	CE	<i>Thelymitra kangaloonica</i> (<i>Thelymitra</i> sp. Kangaloon) is only known to occur on the southern tablelands of NSW in the Moss Vale / Kangaloon / Fitzroy Falls area. It is found in swamps in sedgeland over grey silty grey loam soils.	PMST	None. Rarely recorded in the locality and associated vegetation types are absent

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
					from the site.
Austral Toadflax (<i>Thesium australe</i>)	V	V	Austral Toad-flax is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland and in eastern Asia. Although originally described from material collected in the SW Sydney area, populations have not been seen in a long time. It may persist in some areas in the broader region. Occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast.	PMST	None. Rarely recorded in the locality and associated vegetation types are absent from the site.

Habitat assessment table - Fauna

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Giant Burrowing Frog <i>(Heleioporus australiacus)</i>	V	V	In the northern population there is a marked preference for sandstone ridgetop habitat and broader upland valleys. In these locations, the frog is associated with small headwater creek lines and along slow flowing to intermittent creek lines. The vegetation is typically woodland, open woodland and heath and may be associated with 'hanging swamp' seepage lines and where small pools form from the collected water. They have also been observed occupying artificial ponded structures such as fire dams, gravel 'borrows', detention basins and box drains that have naturalised over time and are still surrounded by other undisturbed habitat. Do not appear to inhabit areas that have been cleared for agriculture or for urban development. Breed in summer and autumn in burrows in the banks of small creeks (Cogger, 2000, NSW National Parks and Wildlife Service, 2001a).	44 OEH Atlas of NSW Wildlife PMST	Low The local area habitat model for this species created by the National Parks and Wildlife Service (2002) was derived from various Upland Swamp and Sandstone Heath and Woodland communities. These communities are widespread above the escarpment but are not present in the study area.
Green and Golden Bell Frog <i>(Litoria aurea)</i>	E	V	Various types of habitat has been documented. For breeding utilises a wide range of waterbodies, including both natural and man-made structures, such as marshes, dams and stream sides, and ephemeral locations that are more often dry than wet. Is found in various small pockets of habitat in otherwise developed areas and has the tendency of often turning up in highly disturbed sites. Lotic situations such as fast flowing streams appear to be one of the few water bodies not utilised, at least for breeding purposes (Department of Environment and Conservation, 2004b, Department of Environment and Conservation, 2005a).	533 OEH Atlas of NSW Wildlife PMST	Low The local area habitat model for this species created by the National Parks and Wildlife Service (2002) was derived from wetland communities with known recent records plus a 100 metre buffer around records in non-wetland habitats. Moderate quality habitat was generated from other wetland habitats, some of which were known to be suitable in the past. No wetland habitat suitable for the Green and Golden Bell Frog is not present in the study area.

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Littlejohn's Tree Frog (<i>Litoria littlejohni</i>)	V	V	Distributed along the eastern slopes of the Great Dividing Range from Watagan State Forest near Wyong, south to Buchan in north-eastern Victoria. It appears to be restricted to sandstone woodland and heath communities at mid to high altitude. It forages both in the tree canopy and on the ground, and it has been observed sheltering under rocks on high exposed ridges during summer. It is not known from coastal habitats (NSW Scientific Committee, 2000).	42 OEH Atlas of NSW Wildlife PMST	Low Littlejohn's Tree Frog is known from only thirteen locations. Several of these are from the Plateau region of the Wollongong LGA. Habitat for this species is restricted to the plateau area and the study area does not contain any suitable sandstone woodland or heath communities.
Stuttering Frog (<i>Mixophyes balbus</i>)	E	V	Terrestrial species, found in rainforest, Antarctic beech forest or wet sclerophyll forest. The species depends on freshwater streams and riparian vegetation for breeding and habitation. No records are known from riparian habitat that has been disturbed (NSW Scientific Committee, 2003, Cogger, 2000).	0 Predicted by the BBCC PMST	Low The rainforests and moist eucalypt forests of the Escarpment are high quality habitat for the Stuttering Frog but this species has declined to the point of near extinction in the region. The National Parks and Wildlife Service (2002) developed a habitat model based on Illawarra Escarpment Subtropical Rainforest and Coachwood Warm Temperate Rainforest for this species. No high quality habitat is present in the study area. In the Wollongong area it was once present in rainforest creeks from Helensburgh to Macquarie Pass but it is now only present in Macquarie Pass NP.
Red-crowned Toadlet (<i>Pseudophryne australis</i>)	V	-	Occurs within 160 km of Sydney where it is restricted to Hawkesbury Sandstone. It breeds in deep grass and debris adjacent to ephemeral drainage lines. When not breeding individuals are found scattered on sandstone ridges under rocks and logs (Cogger, 2000).	30 OEH Atlas of NSW Wildlife	Low The predictive habitat model developed for the region by National Parks and Wildlife Service (2002) predicted a relatively small area of high quality habitat to be present for the Red-crowned Toadlet on sandstone soils and the Wollongong LGA represents the southern extent of its distribution. No suitable

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
					sandstone ridgetop or gully habitat is present in the study area.
Regent Honeyeater (<i>Anthochaera phrygia</i>)	CE	CE	Occurs mostly in box-ironbark forests and woodland and prefers the wet, fertile sites such as along creek flats, broad river valleys and foothills. Riparian forests with <i>Casuarina cunninghamiana</i> and <i>Amyema cambagei</i> are important for feeding and breeding. Important food trees include <i>Eucalyptus sideroxylon</i> (Mugga Ironbark), <i>E. albens</i> (White Box), <i>E. melliodora</i> (Yellow Box) and <i>E. leucoxylon</i> (Yellow Gum) (Garnett and Crowley, 2000) with <i>Eucalyptus robusta</i> (Swamp Mahogany) and <i>Corymbia maculata</i> (Spotted Gum) used in coastal habitats.	1 OEH Atlas of NSW Wildlife PMST	Low The Regent Honeyeater is a rare visitor to the Illawarra with only one recent record from the Wollongong LGA. It is a sporadic visitor to the area and would focus habitat use on the flowering Swamp Mahoganies in winter. No high or moderate quality habitat for the Regent Honeyeater has been modelled in the study area by the National Parks and Wildlife Service (2002).
Cattle Egret (<i>Ardea ibis</i>)	-	M	Subspecies <i>A. i. coromanda</i> is found across the Indian subcontinent and Asia as far north as Korea and Japan, and in South-east Asia, Papua New Guinea and Australia (McKilligan, 2005).	4 OEH Atlas of NSW Wildlife	None No suitable wetland habitat or grazing paddocks exist in the study area.
Dusky Woodswallow (<i>Artamus cyanopterus</i>)	V	-	The Dusky Woodswallow is often reported in woodlands and dry open sclerophyll forests, usually dominated by eucalypts, including mallee associations. It has also been recorded in shrublands and heathlands and various modified habitats, including regenerating forests; very occasionally in moist forests or rainforests (Higgins and Peter, 2002).	2 OEH Atlas of NSW Wildlife	Low This species is only likely to occur on rare occasions in wet forest. It has not been recorded in the built up areas of Wollongong near to the study area.
Australasian Bittern (<i>Botaurus</i>)	V	E	Occurs in shallow, vegetated freshwater or brackish swamps. Requires permanent wetlands with tall dense vegetation, particularly bulrushes and spike rushes. When breeding, pairs are found in areas with a mixture of tall and short sedges but	2 OEH Atlas of NSW	None There is no wetland habitat in the study area suitable

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
<i>poeciloptilus</i>)			will also feed in territory that is more open. (Garnett and Crowley, 2000, NSW National Parks and Wildlife Service, 2002b).	Wildlife PMST	for the Australasian Bittern.
Gang-gang Cockatoo (<i>Callocephalon fimbriatum</i>)	V	-	Occurs in wetter forests and woodland from sea level to an altitude over 2000 metres, timbered foothills and valleys, coastal scrubs, farmlands and suburban gardens (Pizzey and Knight, 1997).	98 OEH Atlas of NSW Wildlife	Low This species is only likely to occur on rare occasions in wet forest. It has not been recorded in the built up areas of Wollongong near to the study area.
Glossy Black- Cockatoo (<i>Calyptorhynchus lathami</i>)	V	-	Occurs in eucalypt woodland and forest with Casuarina/Allocasuarina spp. Characteristically inhabits forests on sites with low soil nutrient status, reflecting the distribution of key Allocasuarina species. The drier forest types with intact and less rugged landscapes are preferred by the species. Nests in tree hollows (Garnett and Crowley, 2000, NSW National Parks and Wildlife Service, 1999b).	8 OEH Atlas of NSW Wildlife	Low This species is only likely to occur on rare occasions in wet forest. It has not been recorded in the built up areas of Wollongong near to the study area.
Spotted Harrier (<i>Circus assimilis</i>)	V	-	The Spotted Harrier occurs throughout the Australian mainland in grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe (e.g. chenopods) (Marchant and Higgins, 1993). It is found mostly commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands. The diet of the Spotted Harrier includes terrestrial mammals, birds and reptiles, occasionally large insects and rarely carrion.	1 OEH Atlas of NSW Wildlife	Low The Spotted Harrier is generally known to avoid densely forested or wooded habitats such as those wet sclerophyll forests near the study area. The study area is not recognised as habitat for this species.

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Barred Cuckoo-shrike (<i>Coracina lineata</i>)	V	-	Found in a variety of habitats including rainforest, eucalypt forests and woodlands, clearings, swamp woodlands and timber along watercourses. Forages among foliage for insects and fruit (NSW National Parks and Wildlife Service, 2002b).	1 OEH Atlas of NSW Wildlife	Low The Barred Cuckoo-shrike is a rare vagrant to the area and has been recorded in the Wollongong Botanic Gardens and at Thirroul (National Parks and Wildlife Service 2002). Birds occasionally occur south of the usual range and individuals may occur sporadically and infrequently in the study area.
Varied Sittella (<i>Daphoenositta chrysoptera</i>)	V	-	The Varied Sittella inhabits most of mainland Australia except the treeless deserts and open grasslands. It inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. The Varied Sittella feeds on arthropods gleaned from crevices in rough or decorticated bark, dead branches, standing dead trees, and from small branches and twigs in the tree canopy. It builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.	2 OEH Atlas of NSW Wildlife	Low No suitable habitat is present.
Black-necked Stork (<i>Ephippiorhynchus asiaticus</i>)	E	-	Feed in shallow water up to 0.5 m deep on fish, reptiles and frogs. Build nests in trees close to feeding sites (Garnett and Crowley, 2000).	3 OEH Atlas of NSW Wildlife	None Associated habitat absent from site. Only a rare visitor to the locality (National Parks and Wildlife Service 2002).
White-fronted Chat (<i>Epthianura</i>)	V	-	the White-fronted Chat occupies foothills and lowlands below 1000 m above sea level (Higgins et al., 2001, Royal Australian Ornithologists Union, 2003). In New South Wales the White-fronted Chat occurs mostly in the southern half of the state,	1 OEH Atlas of NSW	None Associated habitat absent from site.

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
<i>albifrons</i>)			occurring in damp open habitats along the coast, and near waterways in the western part of the state (Higgins et al., 2001). Along the coastline, White-fronted Chats are found predominantly in saltmarsh vegetation although they are also observed in open grasslands and sometimes in low shrubs bordering wetland areas (Higgins et al., 2001, Royal Australian Ornithologists Union, 2003)	Wildlife	
Latham's Snipe (<i>Gallinago hardwickii</i>)	-	M	Occurs in freshwater or brackish wetlands generally near protective vegetation cover. This species feeds on small invertebrates, seeds and vegetation. It migrates to the northern hemisphere to breed (Garnett and Crowley, 2000).	1 OEH Atlas of NSW Wildlife PMST	None Associated habitat absent from site.
Little Lorikeet (<i>Glossopsitta pusilla</i>)	V	-	The distribution of the Little Lorikeet extends from just north of Cairns, around the east coast of Australia, to Adelaide. In New South Wales Little Lorikeets are distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri (Royal Australian Ornithologists Union, 2003). Little Lorikeets are generally considered to be nomadic (Higgins, 1999) and forage mainly on flowers, nectar and fruit. The breeding biology of Little Lorikeets is little known however studies indicate that nest hollows are located at heights of between 2 m and 15 m, mostly in living, smooth-barked eucalypts, and hollow openings are approximately 3 cm	1 OEH Atlas of NSW Wildlife	None Associated habitat absent from site.

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
			in diameter (Courtney and Debus, 2006).		
Painted Honeyeater (<i>Grantiella picta</i>)	V	V	Lives in dry forests and woodlands. Primary food is the mistletoes in the genus <i>Amyema</i> , though it will take some nectar and insects. Its breeding distribution is dictated by presence of mistletoes which are largely restricted to older trees. Less likely to be found in in strips of remnant box-ironbark woodlands, such as occur along roadsides and in windbreaks, than in wider blocks (Garnett and Crowley, 2000).	1 OEH Atlas of NSW Wildlife	Low. Associated habitat absent from site.
Little Eagle (<i>Hieraaetus morphnoides</i>)	V	-	The Little Eagle is distributed throughout the Australian mainland occupying habitats rich in prey within open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. For nest sites it requires a tall living tree within a remnant patch, where pairs build a large stick nest in winter and lay in early spring. Prey includes birds, reptiles and mammals, with the occasional large insect and carrion. Most of its former native mammalian prey species in inland NSW are extinct and rabbits now form a major part of the diet (Marchant and Higgins, 1993).	5 OEH Atlas of NSW Wildlife	Low. Associated habitat absent from site.
White-throated Needletail (<i>Hirundapus caudacutus</i>)	-	M	Occurs in airspace over forests, woodlands, farmlands, plains, lakes, coasts and towns. Breeds in the northern hemisphere and migrates to Australia in October-April (Pizzey and Knight, 1997).	4 OEH Atlas of NSW Wildlife PMST	Moderate. A migrant that does not breed in the locality. Only likely to forage in the aerial spaces above the site.

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Black Bittern (<i>Ixobrychus flavicollis</i>)	V	-	Usually found in dense vegetation in and fringing streams, swamps, tidal creeks and mudflats, particularly amongst swamp she-oaks and mangroves. Feeds on aquatic fauna along streams, in estuaries and beside billabongs and pools. Breeding occurs in summer in secluded places in densely vegetated wetlands. It nests in trees that overhang the water (NSW National Parks and Wildlife Service, 2002b, Garnett and Crowley, 2000).	7 OEH Atlas of NSW Wildlife	Low. Associated wetland habitat absent from site.
Swift Parrot (<i>Lathamus discolor</i>)	CE	E	Breeding occurs in Tasmania, majority migrates to mainland Australia in autumn, over-wintering, particularly in Victoria and central and eastern NSW, but also south-eastern Queensland as far north as Duaringa. Until recently it was believed that in New South Wales, swift parrots forage mostly in the western slopes region along the inland slopes of the Great Dividing Range but are patchily distributed along the north and south coasts including the Sydney region, but new evidence indicates that the forests on the coastal plains from southern to northern NSW are also extremely important. In mainland Australia is semi-nomadic, foraging in flowering eucalypts in eucalypt associations, particularly box-ironbark forests and woodlands (Garnett and Crowley, 2000),(Swift Parrot Recovery Team, 2001).	20 OEH Atlas of NSW Wildlife PMST	Moderate. Marginal habitat associated with planted eucalypts present in the study area. The National Parks and Wildlife Service (2002) identifies the Swift Parrot as an irregular migrant to the Illawarra escarpment, coastal plain and plateau. There have been records of the Swift Parrot made from the Wollongong University campus in 2002 suggesting this species occasionally utilises the habitats. As such, the Swift Parrot is considered moderately likely to occur within the study area on an infrequent basis based on the presence of suitable foraging habitat and nearby records.
Square-tailed Kite (<i>Lophoictinia isura</i>)	V	-	This species hunts primarily over open forest, woodland and mallee communities as well as over adjacent heaths and other low scrubby habitats in wooded towns. It feeds on small birds, their eggs and nestlings as well as insects. Seems to prefer structurally diverse landscapes (Garnett and Crowley, 2000).	7 OEH Atlas of NSW Wildlife	Low. This species is recognised as a rare vagrant to the locality and records of this species from Wollongong are considered likely to be of birds migrating to and from breeding sites on the south coast (National

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
					Parks and Wildlife Service 2002).
Orange-bellied Parrot <i>(Neophema chrysogaster)</i>	CE	CE	The Orange-bellied Parrot breeds in the south-west of Tasmania and migrates in autumn to spend the winter on the mainland coast of south-eastern South Australia and southern Victoria. On the mainland, the Orange-bellied Parrot spends winter mostly within 3 km of the coast in sheltered coastal habitats including bays, lagoons, estuaries, coastal dunes and saltmarshes. The species also inhabits small islands and peninsulas and occasionally saltworks and golf courses.	PMST	None Associated habitat absent from site.
Turquoise Parrot <i>(Neophema pulchella)</i>	V	-	Occurs in the foothills of the great dividing range in eucalypt woodlands and forests with a grassy or sparsely shrubby understorey. Nests in hollows in trees, stumps or even fence posts. It feeds on seeds of both native and introduced grass and herb species (Garnett and Crowley, 2000).	1 OEH Atlas of NSW Wildlife	Low. Associated habitat absent from site. This species is recognised as a rare vagrant to the locality (National Parks and Wildlife Service 2002). The National Parks and Wildlife Service (2002) modelled a large area of habitat for this species on the plateau but the study area is not considered habitat for this species.
Barking Owl <i>(Ninox connivens)</i>	V	-	Occurs in dry sclerophyll woodland. In the south west it is often associated with riparian vegetation while in the south east it generally occurs on forest edges. It nests in large hollows in live eucalypts, often near open country. It feeds on insects in the non-breeding season and on birds and mammals in the breeding season (Garnett and Crowley, 2000).	1 OEH Atlas of NSW Wildlife	Low. No suitable habitat present.
Powerful Owl	V	-	A sedentary species with a home range of approximately 1000 hectares it occurs within open eucalypt, casuarina or Callitris pine forest and woodland. It often roosts in denser vegetation	25 OEH Atlas	Low.

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
(<i>Ninox strenua</i>)			including rainforest of exotic pine plantations. Generally feeds on medium-sized mammals such as possums and gliders but will also eat birds, flying-foxes, rats and insects. Prey are generally hollow dwelling and require a shrub layer and owls are more often found in areas with more old trees and hollows than average stands (Garnett and Crowley, 2000).	of NSW Wildlife	No suitable habitat present..
Blue-billed Duck (<i>Oxyura australis</i>)	V	-	Relatively sparse throughout species range. Regularly found breeding in south-east Queensland, north-east South Australia and throughout New South Wales. Found on temperate, fresh to saline, terrestrial wetlands, and occupies artificial wetlands. Prefers deep permanent open water, within or near dense vegetation. Nest in rushes, sedge, <i>Lignum Muehlenbeckia cunninghamii</i> and paperbark <i>Melaleuca</i> (Garnett and Crowley, 2000).	1 OEH Atlas of NSW Wildlife	None Associated habitat absent from site.
Olive Whistler (<i>Pachycephala olivacea</i>)	V	-	Distributed from Queensland to South Australia, and occurs across the altitudinal range from coastal to alpine areas. In NSW, found north of the Hunter River, NSW, extending just into the Lamington Plateau in far south-east Queensland. There are isolated populations in the Macpherson Range, New England NP, Mt. Boss and Barrington Tops areas, and possibly in the Gibraltar Range and Walcha-Nundle areas. Occurs in tall wet sclerophyll forest, rainforest, woodland, alpine heaths (Simpson and Day, 1996). In NE NSW, occurs in cool temperate rainforest and cool, moist sclerophyll forest at elevations of >=800 metres asl. Also recorded in warm temperate and sub tropical rainforests. South of Sydney, the species inhabits rainforest, moist eucalypt forest, coastal, moist thickets and mountain scrubs. Microhabitat is areas with a	2 OEH Atlas of NSW Wildlife	Low. No suitable habitat present. .

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
			dense, moist understorey (NSW National Parks and Wildlife Service, 1999e).		
Eastern Osprey (<i>Pandion cristatus</i>)	V	M	Generally a coastal species, occurring in estuaries, bays, inlets, islands and surrounding waters, coral atolls, reefs, lagoons, rock cliffs and stacks. Sometimes ascends larger rivers to far inland. Builds nests high in tree, on pylon or on ground on islands. Feeds on fish (Pizzey and Knight, 1997).	2 OEH Atlas of NSW Wildlife	None. Associated habitat absent from site.
Scarlet Robin (<i>Petroica boodang</i>)	V	-	In NSW, the Scarlet Robin occupies open forests and woodlands from the coast to the inland slopes. Some dispersing birds may appear in autumn or winter on the eastern fringe of the inland plains. It prefers an open understorey of shrubs and grasses and sometimes in open areas. Abundant logs and coarse woody debris are important structural components of its habitat. In autumn and winter it migrates to more open habitats such as grassy open woodland or paddocks with scattered trees. It forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other coarse woody debris (Higgins and Peter, 2002).	1 OEH Atlas of NSW Wildlife	Low. Associated habitat absent from site. This species is considered to be absent, or nearly so, from Wollongong (National Parks and Wildlife Service 2002).
Flame Robin (<i>Petroica phoenicea</i>)	V	-	In NSW the Flame Robin breeds in upland moist eucalypt forests and woodlands, often on ridges and slopes, in areas of open understorey. It migrates in winter to more open lowland habitats (Higgins and Peter, 2002). The Flame Robin forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other woody debris. The robin builds an open cup nest of plant fibres and cobweb, which is often near the ground in a sheltered niche, ledge or shallow cavity in a tree, stump or bank.	2 OEH Atlas of NSW Wildlife	Low. Associated habitat absent from site.

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Pink Robin <i>(Petroica rodinogaster)</i>	V	-	Found in open forest and woodland including native tea-tree scrubs. Rarely found in open cleared areas. Breeds in dense gullies in temperate rainforests (Pizzey and Knight, 1997).	0 Predicted by the BBCC	Low. In the Illawarra it is a rare vagrant but may be expected to occur in forested areas every few years, particularly during Winter dispersal (National Parks and Wildlife Service 2002). It is only a vagrant to the bioregion and no suitable habitat was predicted by the models created by the National Parks and Wildlife Service (2002).
Regent Parrot (eastern subspecies) <i>(Polytelis anthopeplus)</i>	E	V	The eastern subspecies is restricted to areas around the Murray River in South Australia, Victoria and NSW. In NSW it occurs along the Murray River downstream of Tooleybuc (though there are few records between Mildura and the South Australian border), the Wakool River downstream of Kyalite, and the Murrumbidgee River immediately upstream from the junction with the Murray River and adjoining areas of mallee.	1 OEH Atlas of NSW Wildlife	Low. Associated habitat absent from site. Local records are likely to be of aviary escapees.
Superb Parrot <i>(Polytelis swainsonii)</i>	V	V	Mainly found in the Riverina where they nest in loose colonies in riparian woodland on River Red Gum. On the inland slopes, Superb Parrots both forage and feed within box woodland, mostly nesting in dead trees (Garnett and Crowley, 2000).	1 OEH Atlas of NSW Wildlife	Low. Associated habitat absent from site. Local records are likely to be of aviary escapees.
Wompoo Fruit-Dove <i>(Ptilinopus magnificus)</i>	V	-	Occurs in rainforests, monsoon forests, adjacent eucalypt forests, fruiting trees on scrubby creeks or in open country (Garnett and Crowley, 2000).	2 OEH Atlas of NSW Wildlife	Low. The species is considered to be locally extinct with the last sighting made in the area in 1920 (National Parks and Wildlife Service 2002).

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Rose-crowned Fruit-Dove (<i>Ptilinopus regina</i>)	V	-	Occurs in subtropical and dry rainforests and occasionally in moist eucalypt forests and swamp forests where fruit is plentiful. They are thought to move locally as they follow the ripening fruit (NSW National Parks and Wildlife Service, 2002b)	2 OEH Atlas of NSW Wildlife	Low. Associated habitat absent from site. The species is a vagrant in the study area with the two records in the Wollongong LGA both being individuals flying into windows (National Parks and Wildlife Service 2002).
Superb Fruit-Dove (<i>Ptilinopus superbus</i>)	V	-	Occurs in rainforests and fringes, scrubs, mangroves and wooded stream-margins, lantana thickets, isolated figs, pittosporums, lilly pillies and blackberries (Pizzey and Knight, 1997).	3 OEH Atlas of NSW Wildlife	Low. Associated habitat absent from site. The species is a vagrant in the study area. In the Illawarra, it is a rare nomad with ten records between 1880 and 2000 (National Parks and Wildlife Service 2002).
Australian Painted snipe (<i>Rostratula australis</i>)	E	E	The Australian Painted Snipe is restricted to Australia. Most records are from the south east, particularly the Murray Darling Basin, with scattered records across northern Australia and historical records from around the Perth region in Western Australia. In NSW many records are from the Murray-Darling Basin including the Paroo wetlands, Lake Cowal, Macquarie Marshes, Fivebough Swamp and more recently, swamps near Balldale and Wanganella. Other important locations with recent records include wetlands on the Hawkesbury River and the Clarence and lower Hunter Valleys. Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber.	PMST	Low. Associated habitat absent from site.
Freckled Duck (<i>Stictonetta</i>)	V	-	In most years this species appear to be nomadic between ephemeral inland wetlands. In dry years they congregate on permanent wetlands while in wet years they breed prolifically and disperse widely, generally towards the coast. In inland	1 OEH Atlas of NSW	Low. Associated habitat absent from site.

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
<i>naevosa</i>)			eastern Australia, they generally occur in brackish to hyposaline wetlands that are densely vegetated with Lignum (<i>Muehlenbeckia cunninghamii</i>) within which they build their nests (Garnett and Crowley, 2000).	Wildlife	
Masked Owl (<i>Tyto novaehollandiae</i>)	V	-	Occurs within a diverse range of wooded habitats including forests, remnants and almost treeless inland plains. This species requires large-hollow bearing trees for roosting and nesting and nearby open areas for foraging. They typically prey on terrestrial mammals including rodents and marsupials but will also take other species opportunistically. Also known to occasionally roost and nest in caves (Garnett and Crowley, 2000).	7 OEH Atlas of NSW Wildlife	Low. The Masked Owl is considered a rare resident in the Illawarra but is known to occur above the escarpment in areas of more open woodland. This species has not been recorded in built up areas of the coastal plain since 1969.
Sooty Owl (<i>Tyto tenebricosa</i>)	V	-	Occurs in wet eucalypt forest and rainforest on fertile soils with tall emergent trees. Typically found in old growth forest with a dense understorey but also occurs in younger forests if nesting trees are present nearby. It nests in large hollows within eucalypts and occasionally caves. It hunts in open and closed forest for a range of arboreal and terrestrial mammals including introduced species and sometimes birds (Garnett and Crowley, 2000).	23 OEH Atlas of NSW Wildlife	Low. The Illawarra is one of the two important areas for Sooty Owls in the Sydney Basin Bioregion (National Parks and Wildlife Service, 2002). These areas of habitat occur along and just above the escarpment and no habitat for this species is modelled in the study area (National Parks and Wildlife Service, 2002). With the urbanisation of the area and total absence of records from the coastal plain this species is considered to have a low likelihood of occurrence in the study area.
Eastern Pygmy-possum	V	-	Found in a range of habitats from rainforest through sclerophyll forest to tree heath. It feeds largely on the nectar and pollen of banksias, eucalypts and bottlebrushes and sometimes soft fruits. It nests in very small tree holes, between the wood and	11 OEH Atlas of NSW	Low. The heathy areas of habitat above the escarpment are the highest quality habitats for this species in the

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
(<i>Cercartetus nanus</i>)			bark of a tree, abandoned birds nests and shredded bark in the fork of trees (Turner and Ward, 1995).	Wildlife	locality (National Parks and Wildlife Service, 2002). There is no moderate or high quality habitat for this species modelled in the study area.
Large-eared Pied Bat (<i>Chalinolobus dwyeri</i>)	V	V	Found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. There are scattered records from the New England Tablelands and North West Slopes. Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (<i>Petrochelidon ariel</i>), frequenting low to mid-elevation dry open forest and woodland close to these features. Found in well-timbered areas containing gullies.	PMST	Low. No roosting habitat is present in the study area and there are no records nearby. Habitat is likely to be limited to the upper escarpment and plateau (see National Parks and Wildlife Service, 2002).
Spotted-tailed Quoll (<i>Dasyurus maculatus</i>)	V	E	Occurs from the Bundaberg area in south-east Queensland, south through NSW to western Victoria and Tasmania. In NSW, it occurs on both sides of the Great Dividing Range and north-east NSW represents a national stronghold (NSW National Parks and Wildlife Service, 1999e). Occurs in wide range of forest types, although appears to prefer moist sclerophyll and rainforest forest types, and riparian habitat. Most common in large unfragmented patches of forest. It has also been recorded from dry sclerophyll forest, open woodland and coastal heathland, and despite its occurrence in riparian areas, it also ranges over dry ridges. Nests in rock caves and hollow logs or trees. Feeds on a variety of prey including birds, terrestrial and arboreal mammals, small macropods, reptiles and arthropods (NSW National Parks and Wildlife Service, 1999d, NSW National Parks and Wildlife Service, 1999e).	3 OEH Atlas of NSW Wildlife	Low. The Spotted-tailed Quoll has been rarely recorded in the Illawarra and appears to occur in the forested catchment lands above and along the escarpment at extremely low densities (National Parks and Wildlife Service, 2002). Associated habitat types present on site (both PCTs); however, the patches of habitat are small and isolated from larger areas of potential habitat. Only possible as an extremely rare vagrant; e.g. during movements associated with juvenile dispersal.

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Eastern Quoll <i>(Dasyurus viverrinus)</i>	E	E	Not recorded on mainland Australia for many years and possibly extinct outside of Tasmania. Recorded in a variety of habitats including dry sclerophyll forest, scrub, heathland and cultivated land. Lives in dens which consist of several chambers located in underground burrows, hollow logs and rock piles (Strahan, 1995).	3 OEH Atlas of NSW Wildlife	None. Almost certainly extinct in the locality and likely extinct throughout mainland Australia. Now restricted to Tasmania.
Eastern False Pipistrelle <i>(Falsistrellus tasmaniensis)</i>	V	-	Usually roosts in tree hollows in higher rainfall forests. Sometimes found in caves (Jenolan area) and abandoned buildings. Forages within the canopy of dry sclerophyll forest. It prefers wet habitats where trees are more than 20 metres high (Churchill, 2008)	5 OEH Atlas of NSW Wildlife	Low. Habitat is likely to be limited to the upper escarpment and plateau (see National Parks and Wildlife Service, 2002).
Southern Brown Bandicoot (eastern) <i>(Isoodon obesulus obesulus)</i>	E	E	The Southern Brown Bandicoot has a patchy distribution. It is found in south-eastern NSW, east of the Great Dividing Range south from the Hawkesbury River, southern coastal Victoria and the Grampian Ranges, south-eastern South Australia, south-west Western Australia and the northern tip of Queensland. They are generally only found in heath or open forest with a heathy understorey on sandy or friable soils.	PMST	Low. There is no suitable habitat for this species in the study area and no records from the locality.
Little Bent-wing Bat <i>(Miniopterus australis)</i>	V	-	Feeds on small insects beneath the canopy of well-timbered habitats including rainforest, Melaleuca swamps and dry sclerophyll forests. Roosts in caves and tunnels and has specific requirements for nursery sites. Distribution becomes coastal towards the southern limit of its range in NSW. Nesting sites are in areas where limestone mining is preferred (Strahan, 1995).	1 OEH Atlas of NSW Wildlife	Low No suitable habitat present.
Eastern Bentwing-	V	-	Usually found in well-timbered valleys where it forages on small	19	Low

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
bat <i>(Miniopterus schreibersii oceanensis)</i>			insects above the canopy. Roosts in caves, old mines, stormwater channels and sometimes buildings and often return to a particular nursery cave each year (Churchill, 2008)	OEH Atlas of NSW Wildlife	No suitable habitat present.
Eastern Free-tail bat <i>(Mormopterus norfolkensis)</i>	V	-	The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW. Occur in dry sclerophyll forest and woodland east of the Great Dividing Range. Roost mainly in tree hollows but will also roost under bark or in man-made structures (Churchill, 2008).	1 OEH Atlas of NSW Wildlife	Low. No roosting habitat is present in the study area and there are few records nearby. Habitat is likely to be limited to the upper escarpment and plateau (see National Parks and Wildlife Service, 2002).
Southern Myotis <i>(Myotis macropus)</i>	V	-	Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Forage over streams and pools catching insects and small fish by raking their feet across the water surface. In NSW females have one young each year usually in November or December.	3 OEH Atlas of NSW Wildlife	Low No suitable habitat present.
Greater Glider <i>(Petauroides volans)</i>	-	V	The Greater Glider inhabits eucalyptus forests and woodlands as this species feeds exclusively on Eucalyptus buds and leaves. They occupy tree hollows in the day and tree canopies at night (Department of Environment and Climate Change 2007).	PMST	Low No suitable habitat present.
Yellow-bellied Glider <i>(Petaurus australis)</i>	V	-	Restricted to tall, mature eucalypt forest in high rainfall areas of temperate to sub-tropical eastern Australia. Feeds on nectar, pollen, the sap of eucalypts and sometimes insects. Preferred habitats are productive, tall open sclerophyll forests where mature trees provide shelter and nesting hollows and year	5 OEH Atlas	Low. This species may exist in very low densities in the catchment areas on the plateau. No suitable habitat is

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
			round food resources are available from a mixture of eucalypt species (NSW National Parks and Wildlife Service, 1999f, NSW National Parks and Wildlife Service, 2003c).	of NSW Wildlife	present.
Brush-tailed Rock-wallaby (<i>Petrogale penicillata</i>)	E	V	The range of the Brush-tailed Rock-wallaby extends from south-east Queensland to the Grampians in western Victoria, roughly following the line of the Great Dividing Range. However the distribution of the species across its original range has declined significantly in the west and south and has become more fragmented. In NSW they occur from the Queensland border in the north to the Shoalhaven in the south, with the population in the Warrumbungle Ranges being the western limit. Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges, often facing north.	PMST	Low. No suitable habitat for this species is present in the study area.
Koala (<i>Phascolarctos cinereus</i>)	V	V	Found in sclerophyll forest. Throughout New South Wales, Koalas have been observed to feed on the leaves of approximately 70 species of eucalypt and 30 non-eucalypt species. However, in any one area, Koalas will feed almost exclusively on a small number of preferred species. The preferred tree species vary widely on a regional and local basis. Some preferred species in NSW include Forest Red Gum <i>Eucalyptus tereticornis</i> , Grey Gum <i>E. punctata</i> , Monkey Gum <i>E. cypellocarpa</i> and Ribbon Gum <i>E. viminalis</i> . In coastal areas,	5 OEH Atlas of NSW Wildlife PMST	Low No suitable habitat present.

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
			Tallowwood <i>E. microcorys</i> and Swamp Mahogany <i>E. robusta</i> are important food species, while in inland areas White Box <i>E. albens</i> , Bimble Box <i>E. populnea</i> and River Red Gum <i>E. camaldulensis</i> are favoured (NSW National Parks and Wildlife Service, 1999c, NSW National Parks and Wildlife Service, 2003a).		
Long-nosed Potoroo (<i>Potorous tridactylus</i> <i>tridactylus</i>)	V	V	The long-nosed potoroo is found on the south-eastern coast of Australia, from Queensland to eastern Victoria and Tasmania, including some of the Bass Strait islands. There are geographically isolated populations in western Victoria. In NSW, it is generally restricted to coastal heaths and forests east of the Great Dividing Range, with an annual rainfall exceeding 760 mm. Inhabits coastal heaths and dry and wet sclerophyll forests. Dense understorey with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature.	PMST	Low. There is no suitable habitat for this species in the study area and no records from the locality.
New Holland Mouse (<i>Pseudomys</i> <i>novaehollandiae</i>)	-	V	The New Holland Mouse has a fragmented distribution across Tasmania, Victoria, NSW and Queensland. The species is now largely restricted to the coast of central and northern NSW, with one inland occurrence near Parkes. In NSW, the New Holland Mouse is known from: Royal National Park (NP) and the Kangaroo Valley; Kuringgai Chase NP; and Port Stephens to Evans Head near the Queensland border. Across the species' range, the New Holland Mouse is known to inhabit open heathland, open woodland with heathy understorey, and vegetated sand dunes.	PMST	Low. No suitable habitat for this species is present in the study area.

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Grey-headed Flying-fox (<i>Pteropus poliocephalus</i>)	V	V	Occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps. Urban gardens and cultivated fruit crops also provide habitat for this species. Feeds on the flowers and nectar of eucalypts and native fruits including lilly pillies. It roosts in the branches of large trees in forests or mangroves (NSW National Parks and Wildlife Service, 2001b, Churchill, 2008)	47 OEH Atlas of NSW Wildlife PMST	Moderate. The Grey-headed Flying-fox is known to flying over the study area and may temporarily perch on trees to rest during the flight to the north as the animals leave the camp at Figtree each night. The rainforests and moist eucalypt forests of the Illawarra Escarpment are recognised as high quality habitat for the Grey-headed Flying-fox (NSW National Parks & Wildlife Service, 2002).
Greater Broad-nosed Bat (<i>Scoteanax rueppellii</i>)	V	-	The preferred hunting areas of this species include tree-lined creeks and the ecotone of woodlands and cleared paddocks but it may also forage in rainforest. Typically it forages at a height of 3-6 metres but may fly as low as one metre above the surface of a creek. It feeds on beetles, other large, slow-flying insects and small vertebrates. It generally roosts in tree hollows but has also been found in the roof spaces of old buildings (Churchill, 2008)	1 OEH Atlas of NSW Wildlife	Low. Habitat is likely to be limited to the upper escarpment and plateau (see National Parks and Wildlife Service, 2002).
Broad-headed Snake (<i>Hoplocephalus bungaroides</i>)	E	V	A nocturnal species that occurs in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they generally use rock crevices and exfoliating rock during the cooler months and tree hollows during summer (Webb and Shine, 1994, Webb and Shine, 1998).	16 OEH Atlas of NSW Wildlife PMST	None. Suitable habitat is not absent the site. Not mapped as potential habitat in the Wollongong LGA (National Parks and Wildlife Service, 2002).
Rosenberg's Goanna	V	-	Found in coastal heaths, humid woodlands, wet and dry sclerophyll forests. Mostly a terrestrial species it shelters in	16 OEH Atlas	None.

Common Name (Scientific Name)	TSC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
(<i>Varanus rosenbergi</i>)			burrows, hollow logs and rock crevices (Cogger, 2000).	of NSW Wildlife	Associated habitat absent from site.

Note: This habitat assessment table does not consider habitat for species such as migratory wading birds, marine birds (such as Albatross, Petrels, Terns, Shearwater, Noddy, Frigatebird etc.), Fish, Whales, Dolphins, Sharks, Rays, or Turtles as the proposal will not impact on habitat for these species.

Appendix C. Assessments of significance

Assessments of significance have been conducted for species, populations and communities that were recorded in the study area during field surveys or were identified as having a moderate or higher potential to occur in the study area based on the presence of habitat (see Appendix B).

The proposed works will be assessed under Part 5 of the EP&A Act. Section 5A of the EP&A Act requires that a '7 part test' is undertaken to assess the likelihood of significant impact upon threat-listed species, populations or ecological communities listed under the TSC Act. These assessments have been undertaken in accordance with the *Threatened Species Assessment Guidelines: The Assessment of Significance* (Department of Environment and Climate Change, 2007) which outlines a set of guidelines to help applicants/proponents of a development or activity with interpreting and applying the factors of assessment in the 'seven-part test'. The guidance provided by the Department of Environment and Climate Change (2007) has been used here in preparing these 'seven-part tests' and in determining whether there is likely to be a significant effect to a threatened species, population or ecological community listed under the TSC Act.

For threatened biodiversity listed under the EPBC Act, significance assessments have been completed in accordance with the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (Department of Environment, 2013). Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment that is affected, and upon the intensity, duration, magnitude and geographic extent of the impacts (Department of Environment, 2013). Importantly, for a 'significant impact' to be 'likely', it is not necessary for a significant impact to have a greater than 50 per cent chance of happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility (Department of Environment, 2013).

The species subject to this assessment are outlined in **Table C.1** along with the predicted impact from the proposal

Table C.1 Threatened biodiversity subject to this assessment

Species	Status		Predicted impact
	TSC Act	EPBC Act	
Swift Parrot (<i>Lathamus discolor</i>)	E	CE	According to the arborist report there are 23 trees within the work area that would need to be removed. Three of these trees are <i>Corymbia maculata</i> trees that may provide some marginal foraging habitat for these two species.
Grey-headed Flying-fox (<i>Pteropus poliocephalus</i>)	V	V	

C.1 Environmental Planning & Assessment Act 1979 assessment

Swift Parrot (*Lathamus discolor*)

The Swift Parrot is endemic to south-eastern Australia and breeds only in Tasmania. It migrates to mainland Australia in autumn. The National Parks and Wildlife Service (2002) identifies the Swift Parrot as an irregular migrant to the Illawarra escarpment, coastal plain and plateau. There have been records of the Swift Parrot made from the Wollongong University campus in 2002 suggesting this species occasionally utilises the habitats. As such, the Swift Parrot is considered moderately likely to occur within the study area on an infrequent basis based on the presence of suitable foraging habitat and nearby records.

According to the arborist report there are 23 trees within the work area that would need to be removed. Three of these trees are *Corymbia maculata* trees that may provide some marginal foraging habitat for this species.

The factors to be considered when determining whether an action, development or activity is likely to significantly affect threatened species or their habitats are outlined below:

- 1. 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**

The Swift Parrot is endemic to south-eastern Australia and breeds only in Tasmania. It migrates to mainland Australia in autumn. As such, the project would not affect breeding habitat for this species. Additionally, the study area does not contain any important winter foraging grounds as modelled by the National Parks and Wildlife Service (2002) so none would be impacted. No impacts to the life cycle of the Swift Parrot species are anticipated as a result of the project and the project is not considered 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.

- 2. 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**

Not applicable.

- 3. 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**
- 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**

Not applicable.

- 4. 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**
- 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**
- 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.**

As a specialist nectarivore dependent on flowering eucalypts and lerp, Swift Parrots are vulnerable to the loss of quantity and quality of key forage tree species. As a large-scale migrant, it has the ability to cover vast areas of its winter range, seeking suitable flowering eucalypt habitat. The species is a very rare occasional visitor to the region and may utilise trees in the study area for foraging intermittently when no other suitable resources are available. According to the arborist report, there are 23 trees within the work area that would need to be removed. Three of these trees are *Corymbia maculata* trees that may provide some marginal foraging habitat for this species. This is a small proportional impact considering the National Parks and Wildlife Service (2002a) has mapped 48 hectares of high quality habitat for the Swift Parrot in the region of the Illawarra escarpment, coastal plain and plateau.

Importantly, the project would not result in any further substantial landscape scale fragmentation of habitat for the Swift Parrot. The Swift Parrot is a highly mobile nomad and will freely fly long distances over open areas to move between foraging grounds. The level of fragmentation caused by the project will not have an impact on the ability of the Swift Parrot to move through the landscape.

The National Parks and Wildlife Service (2002a) has mapped 48 hectares of high quality habitat for the Swift Parrot in the region of the Illawarra escarpment, coastal plain and plateau. The habitat model was developed for this species with high quality habitat derived from vegetation communities dominated by Swamp Mahogany, and with communities with high presence of Coast Banksia (*Banksia integrifolia* subsp. *integrifolia*) included as

moderate quality habitat (NSW National Parks and Wildlife Service, 2002a). High quality habitat for the Swift Parrot is not mapped in the study area. As such, the habitats in the study area are not considered important to the long-term survival of the Swift Parrot in the locality.

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

Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable, as no critical habitat has been listed for the Swift Parrot.

6. whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The *National Recovery Plan for the Swift Parrot* (Saunders and Tzaros, 2011) aims to prevent further population decline of the Swift Parrot and to achieve a demonstrable sustained improvement in the quality and quantity of Swift Parrot habitat to increase carrying capacity. These objectives will be achieved by implementing recovery actions for each of the following specific recovery objectives:

- Objective 1: To identify and prioritise habitats and sites used by the species across its range, on all land tenures.
- Objective 2: To implement management strategies to protect and improve habitats and sites on all land tenures
- Objective 3: To monitor and manage the incidence of collisions, competition and Beak and Feather Disease (BFD).
- Objective 4: To monitor population trends and distribution throughout the range.

These objectives, and the associated recovery actions outlined in the *National Recovery Plan for the Swift Parrot* (Saunders and Tzaros, 2011) are not applicable to the study area or project. The identified recovery actions mostly relate to identifying the extent and quality of habitat, monitoring, raising community awareness, and coordinating and reviewing the recovery process. There is an action relating to manage and protect Swift Parrot habitat at the landscape scale. However, this action applies to fencing off habitat on private land to encourage regeneration of habitat, revising forestry practices, developing a strategic management plan for Swift Parrot breeding habitat in Tasmania, and providing Swift Parrot conservation information for consideration during the New South Wales Local Government Local Environmental Planning review process. The recovery actions identified in the *National Recovery Plan for the Swift Parrot* (Saunders and Tzaros, 2011) will not be interfered with by the project

A targeted strategy for managing threatened species is also being developed under the OEH Saving Our Species program. The Swift Parrot has been assigned to the Landscape species management stream under the OEH Saving our Species program and the following actions for recovery have been identified for this species:

- Raise public awareness of the importance of large old trees of species that provide important food resources. Protect large old trees, including from the effects of fire. Ensure the recruitment of large old trees by retaining medium-sized trees, facilitating regeneration, and undertaking replanting.
- Within a region, increase the extent and quality of habitat to increase food supply and improve foraging efficiency. Focus on sites that may better function as drought refuges. Include locally occurring species that provide important food resources in revegetation programs where appropriate. Ensure that fuel reduction burns do not result in canopy scorch, which can reduce flowering in subsequent years. Manage aggressive honeyeater impacts through habitat modification (e.g. reduce the amount of edge and establish a structurally complex understorey).
- Engage the community in the identification and enhanced management of priority sites. Priority sites are those that (1) have been used by a large proportion of the population, or (2) have been used in multiple seasons, or (3) have been used for an extended period of time within a season. Engage stakeholders in the identification and development of site-based management projects for priority areas, being areas containing a high proportion of priority sites, or areas that contribute to the overall diversity and distribution of resources available to swift parrots under a range of environmental conditions.

- With the assistance of the community, monitor swift parrot distribution, abundance, and habitat use. Investigate knowledge gaps to improve the effectiveness of management actions, including understanding the phenology of key food species, determining movement strategies, patterns and pathways between regions, and modelling the impacts of climate change projections on the distribution and abundance of foraging habitat and resources.
- Raise public awareness on collision risks and how these can be minimised. At priority sites and movement pathways assessed as having a high risk of collision, develop and implement mitigation strategies.
- Establish the Beak and Feather Disease Virus (BFDV) status of rehabilitated parrots proposed to be released using appropriate tests and quarantine procedures. Parrots carrying BFDV should not be released into the wild.

The recovery actions listed above, and those identified in the Saving Our Species program, that have been identified by the OEH to help recover the Swift Parrot are largely not applicable to the project. The project would not interfere with the recovery actions identified for the Swift Parrot.

7. 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.

A KTP is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. Key threatening processes are listed under the TSC Act and at the present there are currently 38 listed KTPs. Of the 38 listed KTPs under the TSC Act, none would be increased by the project.

Conclusion

The Swift Parrot is endemic to south-eastern Australia and breeds only in Tasmania. It migrates to mainland Australia in autumn. As such, the project would not affect breeding habitat for this species. Additionally, the study area does not contain any important winter foraging grounds. This species has been rarely recorded on the university grounds so it does occur in the habitats infrequently. As such, the impacts of the project to the Swift Parrot would be limited to loss of some lower quality foraging habitat caused by direct clearing or damage to vegetation during the construction phase. According to the arborist report there are 23 trees within the work area that would need to be removed. Three of these trees are *Corymbia maculata* trees that may provide some marginal foraging habitat for this species.

After consideration of the factors above, an overall conclusion has been made that the project is unlikely to result in a significant effect to the Swift Parrot.

Grey-headed Flying-fox (*Pteropus poliocephalus*)

The Grey-headed Flying-fox is known to fly over the study area during the field survey and may temporarily perch on trees within the study area to rest during the flight to the north as the animals leave the camp at Figtree. Animals may also feed on the eucalypts and palms when in flower and fruit. The Wollongong Figtree camp is located in the suburb of West Wollongong approximately 3 kilometres southeast of the study area. The rainforests and moist eucalypt forests of the Illawarra Escarpment are recognised as high quality habitat for the Grey-headed Flying-fox (NSW National Parks and Wildlife Service, 2002a).

The factors to be considered when determining whether an action, development or activity is likely to significantly affect threatened species or their habitats are outlined below:

8. 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

The Grey-headed Flying-fox occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy. Annual mating commences in January and conception occurs in April or May; a single young is born in October or November.

There are no roost camps located in the study area and at the time of this assessment the project would not directly impact on any known breeding / maternity site. The Wollongong Figtree camp is located in the suburb of West Wollongong approximately 3 kilometres southeast of the study area and will not be impacted by the project. According to the arborist report there are 23 trees within the work area that would need to be removed. Three of these trees are *Corymbia maculata* trees that may provide some marginal foraging habitat for this species. As such, the impacts of the project to the Grey-headed Flying-fox would be limited to loss of foraging habitat caused by direct clearing or damage to vegetation during the construction phase.

The affected area of foraging habitat would represent a small percentage of the total extent of foraging habitats for the Grey-headed Flying-fox present within the locality and within the broader foraging range of individuals from the Wollongong Figtree camp. Given the relative widespread nature of similar vegetation along the Illawarra Escarpment, the project is not expected to significantly affect the life cycle of the Grey-headed Flying-fox. While some high quality seasonal foraging habitat will be removed, the impact is not considered likely to have an adverse effect on the life cycle of the species such that a viable local population of the species (taken here to be the Wollongong Figtree sub-population) is likely to be placed at risk of extinction. Extensive areas of high quality foraging habitat will remain within the foraging range of the Grey-headed Flying-fox individuals that use the Wollongong Figtree camp and sufficient foraging resources will remain in the locality after the project has been built for this species to complete its life cycle.

9. 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

Not applicable.

10. 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
- 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

Not applicable.

11. 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
- 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
- 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.

According to the arborist report there are 23 trees within the work area that would need to be removed. Three of these trees are *Corymbia maculata* trees that may provide some marginal foraging habitat for this species. This represents less than 0.5% of the suitable foraging habitat for this species in the locality which is a small proportion..

Importantly, the project would not result in any further substantial landscape scale fragmentation of habitat for the Grey-headed Flying-fox. Due to its nature, the project will result in the breaking apart of some habitat blocks into smaller portions. The Grey-headed Flying-fox is highly mobile and will freely fly long distances (up to 50 km) over open areas including urbanised city centres to move between roost camps and foraging sites. The Grey-headed Flying-fox currently flies over the study area and uses the habitat patches and any fragmentation caused by the project is considered unlikely to alter this behaviour. Importantly, the project would not affect the movement of the Grey-headed Flying-fox between habitat patches.

The project will result in the removal of some marginal quality foraging habitat for the Grey-headed Flying-fox in the form of planted eucalypt trees. The National Parks and Wildlife Service (2002a) modelled the habitats for the Grey-headed Flying-fox on the Illawarra Escarpment, Coastal Plain and Plateau and found that there were

3,500 hectares of high quality habitats on the escarpment for the Grey-headed Flying-fox. The National Parks and Wildlife Service (2002a) modelling does not include the study area in the area of high quality habitat.

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

Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable as no critical habitat has been listed for the Grey-headed Flying-fox.

13. whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The *Draft National Recovery Plan for the Grey-headed Flying-fox* (Department of Environment Climate Change and Water, 2009) outlines the following actions:

- Identify and protect foraging habitat critical to the survival of Grey-headed Flying-foxes across their range
- Enhance winter and spring foraging habitat for Grey-headed Flying-foxes
- Identify, protect and enhance roosting habitat critical to the survival of Grey-headed Flying-foxes
- Significantly reduce levels of deliberate Grey-headed Flying-fox destruction associated with commercial horticulture
- Provide information and advice to managers, community groups and members of the public that are involved with controversial flying-fox camps
- Produce and circulate educational resources to improve public attitudes toward Grey-headed Flying-foxes, promote the recovery program to the wider community and encourage participation in recovery actions
- Monitor population trends for the Grey-headed Flying-fox
- Assess the impacts on Grey-headed Flying-foxes of electrocution on powerlines and entanglement in netting and barbed wire, and implement strategies to reduce these impacts
- Oversee a program of research to improve knowledge of the demographics and population structure of the Grey-headed Flying-fox
- Maintain a National Recovery Team to oversee the implementation of the Grey-headed Flying-fox National Recovery Plan

A targeted strategy for managing threatened species is also being developed under the OEH Saving Our Species program. The Grey-headed Flying-fox has been assigned to the Landscape species management stream under the OEH Saving our Species program and the following actions for recovery have been identified for this species:

- Increase the extent and viability of foraging habitat for the Grey-headed Flying-fox that is productive during winter and spring through dedicated habitat creation and restoration using guides published by OEH (in preparation).
- Negotiate agreements with landholders, particularly in-perpetuity covenants or stewardship agreements that promote the protection and retention of high quality foraging habitat and roost sites for Grey-headed Flying-foxes.
- Rehabilitate degraded flying-fox roost sites through weed management, planting new roost trees, managing understorey vegetation to maintain suitable microclimate conditions, establishing buffers between roost camps and nearby human settlements to minimise conflict.
- Conduct dedicated engagement programs in communities affected by flying-fox roost sites, building the capacity of all stakeholders to engage in the process of decision-making and developing camp management plans. Provide information about mitigating the impacts of flying-foxes on nearby residences and businesses such as strategic vegetation management, and structural modifications like double-glazing, air conditioning and shade cloths.

- Distribute public education materials to land managers and local community groups working with contentious flying-fox roost sites highlighting species status, reasons for being in urban areas, reasons for decline etc.
- Develop site-based heat stress response protocols for camps likely to be affected by heat stress events. Protocols should be based on best practice guidelines, and should be implemented by licensed fauna rehabilitators. Data should be recorded to inform future management of heat stress events.
- Increase the extent and viability of foraging habitat for the Grey-headed Flying-fox that is productive during winter and spring through dedicated habitat creation and restoration using guides published by OEH (in preparation).
- Negotiate agreements with landholders, particularly in-perpetuity covenants or stewardship agreements that promote the protection and retention of high quality foraging habitat and roost sites for Grey-headed Flying-foxes.
- Rehabilitate degraded flying-fox roost sites through weed management, planting new roost trees, managing understorey vegetation to maintain suitable microclimate conditions, establishing buffers between roost camps and nearby human settlements to minimise conflict.
- Conduct dedicated engagement programs in communities affected by flying-fox roost sites, building the capacity of all stakeholders to engage in the process of decision-making and developing camp management plans. Provide information about mitigating the impacts of flying-foxes on nearby residences and businesses such as strategic vegetation management, and structural modifications like double-glazing, air conditioning and shade cloths.
- Distribute public education materials to land managers and local community groups working with contentious flying-fox roost sites highlighting species status, reasons for being in urban areas, reasons for decline etc.

The recovery actions listed above, and those identified in the Saving Our Species program, that have been identified by the OEH to help recover the Grey-headed Flying-fox are largely not applicable to the project as they are actions for the OEH to complete and focus on priority conservation lands which are outside of the study area. The project would not interfere with the recovery actions that have been identified for the recovery of the Grey-headed Flying-fox.

14. 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.

A KTP is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. Key threatening processes are listed under the TSC Act and at the present, there are currently 38 listed KTPs. The project would not increase the impact of any KTPs relevant to the Grey-headed Flying-fox.

Conclusion

There are no roost camps located in the study area and at the time of this assessment the project would not directly impact on any known breeding / maternity site. As such, the impacts of the project to the Grey-headed Flying-fox would be limited to loss of marginal foraging habitat caused by direct clearing or damage to vegetation during the construction phase.

After consideration of the factors above, an overall conclusion has been made that the project is unlikely to result in a significant effect to the Grey-headed Flying-fox.

C.2 Environment Protection and Biodiversity Conservation Act 1999

Swift Parrot (*Lathamus discolor*)

The Swift Parrot is endemic to south-eastern Australia and breeds only in Tasmania. It migrates to mainland Australia in autumn. The National Parks and Wildlife Service (2002) identifies the Swift Parrot as an irregular migrant to the Illawarra escarpment, coastal plain and plateau. There have been records of the Swift Parrot

made from the Wollongong University campus in 2002 suggesting this species occasionally utilises the habitats. As such, the Swift Parrot is considered moderately likely to occur within the study area on an infrequent basis based on the presence of some marginally suitable foraging habitat and nearby records. No critical or high quality foraging habitats are present.

An action is likely to have a significant impact on a Critically Endangered or Endangered species if there is a real chance or possibility that it will:

15. lead to a long-term decrease in the size of a population

The study area contains some marginal foraging habitat for the Swift Parrot. While the habitat in the study area is not optimal, the loss of potential feed trees would directly affect the species opportunity to feed in the area. However, the study area is not considered a critical area for the Swift Parrot. The Swift Parrot may utilise trees in the study area for foraging intermittently when no other suitable inland (i.e. box ironbark woodlands) or coastal resources (i.e. Spotted Gum and Swamp Mahogany forests) are available. According to the arborist report there are 23 trees within the work area that would need to be removed. Three of these trees are *Corymbia maculata* trees that may provide some marginal foraging habitat for this species. This is a small proportional impact considering the National Parks and Wildlife Service (2002a) has mapped 48 hectares of high quality habitat for the Swift Parrot in the region of the Illawarra escarpment, coastal plain and plateau.

The Swift Parrot does not breed in the study area and the extent of habitat remaining in the locality would provide sufficient resources to sustain future visitation, such that the action is unlikely to lead to a long-term decrease in the size of the Australian population.

16. reduce the area of occupancy of the species

As a specialist nectarivore dependent on flowering eucalypts, Swift Parrots are vulnerable to the loss of quantity and quality of key forage tree species. As a large-scale migrant, it has the ability to cover vast areas of its winter range, seeking suitable flowering eucalypt habitat. The species is an occasional visitor to the region and may utilise trees in the study area for foraging intermittently when no other suitable resources are available.

The project would contribute to the loss of marginal foraging habitat that would reduce the area of habitat available. However, the action will not reduce the area of occupancy of this species, which is estimated at 4,000 km².

17. fragment an existing population into two or more populations

Importantly, the action will not result in fragmentation of habitat for the Swift Parrot. The level of fragmentation likely to be caused will not affect large-scale migrants such as the Swift Parrot. This species is highly mobile and as a regular behaviour flies long distances over open areas to move between suitable foraging habitats. The action will not affect the movement of the Swift Parrot between habitat patches or fragment the population.

18. adversely affect habitat critical to the survival of a species

Key habitats for this species on the coast and coastal plains of New South Wales include large stands of Spotted Gum (*Corymbia maculata*), Swamp Mahogany (*E. robusta*), Red Bloodwood (*Corymbia gummifera*) and Forest Red Gum (*E. tereticornis*) forests. The study area does not have forests of these species. The habitat within the study area is considered to be secondary or supplementary habitat for the Swift Parrot as this species is not regularly recorded from the area and the area is not known as critical habitat.

19. disrupt the breeding cycle of a population

The Swift Parrot is endemic to south-eastern Australia and breeds only in Tasmania, and migrates to mainland Australia in autumn. As such, the action will not impact on breeding habitat for this species. Important winter foraging grounds will not be impacted.

20. modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

According to the arborist report there are 23 trees within the work area that would need to be removed. Three of these trees are *Corymbia maculata* trees that may provide some marginal foraging habitat for this species. As a large-scale migrant, it has the ability to cover vast areas of its winter range, seeking suitable flowering eucalypt habitat. The species is an occasional visitor to the region and may utilise trees in the study area for foraging intermittently when no other suitable resources are available. The action is unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

21. result in invasive species that are harmful to a Critically Endangered or Endangered species becoming established in the Endangered or Critically Endangered species' habitat

The main invasive species harmful to the habitat for the Swift Parrot are weeds that modify habitat and also other birds that are aggressive competitors. Noisy Miners are abundant in the habitat which may make the habitat less suitable for the Swift Parrot due to competitive exclusion. The action may result in weed invasion and the removal of habitat may concentrate local miner populations increasing competition. The management of invasive species would be managed under the construction environmental management plan and during operation.

22. introduce disease that may cause the species to decline, or

Infection of native plants by *Phytophthora cinnamomi* has been identified as being spread by construction machinery. This water-borne mould infects the roots of plants and has the potential to cause dieback. Machinery associated with vegetation clearance and subsequent construction has the potential to transmit the fungus to remaining native vegetation remnants. This is a potential indirect impact to habitat for the species but this can be mitigated through the development and implementation of suitable control measures for vehicle and plant hygiene and is unlikely to have a significant impact.

The projects mitigation strategy and environmental management procedures would include guidance for preventing the introduction and/or spread of disease causing agents such as bacteria and fungi.

23. interfere with the recovery of the species.

The *National Recovery Plan for the Swift Parrot* (Saunders and Tzaros, 2011) aims to prevent further population decline of the Swift Parrot and to achieve a demonstrable sustained improvement in the quality and quantity of Swift Parrot habitat to increase carrying capacity. These objectives will be achieved by implementing recovery actions for each of the following specific recovery objectives:

- Objective 1: To identify and prioritise habitats and sites used by the species across its range, on all land tenures.
- Objective 2: To implement management strategies to protect and improve habitats and sites on all land tenures
- Objective 3: To monitor and manage the incidence of collisions, competition and Beak and Feather Disease (BFD).
- Objective 4: To monitor population trends and distribution throughout the range.

These objectives, and the associated recovery actions outlined in the *National Recovery Plan for the Swift Parrot* (Saunders and Tzaros, 2011) are not applicable to the study area or project. The identified recovery actions mostly relate to identifying the extent and quality of habitat, monitoring, raising community awareness, and coordinating and reviewing the recovery process. There is an action relating to manage and protect Swift Parrot habitat at the landscape scale. However, this action applies to fencing off habitat on private land to encourage regeneration of habitat, revising forestry practices, developing a strategic management plan for Swift Parrot breeding habitat in Tasmania, and providing Swift Parrot conservation information for consideration during the New South Wales Local Government Local Environmental Planning review process. The recovery actions identified in the *National Recovery Plan for the Swift Parrot* (Saunders and Tzaros, 2011) will not be interfered with by the project.

Conclusion

The Swift Parrot will suffer a small reduction in extent of marginal foraging habitat from the action. The action is unlikely to reduce the population size of the Swift Parrot or decrease the reproductive success of this species. The action will not interfere with the recovery of the Swift Parrot. For the Swift Parrot, impacts are most likely to be significant where a project or activity may result in loss of habitat in, or adjacent to priority foraging, nesting and roosting sites (Saunders and Tzaros, 2011). The project will not impact on any priority foraging habitat. As such, after consideration of the factors above, an overall conclusion has been made that the action is unlikely to result in a significant impact to the Swift Parrot.

Grey-headed Flying-fox (*Pteropus poliocephalus*)

The Grey-headed Flying-fox is known to fly over the study area and may temporarily perched on trees within the study area to rest during the flight to the north as the animals leave the camp at Figtree. The animals may also forage on the eucalypt and palm trees when in flower and fruit. The Wollongong Figtree camp is located in the suburb of West Wollongong approximately 3 kilometres southeast of the study area. The rainforests and moist eucalypt forests of the Illawarra Escarpment are recognised as high quality habitat for the Grey-headed Flying-fox (NSW National Parks and Wildlife Service, 2002a).

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

24. lead to a long-term decrease in the size of an important population of a species

There are no roost camps in the study area and the project will not affect any known permanent roosting, breeding / maternity site. Therefore, it is likely that the impacts of construction and operation of the project would be confined to loss of feeding habitat caused by direct clearing or damage to native vegetation during the construction phase.

According to the arborist report there are 23 trees within the work area that would need to be removed. Three of these trees are *Corymbia maculata* trees that may provide some marginal foraging habitat for this species. Given the relative widespread nature of higher quality native vegetation and other planted vegetation in the locality and abundance of higher quality foraging habitat within the feeding range of regional populations, the project is not expected to lead to a long-term decrease in the size of an important population.

25. reduce the area of occupancy of an important population

The area of occupancy of the Grey-headed Flying-fox is not known but the species exists as one interconnected population along the eastern Australian coastal belt from Rockhampton in central Queensland to Melbourne in Victoria. The area occupied by this species will remain the same after the project is complete. No decrease in the area of occupancy for this species expected as a result of the project.

26. fragment an existing important population into two or more populations

Highly mobile species such as bats are expected to be less impacted by fragmentation. The Grey-headed Flying-fox is particularly well adapted to accessing widely spaced habitat resources given its mobility and preference for seasonal fruits and blossom in differing parts of the landscape. The project would not fragment an important population of the Grey-headed Flying-fox. Individuals will still be able to disperse between roosts along the east Australian coast. Genetic exchange within the population and dispersal will not be disrupted by the project.

27. adversely affect habitat critical to the survival of a species

This species typically exhibits very large home range and Grey-headed Flying-fox is known to travel distances of at least 50 kilometres from roost sites to access seasonal foraging resources. There are no known roost camps within the study area and the site does not provide critical roosting habitat.

However there are a number of known roost camps with a 50km radius of the project, the closest being the Fig Tree camp. The draft recovery plan for the Grey-headed Flying-fox identifies critical foraging habitat for this species as:

- Productive during winter and spring, when food bottlenecks have been identified
- Known to support populations of >30,000 individuals, within an area of 50 kilometre radius of a camp site
- Productive during the final weeks of gestation, and during the weeks of birth, lactation and conception (Sept-May)
- Productive during the final stages of fruit development and ripening in commercial crops affected by Grey-headed Flying-foxes
- Known to be continuously occupied as a camp site.

The planted vegetation within the study area would not constitute critical foraging habitat. The affected area of foraging habitat would represent a small percentage of the total extent of important foraging vegetation types present within a 50 kilometre radius of the Fig Tree camp site. Given the extensive nature of high quality foraging habitats along the escarpment, the project is not expected to adversely affect foraging habitat critical to the survival of this species in this region.

28. disrupt the breeding cycle of an important population

As stated above there would be a minor impact on foraging habitat that would not be considered important during the breeding cycle of the species. The work would not directly impact on a known roost camp / breeding or maternity site. Extensive foraging resources are available on the escarpment that will provide suitable resources during the maternity season. The habitats in the study area are not limiting for this species.

29. modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

No evidence of a roost camp has been identified from the study area. Further, there would be a relatively minor impact on foraging habitat. This impact is not expected to lead to a decline in the species in this region considering the magnitude of this impact and the expanse of high quality foraging habitat available to local animals along the escarpment.

30. result in invasive species that are harmful to a vulnerable species becoming established in the Vulnerable species' habitat

The project is unlikely to result in an invasive species harmful to the Grey-headed Flying-fox becoming established in the habitat. The potential for weed invasion was considered possible with a project of this nature but is considered unlikely given the nature of the environment. The management of invasive species would be managed under the construction environmental management plan using best practice methods.

31. introduce disease that may cause the species to decline, or

There are no known disease issues affecting this species in relation to the project. The project would be unlikely to increase the potential for significant disease vectors to affect local populations.

32. interfere substantially with the recovery of the species.

The *Draft National Recovery Plan for the Grey-headed Flying-fox (Pteropus poliocephalus)* (Department of Environment Climate Change and Water, 2009) outlines the following actions:

- Identify and protect foraging habitat critical to the survival of Grey-headed Flying-foxes across their range
- Enhance winter and spring foraging habitat for Grey-headed Flying-foxes
- Identify, protect and enhance roosting habitat critical to the survival of Grey-headed Flying-foxes
- Significantly reduce levels of deliberate Grey-headed Flying-fox destruction associated with commercial horticulture
- Provide information and advice to managers, community groups and members of the public that are involved with controversial flying-fox camps

- Produce and circulate educational resources to improve public attitudes toward Grey-headed Flying-foxes, promote the recovery program to the wider community and encourage participation in recovery actions
- Monitor population trends for the Grey-headed Flying-fox
- Assess the impacts on Grey-headed Flying-foxes of electrocution on powerlines and entanglement in netting and barbed wire, and implement strategies to reduce these impacts
- Oversee a program of research to improve knowledge of the demographics and population structure of the Grey-headed Flying-fox
- Maintain a National Recovery Team to oversee the implementation of the Grey-headed Flying-fox National Recovery Plan

The recovery actions listed above are largely not applicable to the project and the project is not expected to interfere substantially with the recovery of the species.

Conclusion

The Grey-headed Flying-fox will suffer a small reduction in extent of suitable foraging habitat from the project. According to the arborist report there are 23 trees within the work area that would need to be removed. Three of these trees are *Corymbia maculata* trees that may provide some marginal foraging habitat for this species. No breeding camps or other important habitat will be impacted. The project is unlikely to reduce the population size of the Grey-headed Flying-fox or decrease the reproductive success of this species. The project will not interfere with the recovery of the Grey-headed Flying-fox and will not contribute to the key threats to this species. After consideration of the factors above, an overall conclusion has been made that the project is unlikely to result in a significant impact to the Grey-headed Flying-fox.

Migratory species

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- 1) substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a Migratory species
- 2) result in an invasive species that is harmful to the Migratory species becoming established in an area of important habitat for the Migratory species, or
- 3) seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a Migratory species.

An area of 'important habitat' for a migratory species is defined as:

- habitat used by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or
- habitat that is of critical importance to the species at particular life-cycle stages, and/or
- habitat used by a migratory species which is at the limit of the species range, and/or
- habitat within an area where the species is declining.

While migratory species of bird do use the study area and locality, the study area would not be classed as an 'important habitat' as defined under the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (Department of Environment, 2013), in that the study area does not contain:

- a region that supports an ecologically significant proportion of a population of migratory species
- habitat utilised by a migratory species which is at the limit of the species range
- habitat within an area where the species is declining.

As such, it is unlikely that the project would significantly affect migratory species. There is no evidence to suggest that an ecologically significant proportion of the population of any identified migratory species exists

within the study area. The potential for weed invasion has been considered highly likely with an project of this nature and appropriate controls will be provided during the construction and operation to reduce this threat. The management of invasive species would be managed under the construction environmental management plan.