Travers

bushfire & ecology

ecological constraints assessment

Rezoning / Planning Proposal
Lot 1 DP 218016,
Lot B DP 370979 &
Lot 22 DP 564065
166 - 176 St Andrews Road,
Varroville, NSW.

September 2013
(REF: A13060F)

Ecological Constraints Assessment

Lot 1 DP 218016, Lot B DP 370979 & Lot 22 DP 564065
166-176 St. Andrews Road
Varroville, NSW

September 2013

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The mapping is indicative of available space and location of features which may prove critical in assessing the viability of the proposed works. Mapping has been produced on a map base with an inherent level of inaccuracy, the location of all mapped features are to be confirmed by a registered surveyor.

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Executive Summary

Travers bushfire & ecology has been engaged by *Catholic Metropolitan Cemeteries Trust c/- Urbis* to undertake flora and fauna survey and review the ecological constraints within Lot 1 DP 218016, Lot B DP 370979 & Lot 22 DP 564065, 166-176 St. Andrews Road, Varroville. These combined lots will be referred to as the study area.

Recorded threatened flora, fauna and endangered ecological communities (EECs)

Ecological survey and assessment has been undertaken in accordance with relevant legislation including the *Environmental Planning and Assessment Act (EP&A Act)*, the *Threatened Species Conservation Act (TSC Act)*, the *Environment Protection and Biodiversity Conservation Act (EPBC Act)*and the *Fisheries Management Act (FM Act)*.

In respect of matters required to be considered under the *EP&A Act* and relating to the species / provisions of the *TSC Act*, three (3) threatened fauna species, Eastern Bentwing-bat (*Miniopterus orianae oceansis*), East-coast Freetail Bat (*Micronomus norfolkensis*) and Large-footed Myotis (*Myotis macropus*), no threatened flora species, and two (2) EECs, Cumberland Plain Woodland and Moist Shale Woodland were recorded within the study area. The proposed cemetery proposes works that are unlikely to cause any significant impact on threatened species, EECs or populations.

In respect of matters required to be considered under the *EPBC Act*, no threatened fauna species, one (1) protected migratory bird species, Cattle Egret (*Ardea ibis*), no threatened flora species, and two (2) EECs Cumberland Plain Shale Woodlands and Shale-Gravel Transition and Western Sydney Dry Rainforest and Moist Woodland on Shale listed under this Act were recorded within the study area. Given the low level impact of the proposed cemetery, the proposal will not cause a significant impact on any listed matters if National Environmental Significance.

In respect of matters relative to the *FM Act*, no suitable habitat for threatened marine or aquatic species was observed within the study area and there are no matters requiring further consideration under this act. The proposed cemetery proposes works that are unlikely to cause any significant impact on threatened marine or aquatic species.

Ecological constraints

The key ecological constraints (Figure 3) are as follows:

- **EECs –** Cumberland Plain Woodland, Moist Shale Woodland Floodplains occur throughout the site in variable condition and Swamp Sclerophyll Forest on Coastal occurs on the adjoining crown lands, but no high quality remnants were observed because of grazing, clearing and dense infestations of African Olive. There is approximately 12.45ha of Cumberland Plain Woodland of which 2.76ha is of low condition. There is approximately 9.53ha of Moist Shale Woodland of which 3.05ha is of low condition. Cumberland Plain Woodland occurs on the gentle topography in the mid and lower slopes of the study area. Moist Shale Woodland occurs on the steeper south-facing slopes in the northern most part of the study area. Swamp Sclerophyll Forest on Coastal Floodplains occurs in very small fragmented patches on the lower floodplains within the adjoining crown land.

- **Hollow dependent threatened fauna species habitat** - Two (2) of the three (3) recorded threatened microbat species East-coast Freetail Bat (*Micronomus norfolkensis*) and Large-footed Myotis (*Myotis macropus*) utilise hollows for roosting and breeding. The Large-footed Myotis is also known to utilise subterranean habitats and artificial structures for roosting. Given the recorded level of presence by these species and also considering that survey was undertaken during the low activity winter period, there is real potential that valuable roosting habitat is present within the site or nearby locality. Exact locations of roosting and breeding trees is difficult to determine without extensive target surveys and therefore assessment of these species is often dependent on the estimated loss of hollow bearing trees, the availability of other hollow resources in the locality and the creation of supplementary habitat (such as nest boxes) on site.

Potential ecological impacts

The rural nature of the landscape and highly fragmented vegetation has resulted in a low level impact on any vegetation and habitat within the site. Consequently, the impacts caused are not considered to be significant. The proposed cemetery landscape proposes to retain the majority of on site vegetation remnants and has clearly demonstrated an approach that avoids causing direct impacts.

Over the life of the cemetery, which is approximately 150 years, the proposed cemetery concept will result in a maximum loss of:

- 1.14ha of moderate quality Cumberland Plain Woodland affecting four (4) vegetation remnants
- Potential loss of hollows suitable for hollow dependent threatened fauna.

As the cemetery will be staged it is not expected to cause mass habitat loss at any point in time that cannot be compensated by revegetation works. Approximately 7.19ha of riparian lands are available to be used for restoration of Cumberland Plain Woodland.

Travers bushfire & ecology recommends that a vegetation management plan be prepared that stages the restoration works and outlines the vegetation and fauna habitat enrichment works that can be undertaken to achieve an overall positive biodiversity conservation outcome onsite.

List of abbreviations

APZ	asset protection zone
BPA	bushfire protection assessment
CLUMP	conservation land use management plan
DBH	diameter at breast height
DCP	Development Control Plan
DEC	NSW Department of Environment and Conservation (superseded by DECC from 4/07)
DECC	NSW Department of Environment and Climate Change (superseded by DECCW from 10/09)
DECCW	NSW Department of Environment, Climate Change and Water (superseded by OEH from 4/11)
EEC	endangered ecological community
EPA	Environmental Protection Agency
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESMP	ecological site management plan
FF	flora and fauna assessment
FM Act	*Fisheries Management Act 1994*
FMP	fuel management plan
HTA	habitat tree assessment
IPA	inner protection area
LEP	Local Environment Plan
LGA	local government area
NES	national environmental significance
NPWS	NSW National Parks and Wildlife Service
NSW DPI	NSW Department of Industry and Investment
OEH	Office of Environment and Heritage (Part of the NSW Department of Premier and Cabinet)
OPA	outer protection area
PBP	*Planning for Bush Fire Protection 2006*
POM	plan of management
RF Act	*Rural Fires Act 1997*
RFS	NSW Rural Fire Service
ROTAP	rare or threatened Australian plants
SEPP 44	*State Environmental Protection Policy No 44 – Koala Habitat Protection*

SEWPAC	Federal Department of Sustainability, Environment, Water, Population and Communities
SIS	species impact statement
SULE	safe useful life expectancy
TBE	*Travers bushfire & ecology*
TPO	tree preservation order
TPZ	tree preservation zone
TRRP	tree retention and removal plan
TSC Act	*Threatened Species Conservation Act 1995*
VMP	vegetation management plan

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Introduction 1

Travers bushfire & ecology has been engaged by *Catholic Metropolitan Cemeteries Trust c/- Urbis* to undertake flora and fauna survey and review the ecological constraints within Lot 1 DP 218016, Lot B DP 370979 & Lot 22 DP 564065, 166-176 St. Andrews Road, Varroville. These combined lots will be referred to as the study area with the aim of providing ecological information to the proponent to identify suitability for rezoning.

1.1 Aims of the assessment

The aims of the flora and fauna assessment are to:

- Carry out a botanical survey to describe the vegetation communities and their conditions;
- Carry out a fauna survey for the detection and assessment of fauna and their habitats;
- Complete target surveys for threatened species, populations and ecological communities; and
- Prepare a flora and fauna constraints analysis in accordance with the requirements of the *EPBC Act,* the *TSC Act,* the *FM Act* and *Threatened species assessment guidelines, the assessment of significance* (DECC 2007).

1.2 Statutory requirements

1.2.1 Threatened Species Conservation Act (TSC Act)

The specific requirements of the *TSC Act* must be addressed in the assessment of impacts on threatened flora and fauna, populations and ecological communities. The factors to be taken into account in deciding whether there is a significant effect are set out in Section 5A of the *EP&A Act* and are based on a 7 part test of significance. Where a proposed activity is located in an area identified as critical habitat, or such that it is likely to significantly affect threatened species, populations, ecological communities, or their habitats, a species impact statement (SIS) is required to be prepared.

1.2.2 Fisheries Management Act (FM Act)

The *FM Act* provides a list of threatened aquatic species that require consideration when addressing the potential impacts of a proposed development. Where a proposed activity is located in an area identified as critical habitat, or such that it is likely to significantly affect threatened species, populations, ecological communities, or their habitats, an SIS is required to be prepared.

1.2.3 Environment Protection and Biodiversity Conservation Act (EPBC Act)

The *EPBC Act* requires that Commonwealth approval be obtained for certain actions. It provides an assessment and approvals system for actions that have a significant impact on matters of national environmental significance (NES). These may include:

- World heritage properties and national heritage places;
- Wetlands of international importance protected by international treaty;
- Nationally listed threatened species and ecological communities;
- Nationally listed migratory species; and
- Commonwealth marine environments.

Actions are projects, developments, undertakings, activities, and series of activities or alteration of any of these. An action that needs Commonwealth approval is known as a controlled action. A controlled action needs approval where the Commonwealth decides the action would have a significant effect on an NES matter.

Where a proposed activity is located in an area identified to be of NES, or such that it is likely to significantly affect threatened species, ecological communities, migratory species or their habitats, then the matter needs to be referred to the Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) for assessment. In the case where no listed federal species are located on site then no referral is required. The onus is on the proponent to make the application and not on the Council to make any referral.

A threshold criterion applies to specific NES matters which may determine whether a referral is or is not required, such as for the *EPBC Act* listed ecological communities Cumberland Plain Woodland and Shale-Gravel Transition Forest. Consultation with SEWPAC may be required to determine whether a referral is or is not required. If there is any doubt as to the significance of impact or whether a referral is required, a referral is generally recommended to provide a definite decision under the *EPBC Act* thereby removing any further obligations in the case of not controlled actions.

A significant impact is regarded as being:

> *important, notable, or of consequence, having regard to its context or intensity and depends upon the sensitivity, value, and quality of the environment which is impacted and upon the duration, magnitude, and geographical extent of the impacts. A significant impact is likely when it is a real or not a remote chance or possibility.*
>
> *Source: EPBC Policy Statement*

Guidelines on the correct interpretation of the actions and assessment of significance are located on the department's web site http://www.environment.gov.au/epbc/publications

1.3 Proposed masterplan

It is proposed to rezone the study area for use as a cemetery. A concept plan is provided in Figure 1. The design of the proposed cemetery has avoided impacting on significant ecological constraints of the site. Minor impacts on existing vegetation areas are identified with a red hatch.

Figure 1 – Concept Masterplan – Varroville Cemetery

1.4 Site description

Table 1.1 provides a summary of the planning, cadastral, topographical, and disturbance details of the study area.

Table 1.1 – Site features

Location	St. Andrews Road, Varroville
Local government area	City of Campbelltown
Grid reference	299000E 6235700N
Elevation	50-100m AMSL
Topography	Situated on a steady SE sloping landscape parallel to St Andrews Road with a steeper incline towards the vegetated northern boundary.
Geology and soils	Geology; Shale carbonaceous claystone, laminate, coal in parts. Unnamed sandstone member – fine to medium grained quartz-lithic sandstone.
Catchment and drainage	Catchment – Bunbury Curran Creek Small creeks and tributaries across the site drain SE joining until they reach Bunbury Curran Creek.
Vegetation	Where present, native vegetation has a riparian structure due to small creeks and tributaries running through the site. In most areas, trees are around 15-25m tall, there is a limited mid-storey which is mostly made up of weeds such as African Olive, and a ground layer of grasses and herbs. The vegetation is highly modified throughout the study area due to previous clearing.
Existing land use	Rural, grazing and unmanaged
Clearing	The majority of the study area has been previously cleared for indicated land uses.

Survey Methodology 2

2.1 Information collation, technical resources, desktop assessment, specialist identification and licences

A review of the relevant information pertinent to the study area was undertaken.

Client documents reviewed include:

- Masterplan prepared by *Florence Jaquet Landscape Architect*

Standard Technical Resources utilised:

- *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities 2004* (working draft), Department of Environment and Conservation (DEC)
- Aerial photographs (*Google Earth Pro* / *Spatial Information Exchange*)
- Topographical maps (scale 1:25,000)
- *Threatened Species Conservation Act* (*TSC Act*)
- *Fisheries Management Act* (*FM Act*)
- *Environment Protection and Biodiversity Conservation Act* (*EPBC Act*)
- Rare or threatened Australian plants (ROTAP)
- *Vegetation mapping of the Cumberland Plain* (NPWS 2002)

Desktop Assessment:

To determine the likely and actual occurrence of flora species, fauna species and plant communities on the study area, desktop assessments were undertaken including:

- ***A literature review*** – A review of readily available literature for the area was undertaken to obtain reference material and background information for this survey.

- ***A data search*** – A search of the *Atlas of NSW Wildlife* (OEH 2013) was undertaken to identify records of threatened flora and fauna species located within a 10km radius of the site. Searches were also undertaken on the SEWPAC – protected matters search tool website to generate a report which helps determine whether matters of national environmental significance or other matters protected by the *EPBC Act* are likely to occur in the area of interest. The search was broadened to a 10km radius in accordance with the *Atlas of NSW Wildlife* (OEH 2013) search. These two searches combined, enabled the preparation of a list of threatened flora and fauna species that could potentially occur within the habitats found on the site (Tables A2.1, A2.2 and A2.3).

Accuracy of identification:

Specimens of plants not readily discernible in the field were collected for identification. Structural descriptions of the vegetation were made according to Specht *et al* (1995).

Photographic representations of snails recorded were sent to Michael Shea, Malacology Section, Australian Museum.

***Licences*:**

Individual staff members of *Travers bushfire & ecology* are licensed under Clause 20 of the *National Parks and Wildlife (Land Management) Regulation 1995* and Sections 120 & 131 of the *National Parks and Wildlife Act 1974* to conduct flora and fauna surveys within service and non-service areas. NPWS Scientific Licence Numbers: SL100848.

Travers bushfire & ecology staff is licensed under an Animal Research Authority issued by the Department of Agriculture. This authority allows *Travers bushfire & ecology* staff to conduct various fauna surveys of native and introduced fauna for the purposes of environmental consulting throughout New South Wales.

2.2 Flora survey methodology

Flora survey was undertaken on 1 July, 2013. A random meander search was undertaken in accordance with Cropper (1993) to create a broad species list.

Thirteen (13) 20x20m floristic biometric style quadrats were assessed within vegetation portions of the study area. Target searches for threatened species were undertaken for those considered to have potential habitat during the random meander and stratified surveys.

A review of the *Atlas of NSW Wildlife* (OEH 2013) was undertaken prior to the botanical survey to identify threatened species previously recorded within 10km of the study area and determine whether target searches were needed to be undertaken.

2.3 Fauna survey methodology

Site survey effort accounting for techniques deployed, duration, and weather conditions are outlined in Table 2.1 and are depicted on Figure 3.

Current standard fauna survey techniques employed by *Travers bushfire & ecology* in line with relevant survey guidelines as well as current survey knowledge are provided in Appendix 1. Fauna survey techniques that have been tailored to the site are provided in Section 2.6.

2.4 Field survey effort

Tables 2.1 and 2.2 below detail the flora and fauna survey effort undertaken for the study area.

Table 2.1 – Fauna survey effort

Fauna group	Date	Weather conditions	Survey technique(s)	Survey effort / time (24hr)
Diurnal birds	10/7/13 11/7/13	7-2/8 cloud, no wind, no rain, temp 18°C 0/8 cloud, light W wind, no rain, temp 20-10°C	Diurnal opportunistic Diurnal bird census points x 3 Diurnal opportunistic Diurnal bird census points x 7	3hrs 55min 1320 - 1715 > 60min 7hrs 15min 1000 - 1715 >1400min
Nocturnal birds	10/7/13 11/7/13	1/8 cloud, no wind, no rain, ¼ moon, temp 10-8°C 0/8 cloud, no wind, no rain, ¼ moon, temp 10-9°C	Spotlighting Call playback (Section 2.6 species) Spotlighting Call playback (Section 2.6 species)	2hrs 1730 - 1930 Commenced @ 1815 3hrs 5min 1715 - 2020 Commenced @ 1915
Arboreal mammals	10/7/13 11/7/13	1/8 cloud, no wind, no rain, ¼ moon, temp 10-8°C 0/8 cloud, no wind, no rain, ¼ moon, temp 10-9°C	Spotlighting Call playback (Section 2.6 species) Spotlighting Call playback (Section 2.6 species)	2hrs 1730 - 1930 Commenced @ 1830 3hrs 5min 1715 - 2020 Commenced @ 1930
Terrestrial mammals	10/7/13 11/7/13	1/8 cloud, no wind, no rain, ¼ moon, temp 10-8°C 0/8 cloud, no wind, no rain, ¼ moon, temp 10-9°C	Spotlighting Spotlighting	2hrs 1730 - 1930 3hrs 5min 1715 - 2020
Bats	10/7/13 11/7/13	1/8 cloud, no wind, no rain, ¼ moon, temp 10-8°C 0/8 cloud, no wind, no rain, ¼ moon, temp 10-9°C	Spotlighting *Anabat* SD-1 (Active monitoring) *Anabat* SD-1 (Passive monitoring) x1 *Anabat* SD-1 (Passive monitoring) x2 Spotlighting *Anabat* SD-1 (Active monitoring) *Anabat* SD-1 (Passive monitoring) x2	2hrs 1730 - 1930 2hrs 1730 - 1930 o'night from 1930 o'night from 1715 3hrs 5min 1715 - 2020 3hrs 1715 - 2015 3hrs 10min 1715 - 1850

Table 2.1 – Fauna survey effort

Fauna group	Date	Weather conditions	Survey technique(s)	Survey effort / time (24hr)
Reptiles	10/7/13	7-2/8 cloud, no wind, no rain, temp 18°C	Habitat search, opportunistic	3hrs 55min 1320 - 1715
	11/7/13	0/8 cloud, light W wind, no rain, temp 20-10°C	Habitat search, opportunistic	7hrs 15min 1000 - 1715
Amphibians	10/7/13 11/7/13	1/8 cloud, no wind, no rain, ¼ moon, temp 10-8°C 0/8 cloud, no wind, no rain, ¼ moon, temp 10-9°C	Spotlighting & call identification Spotlighting & call identification	2hrs 1730 - 1930 3hrs 5min 1715 - 2020
Molluscs	10/7/13 11/7/13	7-2/8 cloud, no wind, no rain, temp 18°C 0/8 cloud, light W wind, no rain, temp 20-10°C	Diurnal searches in woodland remnants x3 Diurnal searches in woodland remnants x4	>60min >140min

Table 2.2 – Flora survey effort

Flora survey	Survey technique(s)	Dates
Vegetation communities	Survey of the boundaries of all communities – field verification and aerial photographic interpretation Vegetation condition assessment – Biometric field method	1/7/13
Stratified sampling	20x20m quadrats in all existing bushland or remnant areas	1/7/13
Target searches	Target searches in known habitats	1/7/13

2.5 Site specific survey techniques

Diurnal birds

Ten (10) diurnal bird census points were undertaken within the study area. A minimum of 20 minutes of survey was undertaken at each census point in an area radiating out to between 30-50m. Bird census points were selected to give an even spread and representation across the site and its communities (Figure 3). Census points were also commenced in locations where bird activity was apparent, as often different small bird species are found foraging together. Opportunistic diurnal bird survey was conducted between census points and whilst undertaking other diurnal surveys.

Nocturnal birds

Given the varying suitability of habitat present Masked Owl (*Tyto novaehollandiae*), Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*) and Bush Stone-curlew (*Burhinus grallarius*) were targeted by call playback techniques (Figure 3).

Bats

Mobile vehicle *Anabat* active recording was undertaken on both nights of survey through the areas of the site accessible by vehicle. The northern hills and ridgeline was not surveyed by active *Anabat* recording, however, a passive recording station was located along this ridge (Figure 3).

Amphibians

Habitat searches for snails also contributed to habitat search survey effort for amphibians located under logs.

Invertebrates

Given the proximity to previous *Atlas of NSW Wildlife* (OEH 2013) records of Cumberland Plain Land Snail (*Meridolum corneovirens*) and the recorded presence of its typical host community, target surveys were undertaken. Habitat searches were undertaken within thirteen (13) areas including ten (10) locations in which the best quality remnant Cumberland Plain Woodland fragments occur as well as three (3) search areas undertaken across the northern hill-slope outside of the typical host community (Figure 3). Within search areas the most appropriate areas of observed habitat were targeted. Dense areas of leaf litter with likely moisture retaining properties were scraped using a three pronged rake. Logs, stumps, artificial refuse and rocks were also turned over.

Significant habitat trees

Significant habitat trees are defined as trees containing large hollows suitable for use by owls and / or containing a number of good quality hollows typically consisting of more than one (1) medium (10-30cm) sized hollow. A tree may also be considered significant where evidence of use by select fauna is found such as Yellow-bellied Glider sap feed tree, raptor nest, or owl roost.

Data such as the number of hollows present in each size category (or other reason for selection), tree species, diameter at breast height, canopy spread and overall height were collected. A summary of significant habitat tree results is provided in Table 4.3.

2.6 Survey limitations

It is important to note that field survey data collected during the survey period is representative of species occurring within the study area for that occasion. Due to effects of fire, breeding cycles, migratory patterns, camouflage, weather conditions, time of day, visibility, predatory and / or feeding patterns, increased species frequency or richness may be observed within the study area outside the nominated survey period. Habitat assessments based on the identification of micro-habitat features for various species of interest, including regionally significant and threatened species, have been used to minimise the implications of this survey limitation.

Given the limited potential for threatened species to occur on site because of the heavily disturbed (and removed understorey), it is unlikely that there are any significant limitations of this study.

Flora survey limitations

Whilst some flora species are difficult to identify unless flowering, the presence of some species on site may have been overlooked. Care has been taken to target any area where native vegetation was present traversing in a zig zag pattern.

Fauna survey limitations

Migratory birds or birds with seasonal movements may be present within the site outside of the survey period. Survey was also undertaken during winter which is outside of microbat peak activity periods and as such higher microbat species diversity and activity is expected in the opposing warmer months.

Survey Results 3

3.1 Flora results

3.1.1 Flora species

The plants observed within the vegetation communities of the study area are listed in the Table 3.1 below.

Table 3.1 – Flora observations for the study area

Family	Scientific name	Common name
Trees		
Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark
Myrtaceae	*Eucalyptus moluccana*	Grey Box
Myrtaceae	*Eucalyptus tereticornis*	Forest Red Gum
Myrtaceae	*Melaleuca decora*	-
Shrubs		
Mimosaceae	*Acacia implexa*	Hickory
Pittosporaceae	*Bursaria spinosa* var. *spinosa*	Native Blackthorn
Apocnynaceae	*Gomphocarpus fruticosus**	Narrow Leaf Cotton Bush
Verbenaceae	*Lantana camara**	Lantana
Solanaceae	*Lycium ferocissimum**	African Boxthorn
Oleaceae	*Olea europaea* subsp. *cuspidata**	African Olive
Phytolaccaceae	*Phytolacca octandra**	Inkweed
Polygalaceae	*Polygala virgata**	-
Rosaceae	*Rubus fruticosus* sp. agg.*	Blackberry Complex
Ground covers		
Amaranthaceae	*Amaranthus viridis**	Green Amaranth
Myrsinaceae	*Anagallis arvensis**	Scarlet Pimpernel
Poaceae	*Aristida vagans*	Three-awn Speargrass
Poaceae	*Austrodanthonia tenuior*	Wallaby Grass
Poaceae	*Austrostipa pubescens*	Tall Speargrass
Poaceae	*Axonopus fissifolius**	Narrow-leafed Carpet Grass
Acanthaceae	*Brunoniella pumilio*	Dwarf Blue Trumpet
Crassulaceae	*Bryophyllum delagoense**	Mother-of-Millions
Carophyllaceae	*Cerastium glomeratum**	Mouse-ear Chickweed
Sinopteridaceae	*Cheilanthes sieberi*	Rock Fern
Poaceae	*Chloris gayana**	Rhodes Grass
Poaceae	*Chloris ventricosa*	Tall Chloris
Asteraceae	*Cirsium vulgare**	Spear Thistle
Asteraceae	*Conyza bonariensis**	Flaxleaf Fleabane
Asteraceae	*Conyza sumatrensis**	Fleabane
Poaceae	*Cynodon dactylon*	Common Couch
Cyperaceae	*Cyperus gracilis*	-
Apiaceae	*Daucus carota**	Wild Carrot
Convolvulaceae	*Dichondra repens*	Kidney Weed

Table 3.1 – Flora observations for the study area

Family	Scientific name	Common name
Boraginaceae	*Echium plantagineum**	Patterson's Curse
Poaceae	*Ehrharta erecta**	Panic Veldtgrass
Chenopodiaceae	*Einadia polygonoides*	-
Poaceae	*Eleusine tristachya**	Goose Grass
Poaceae	*Entolasia marginata*	Bordered Panic
Poaceae	*Eragrostis brownii*	Brown's Lovegrass
Geraniaceae	*Geranium solanderi*	Cutleaf Cranesbill
Clusiaceae	*Hypericum gramineum*	Small St Johns Wort
Poaceae	*Joycea pallida*	Silvertop Wallaby Grass
Juncaceae	*Juncus usitatus*	Common Rush
Lomandraceae	*Lomandra filiformis*	Wattle Mat-rush
Fabaceae	*Lotus suaveolans**	Hairy Bird's Foot Trefoil
Malvaceae	*Malva sylvestris**	Tall Mallow
Fabaceae	*Medicago polymorpha**	Burr Medic
Poaceae	*Microlaena stipoides* var. *stipoides*	Weeping Grass
Malvaceae	*Modiola caroliniana**	Red-flowered Mallow
Poaceae	*Oplismenus aemulus*	Basket Grass
Cactaceae	*Opuntia stricta**	Prickly Pear
Oxalidaceae	*Oxalis corniculata**	Yellow Wood Sorrel
Oxalidaceae	*Oxalis perennans*	-
Poaceae	*Panicum simile*	Two Colour Panic
Poaceae	*Paspalum dilatatum**	Paspalum
Poaceae	*Pennisetum clandestinum**	Kikuyu
Euphorbiaceae	*Phyllanthus tenellus**	Hen and Chicken
Plantaginaceae	*Plantago lanceolata**	Ribwort
Poaceae	*Poa annua**	Winter Grass
Polygonaceae	*Rumex crispus**	Curled Dock
Asteraceae	*Senecio madagascariensis**	Fireweed
Poaceae	*Setaria parviflora**	-
Malvaceae	*Sida corrugata*	-
Malvaceae	*Sida rhombifolia**	Paddy's Lucerne
Solanaceae	*Solanum nigrum**	Black Nightshade
Solanaceae	*Solanum prinophyllum*	Forest Nightshade
Asteraceae	*Soliva sessilis**	Jojo
Asteraceae	*Sonchus oleraceus**	Common Sow-thistle
Poaceae	*Sporobolus creber*	Slender Rat's Tail Grass
Lamiaceae	*Stachys arvensis**	Stagger Weed
Asteraceae	*Taraxacum officinale**	Dandelion
Poaceae	*Themeda australis*	Kangaroo Grass
Fabaceae	*Trifolium repens**	White Clover
Typhaceae	*Typha orientalis*	Cumbungi
Scrophulariaceae	*Verbascum virgatum**	Twiggy Mullein
Verbenaceae	*Verbena brasiliensis**	-
Plantaginaceae	*Veronica plebeia*	Creeping Speedwell
Campanulaceae	*Wahlenbergia gracilis*	Australian Bluebell
Vines		
Apocnyaceae	*Araujia sericifera**	Mothvine
Vitaceae	*Cayratia clematidea*	Native Grape
Chenopodiaceae	*Einadia nutans* subsp. *linifolia*	Climbing Saltbush
Fabaceae	*Glycine clandestina*	Twining Glycine
Fabaceae	*Glycine microphylla*	-

3.1.2 Vegetation communities

Six (6) disturbed vegetation communities were identified within the study area through ground truthing.

- Vegetation Community 1 – Cumberland Plain Woodland
- Vegetation Community 2 – Moist Shale Woodland
- Vegetation Community 3 – African Olive
- Vegetation Community 4 – Heritage Gardens
- Vegetation Community 5 – Exotic Vegetation
- Vegetation Community 6 – Dam with Occasional Fringing Sedges

Cumberland Plain Woodland

This vegetation community encompasses the remnant native terrestrial vegetation south of the escarpment and commensurate with the EEC of the same name under the *TSC Act*.

There is approximately 9.69ha of moderate-high and 2.42ha of low condition Cumberland Plain Woodland present within the study area. Condition assessment has been determined using the biometric field assessment method used for BioBanking applications.

The canopy comprises mostly a mixture of *Eucalyptus tereticornis* and *Eucalyptus moluccana* to a height of between 15-25m and a projected foliage cover of 10-30% dependent upon the age of the trees. There were seldom any *Eucalyptus crebra* within the canopy.

The mid-storey is largely dominated by the exotic African Olive trees. Where native mid-storey was present, the diversity was very low and generally restricted to just *Bursaria spinosa* var. *spinosa.*

The ground layer was found to be sparse in the majority of remnants due to a lack of light and competition from African Olives. Consequently, there was regularly less than 20% coverage of natives in the ground layer. Often half of the ground cover was dominated by African Olive seedlings. Some native species that were found regularly amongst the quadrats included *Microlaena stipoides, Oplismenus aemulus, Themeda australis, Glycine clandestina, Brunoniella pumilio, Dichondra repens, Cheilanthes sieberi* and *Solanum prinophyllum.*

Moist Shale Woodland

This vegetation community encompasses the remnant vegetation on the escarpment and commensurate with the EEC of the same name under the *TSC Act*.

There is approximately 6.48ha of moderate-high and 3.04ha of low condition Moist Shale Woodland present within the study area.

The canopy comprises mostly a mixture of *Eucalyptus tereticornis* and *Eucalyptus moluccana* to a height of between 20-30m and a projected foliage cover of 10-30% dependent upon the age of the trees.

The mid-storey is largely dominated by the exotic African Olive trees. Where native mid-storey was present, the diversity was very low and generally restricted *Acacia implexa* and less frequently *Bursaria spinosa* var. *spinosa.*

The ground layer was found to be sparse in the majority of remnants due to a lack of light and competition from African Olives. Ground layer vegetation was similarly suppressed with less than 20% coverage, 50% of the ground cover was dominated by African Olive seedlings. Some native species that were found amongst the quadrats included *Oplismenus aemulus, Themeda australis, Dichondra repens* and *Cyperus gracilis.*

There was not a lot of difference in species make up between the Cumberland Plain Woodland and Moist Shale Woodland. The lack of native species diversity, intense weed infestation and some past grazing have all lead to its current condition and lack of indicative species. However, the soil type, aspect and topography are more suited to this vegetation unit as opposed to Cumberland Plain Woodland vegetation however.

African Olive stands

African Olives were abundant on the escarpment, in particular, on the eastern side where it is the primary vegetation type. Within this vegetation community, native species was generally around five (5) species or less per 0.04ha area, and typically treeless or less than 5% coverage. Severe African Olive infestations account for 7.3ha of vegetation coverage within the site.

Heritage gardens

These are landscaped garden beds that surround the existing dwelling which form part of the heritage curtilage.

In the immediate surrounds, the gravelled carriage drive, lawn tennis court site and plantings are elements of a substantially intact mid-19th century garden. The garden contains Moreton Bay Figs, Hoop Pines, Funeral Cypresses, White Cedars, Pepper and Coral Trees, a Norfolk Island Hibiscus, Bauhinia, Agaves, Oleanders, Mauritius hemp (the stretch of original drive in front of the house is a forest of these), Yuccas, Aloes and hedges of *Tecoma capensis*, common olive and African Boxthorn. The kitchen garden, laid out in 1809 and described in Sturt's 1839 sale advertisement may have occupied sloping ground to the north west of the house (http://www.scenichills.org.au/history_6.html)

Exotic vegetation

This describes largely the planted rows of African Olives around driveways and near the existing dwelling.

Dam with occasional fringing sedges

This describes the dams on site and their fringing vegetation on low adjacent topography. No target floristic surveys were conducted within the dams.

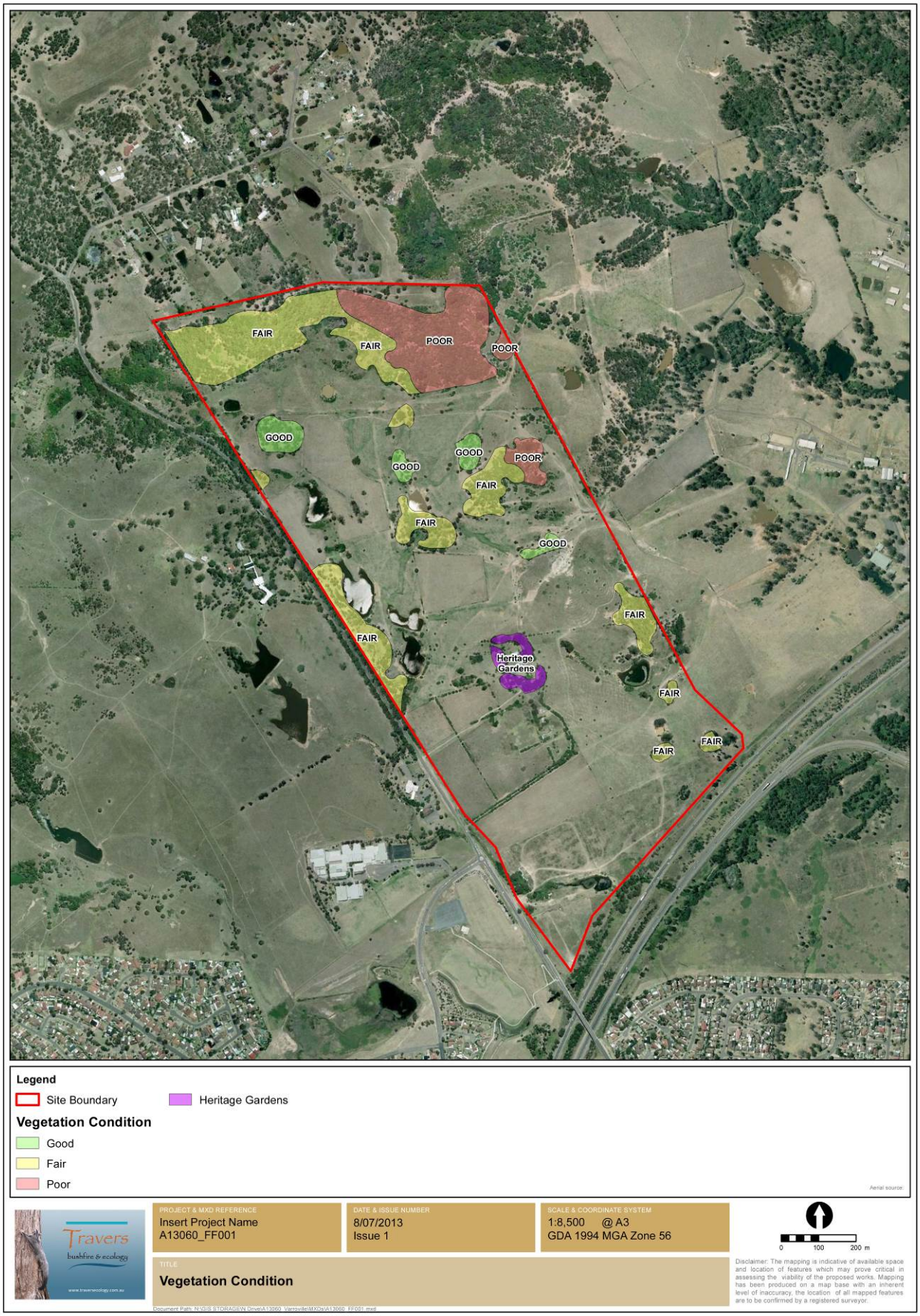

Figure 2 – Vegetation condition

3.2 Fauna results

Fauna species observed throughout the duration of fauna surveys are listed in Table 3.2 below.

Table 3.2 – Fauna observations for the study area

Common name	Scientific name	Method observed
Birds		**July 2013**
Australasian Grebe	*Tachybaptus novaehollandiae*	O
Australian Hobby	*Falco longipennis*	O
Australian King Parrot	*Alisterus scapularis*	O
Australian Magpie	*Gymnorhina tibicen*	O
Australian Raven	*Corvus coronoides*	O
Australian White Ibis	*Threskiornis molucca*	O
Australian Wood Duck	*Chenonetta jubata*	O
Barn Owl	*Tyto alba*	O
Bar-shouldered Dove	*Geopelia humeralis*	W
Bell Miner	*Manorina melanophrys*	W
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	O
Black-shouldered Kite	*Elanus axillaris*	O
Brown Gerygone	*Gerygone mouki*	O
Cattle Egret	*Ardea ibis*	O
Chestnut Teal	*Anas castanea*	O
Common Blackbird *	*Turdus merula*	O
Common Myna *	*Acridotheres tristis*	O
Common Starling *	*Sturnus vulgaris*	O
Crested Pigeon	*Ocyphaps lophotes*	O
Double-barred Finch	*Taeniopygia bichenovii*	O
Dusky Moorhen	*Gallinula tenebrosa*	O
Eastern Rosella	*Platycercus eximius*	O
Eastern Yellow Robin	*Eopsaltria australis*	O
Eurasian Coot	*Fulica atra*	O
Fairy Martin	*Hirundo ariel*	O
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	W
Galah	*Cacatua roseicapilla*	O
Golden Whistler	*Pachycephala pectoralis*	O
Grey Butcherbird	*Cracticus torquatus*	O
Grey Fantail	*Rhipidura fuliginosa*	O
Hardhead	*Aythya australis*	O
Laughing Kookaburra	*Dacelo novaeguineae*	W
Lewin's Honeyeater	*Meliphaga lewinii*	W
Little Black Cormorant	*Phalacrocorax sulcirostris*	O
Little Pied Cormorant	*Phalacrocorax melanoleucos*	O
Long-billed Corella	*Cacatua tenuirostris*	W[PR]
Magpie-lark	*Grallina cyanoleuca*	O
Masked Lapwing	*Vanellus miles*	O
Nankeen Kestrel	*Falco cenchroides*	O
Noisy Miner	*Manorina melanocephala*	O
Pacific Black Duck	*Anas superciliosa*	O
Peregrine Falcon	*Falco peregrinus*	O
Pied Currawong	*Strepera graculina*	W
Purple Swamphen	*Porphyrio porphyrio*	O
Rainbow Lorikeet	*Trichoglossus haematodus*	O
Red-browed Finch	*Neochmia temporalis*	O
Red-rumped Parrot	*Psephotus haematonotus*	O

Table 3.2 – Fauna observations for the study area

Common name	Scientific name	Method observed
Red-whiskered Bulbul *	*Pycnonotus jocosus*	O
Silvereye	*Zosterops lateralis*	O
Spotted Pardalote	*Pardalotus punctatus*	O
Spotted Turtle-Dove *	*Streptopelia chinensis*	O
Striated Pardalote	*Pardalotus striatus*	O
Superb Fairy-wren	*Malurus cyaneus*	O
Wedge-tailed Eagle	*Aquila audax*	O
Welcome Swallow	*Hirundo neoxena*	O
White-browed Scrubwren	*Sericornis frontalis*	W[PR]
White-faced Heron	*Egretta novaehollandiae*	O
Willie Wagtail	*Rhipidura leucophrys*	O
Yellow Thornbill	*Acanthiza nana*	O
Mammals		
Black Rat *	*Rattus rattus*	E
Domesticated Cattle *	*Bos taurus*	O
East-coast Freetail Bat [TS]	*Micronomus norfolkensis*	U
Eastern Bentwing-bat [TS]	*Miniopterus orianae oceansis*	U
Eastern Freetail-bat	*Mormopterus ridei*	U
European Red Fox *	*Vulpes vulpes*	O
Gould's Wattled Bat	*Chalinolobus gouldii*	U
Horse *	*Equus caballus*	O
Large-footed Myotis[TS]	*Myotis macropus*	U
Little Forest Bat	*Vespadelus vulturnus*	U[PR]
Rabbit *	*Oryctolagus cuniculus*	O
Sugar Glider	*Petaurus breviceps*	O
Wallaby sp.	*Wallabia* or *Macropus sp.*	P[PR]
Reptiles		
Grass Skink	*Lampropholis guichenoti*	O
Red-Bellied Black Snake	*Pseudechis porphyriacus*	O
Amphibians		
Common Eastern Froglet	*Crinia signifera*	W
Dwarf Tree Frog	*Litoria fallax*	W
Smooth Toadlet	*Uperoleia laevigata*	O
Whistling Tree Frog	*Litoria verreauxii*	W
Mollusc		
Exotic Garden Snail	*Helix aspersa*	W
Semi-slug (Helicarionidae)	*Stanisicia freycineti*	W

Note: * indicates introduced species
[TS] indicates threatened species
[PR] indicates species identified to a 'probable' level of certainty – more likely than not
[PO] indicates species identified to a 'possible' level of certainty – recorded to a moderate to high level of uncertainty usually applied to a threatened species of note.

E - Nest/roost	H - Hair/feathers/skin	P - Scat	W - Heard call
F - Tracks/scratchings	K - Dead	Q - Camera	X - In scat
FB - Burrow	O - Observed	T - Trapped/netted	Y - Bone/teeth/shell
G - Crushed cones	OW - Obs & heard call	U - *Anabat*/ultrasound	Z - In raptor/owl pellet

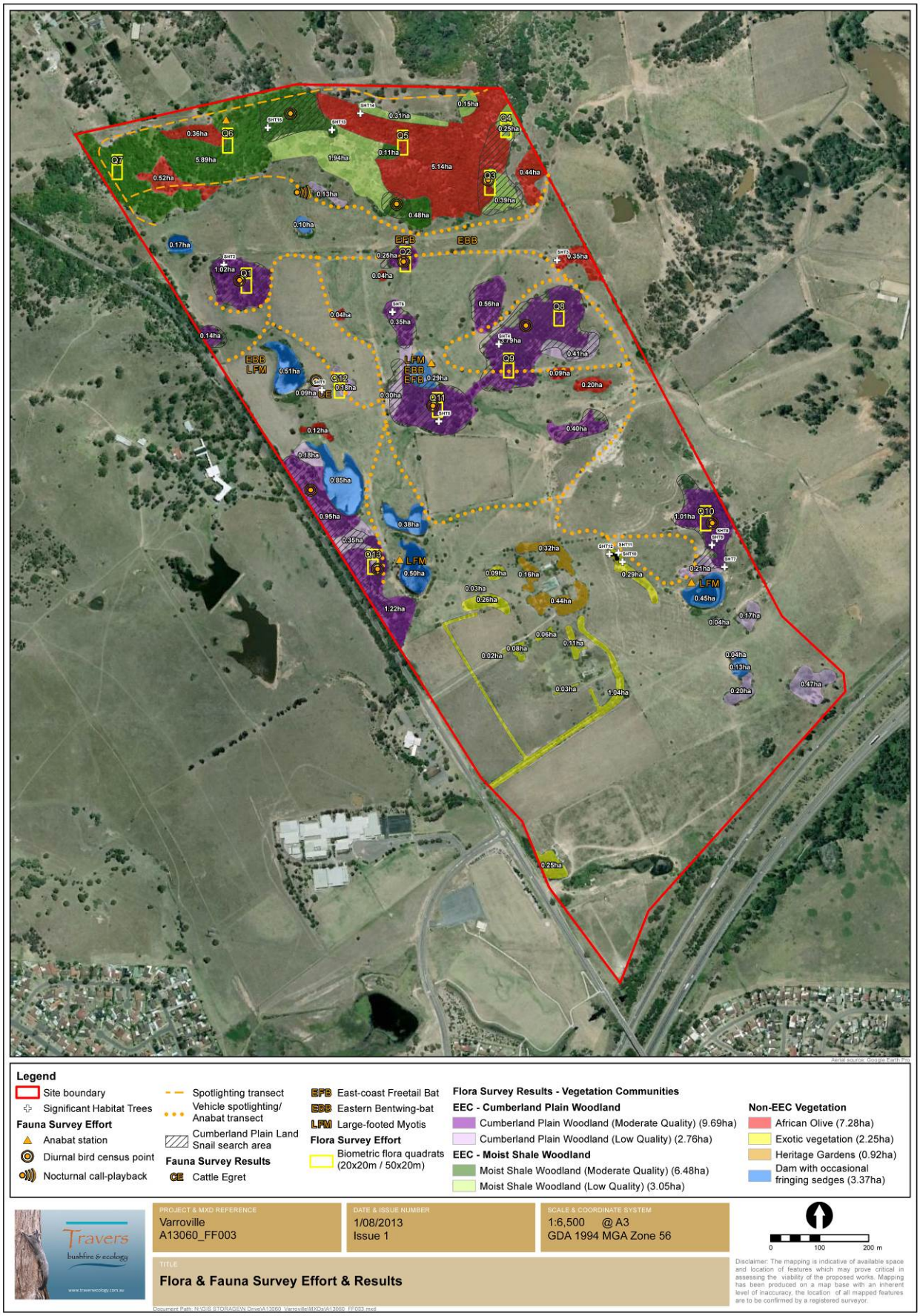

Figure 3 – Flora and fauna survey effort and results

Ecological Assessment 4

4.1 Previous surveys reviewed

The 2002 NPWS regional vegetation mapping of the Cumberland Plain was examined to identify the potential vegetation communities' onsite.

The escarpment area contains a mixture of Map Unit 13 and 14 which relates to Western Sydney Dry Rainforest and Moist Shale Woodland respectively.

Western Sydney Dry Rainforest typically does not contain eucalypts and is found on sheltered lower slopes of steep topography over shale. The conditions are appropriate for this vegetation to occur but it was not observed within the study area.

Moist Shale Woodland contains eucalypts and a relatively sparse shrub stratum dominated by mesomorphic species. This vegetation community usually grades from Cumberland Plain Woodland on the lower slopes to Moist Shale Woodland where the slope gradients are higher and there is some shelter. The topographic elements and typical canopy is present, but the lower strata is mostly absent and the little that is present contains elements that are characteristic of Moist Shale Woodland.

The remaining areas below the escarpment have been mostly mapped as Map Unit 9 and some Map Unit 10 which both relate to Cumberland Plain Woodland vegetation. We concur that these two (2) communities are present.

One (1) small area along the western boundary just south of the location of Quadrat 13 has been mapped as Map Unit 11, Alluvial Woodland. This is incorrect, the vegetation is Cumberland Plain Woodland for the entire patch.

Ecological reports by *ERM* (2006) and *SKM* (2005) undertook survey of lands to the immediate east. The same EECs were observed and no threatened flora species were found. Cumberland Plain Land Snail was observed as well as the Eastern Freetail-bat. No threatened flora species were observed, nor were any species considered to have potential habitat given the extent of clearing, grazing and weed invasion.

4.2 Flora

A number of landscaping species were observed within the western portion of the study area around the existing dwelling. These were generally not taken into consideration in preparing the species list. Section 3 of the report provides a description of the heritage gardens as referenced from the *Scenic Hills Association* website (www.scenichills.org.au). All species are listed in Table 3.1.

No threatened flora species were observed.

4.2.1 State legislative flora matters

(a) Threatened flora species (NSW)

TSC Act – A search of the *Atlas of NSW Wildlife* (OEH 2013) indicated a list of species that have been recorded within a 10km radius of the study area. Those species are considered for suitable habitat and potential to occur in Table A2.1 (Appendix 2).

Based on the habitat assessment within Appendix 2, it is considered that the study area provides varying levels of potential habitat for the following state listed threatened flora species:

Table 4.1 – State listed threatened flora species with suitable habitat present

Common name	*TSC Act*	Potential to occur
Cynanchum elegans	E1	Low – Moist Shale Woodland
Grevillea parviflora var. *parviflora*	V	Marginal / Low
Pimelea spicata	E1	Low – Cumberland Plain Woodland

Note: Full habitat descriptions for these species are provided in Appendix 2

Despite any potential habitat, no state listed threatened flora species were observed during survey.

(b) Endangered flora populations (NSW)

There is one (1) known endangered population within a 10km radius of the study area, *Marsdenia viridiflora* subsp. *viridiflora* population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas (LGAs).

Some parts of the remnant Cumberland Plain Woodland may provide marginal habitat for the population to occur, however, no specimens were observed during the botanical survey.

(c) Endangered ecological communities (NSW)

Two (2) EECs, Cumberland Plain Woodland and Moist Shale Woodland, were observed within the study area.

Cumberland Plain Woodland and Moist Shale Woodland occur throughout the site in variable conditions, but no high quality remnants were observed because of grazing, clearing and dense infestations of African Olive. There is approximately 12.45ha of Cumberland Plain Woodland of which 2.76ha is low condition. There is approximately 9.53ha of Moist Shale Woodland of which 3.05ha is of low condition. Cumberland Plain Woodland occurs on the gentle topography in the lower slopes of the study area. Moist Shale Woodland occurs on the steeper south facing slopes in the northern most part of the study area.

The low quality remnants are those which meet the criteria for low condition under a biometric assessment as the over storey is less than 25% of the lower benchmark figure and the ground layer contained greater than 50% exotic coverage. Low condition vegetation patches are deemed not viable in the long term and have been incorporated into the proposed burial zones.

4.2.2 Matters of national environmental significance - flora

(a) Threatened flora species (national)

A review of the schedules of the *EPBC Act* indicated the potential for a list of threatened flora species to occur within a 10km radius of the site. These species have been considered for habitat presence and potential to occur within Appendix 2.1.

Based on the habitat assessment within Appendix 2.1, it is considered that the study area provides varying levels of potential habitat for the following nationally listed threatened flora species:

Table 4.2 – Nationally listed threatened flora species with suitable habitat present

Common name	*EPBC Act*	Potential to occur
Cynanchum elegans	E	Low – Moist Shale Woodland
Grevillea parviflora var. *parviflora*	V	Marginal / Low
Pimelea spicata	E	Low – Cumberland Plain Woodland

Despite potential habitat, no nationally listed threatened species were observed during the field survey.

(b) Endangered ecological communities (national)

Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest is equivalent to the Cumberland Plain Woodland vegetation as mapped on Figure 3. This is the non-escarpment vegetation occupying 12.45ha of land. Cumberland Plain Woodland is listed as critically endangered.

Western Sydney Dry Rainforest and Moist Woodland on Shale occur on the escarpment and occupy approximately 9.53ha of the study area. This EEC has recently been listed as critically endangered.

4.2.3 Flora and EEC constraints analysis

Whilst potential habitat for threatened flora includes the species *Acacia bynoeana, Cynanchum elegans, Grevillea parviflora* subsp. *parviflora, Lepidium hyssopifolium* and *Pimelea spicata,* the study area is unlikely to support *Acacia bynoeana* and *Lepidium hyssopifolium* given past land management or lack of recent / nearby records, and thus a 7 part test of significance would not be required for these species. For *Cynanchum elegans, Grevillea parviflora* subsp. *parviflora* and *Pimelea spicata,* a 7 part test of significance would be required. As there have been no observations of any threatened flora species, a significant impact will not be caused on this species.

The endangered population of *Marsdenia viridiflora* subsp. *viridiflora* needs to be considered within a 7 part test of significance. As there have been no observations of this population within the study area, the likely outcome of a 7 part test of significance would be that there is no significant impact upon an endangered population.

The presence of state and nationally listed critically EECs poses constraints for future development.

Cumberland Plain Woodland which occurs within riparian corridors will likely be protected insitu. The Moist Shale Woodland on the escarpment is mostly too steep for the proposed land use and has connectivity values to woodland on the adjacent properties.

There is ample land within the riparian zone that could be rehabilitated to Cumberland Plain Woodland to offset the loss of small areas by the proposed cemetery.

With respect to *EPBC Act* legislation, the removal of Cumberland Plain Woodland and Moist Shale Woodland that is part of a patch larger than 0.5ha requires a significance assessment and potential referral to SEWPAC. However, the impacts are minor, can be compensated by revegetation works and are not considered to be significant. Therefore a referral is not required under the *EPBC Act*.

4.3 Fauna

All fauna species recorded during survey are listed in Table 3.2.

4.3.1 Fauna habitat

The fauna habitats present within the site are identified within Table 4.3.

Table 4.3 – Observed fauna habitat

Topography				
Flat ✓	Gentle ✓	Moderate ✓	Steep ✓	Drop-offs
Vegetation structure				
Closed Forest	Open Forest ✓	Woodland ✓	Heath	Grassland ✓
Disturbance history				
Fire	Under-scrubbing ✓	Cut and fill works		
Tree clearing ✓	Grazing ✓			
Soil landscape				
DEPTH:	Deep ✓	Moderate ✓	Shallow	Skeletal
TYPE:	Clay ✓	Loam ✓	Sand	Organic ✓
VALUE:	Surface foraging ✓	Sub-surface foraging	Denning / burrowing ✓	
WATER RETENTION:	Well drained ✓	Damp / moist ✓	Water logged	Swamp / soak
Rock habitat				
None				
Feed resources				
FLOWERING TREES:	Eucalypts ✓	Corymbias	Melaleucas ✓	
SEEDING TREES:	Allocasuarinas	Conifers		
WINTER FLOWERING EUCALYPTS:	*C. maculata*	*E. crebra* ✓	*E. globoidea*	*E. sideroxylon*
	E. robusta	E. tereticornis ✓	*E. agglomerata*	*E. siderophloia*
FLOWERING PERIODS:	Autumn ✓	Winter ✓	Spring ✓	Summer ✓
OTHER:	Mistletoe ✓	Figs / fruit	Sap / manna	Termites ✓
Foliage protection				
UPPER STRATA:	Dense	Moderate ✓	Sparse ✓	
MID STRATA:	Dense ✓	Moderate ✓	Sparse ✓	
PLANT / SHRUB LAYER:	Dense ✓	Moderate	Sparse ✓	
GROUNDCOVERS:	Dense	Moderate	Sparse ✓	
Hollows / logs				
TREE HOLLOWS:	Large ✓	Medium ✓	Small ✓	
TREE HOLLOW TYPES:	Spouts / branch ✓	Trunk ✓	Broken trunk ✓	Basal cavities ✓	Stags ✓
GROUND HOLLOWS:	Large	Medium	Small	

Table 4.3 – Observed fauna habitat

Vegetation debris						
FALLEN TREES:	Large		Medium		Small	
FALLEN BRANCHES:	Large	✓	Medium	✓	Small	✓
LITTER:	Deep	✓	Moderate	✓	Shallow	✓
HUMUS:	Deep		Moderate	✓	Shallow	✓
Drainage catchment						
WATER BODIES:	Wetland(s)	Soak(s)	Dam(s) ✓	Drainage line(s) ✓	Creek(s)	River(s)
RATE OF FLOW:	Still	✓	Slow		Rapid	
CONSISTENCY:	Permanent	✓	Perennial		Ephemeral	
RUNOFF SOURCE:	Urban / Industrial		Parkland		Grazing ✓	Natural
RIPARIAN HABITAT:	High quality		Moderate quality		Low quality ✓	Poor quality ✓
Artificial habitat						
STRUCTURES:	Sheds		Infrastructure		Equipment	✓
SUB-SURFACE:	Pipe / culvert(s)		Tunnel(s)		Shaft(s)	
FOREIGN MATERIALS:	Sheet	✓	Pile / refuse			

4.3.2 Habitat trees

A complete assessment of the location of habitat trees and the size of hollows within was not conducted as part of surveys undertaken. The available size range and quality of hollows were noted during site visits.

Data on significant habitat trees was collected and identified by GPS; locations are depicted on Figure 3 and data is provided in Table 4.4 below. Significant habitat trees are defined as trees containing large hollows suitable for use by owls and / or containing a number of good quality hollows typically consisting of more than one (1) medium (10-30cm) sized hollow. A tree may also be considered significant where evidence of use by select fauna is found such as Yellow-bellied Glider sap feed tree, raptor nest, or owl roost.

Although some large hollows were identified within the study area and the small Barn Owl was recorded present during survey, these hollows were not considered to be suitable for use by the threatened large forest owls due generally to their limited size and the surrounding habitat types. Some hollow dependent fauna species were recorded during survey including Sugar Glider, Barn Owl, Australian King Parrot, Australian Wood Duck, Eastern Rosella, Galah, Laughing Kookaburra, Long-billed Corella, Pacific Black Duck, Rainbow Lorikeet, Red-rumped Parrot, Striated Pardalote, Eastern Freetail-bat, Gould's Wattled Bat, Little Forest Bat, Dwarf Tree Frog and Whistling Tree Frog as well as two threatened fauna species including East-coast Freetail Bat and Large-footed Myotis.

Significant habitat trees, whilst offering the most likely nesting or roosting habitat for many of these species, do not represent the best quality hollows for nesting. It should be noted also that many other hollows exist across the study area and therefore the roosting colony of a threatened microbat, if present, may not be located within the observed habitat trees or may be located in adjoining landscapes to the site.

Table 4.4 – Significant habitat tree data

Tree No	Scientific name	Common name	DBH (cm)	Spread (m)	Height (m)	Vigour (%)	Hollows and other habitat features recorded
SHT1	Forest Red Gum	*E. tereticornis*	115	24	30	70	2x 0-5 branch hollows, 1x 30-35cm trunk hollow
SHT2	Forest Red Gum	*E. tereticornis*	100	13	24	30	2x 0-5 branch hollows, 3x 0-5cm trunk hollows, 2x 10-15cm branch hollows
SHT3	dead tree	stag	90	13	19	0	3x 0-5 branch hollows, 2x 5-10cm trunk hollows, 2x 5-10cm branch hollows, 4x 10-15cm branch hollows
SHT4	dead tree	stag	110	13	27	0	5x 0-5 branch hollows, 2x 0-5cm trunk hollows, 1x 5-10cm branch hollows, 2x 15-20cm branch hollows
SHT5	Forest Red Gum	*E. tereticornis*	90	19	28	70	4x 0-5 branch hollows, 2x 5-10cm branch hollows, 3x 10-15cm trunk hollows
SHT6	dead tree	stag	90	12	22	0	4x 0-5 branch hollows, 5x 5-10cm branch hollows, 1x 15-20cm trunk hollows
SHT7	dead tree	stag	110	13	25	0	1x 0-5 branch hollows, 1x 5-10cm trunk hollows, 2x 5-10cm branch hollows, 1x 10-15cm branch hollows, 2x 10-15cm trunk hollows (good quality), 1x 15-20cm broken trunk hollows
SHT8	Grey Box	*E. moluccana*	45	11	26	65	Small-sized raptor nest
SHT9	Grey Box	*E. moluccana*	65	14	29	60	1x 5-10cm trunk hollows, 1x 5-10cm branch hollows, 1x 10-15cm branch hollows, 1x 25-30cm broken trunk hollow (good quality)
SHT10	Grey Box	*E. moluccana*	110	17	32	60	2x 5-10cm branch hollows, 2x 10-15cm branch hollows, 2x 15-20cm broken trunk hollows
SHT11	Grey Box	*E. moluccana*	80	13	27	65	2x 10-15cm branch hollows, 2x 15-20cm blow branch hollows
SHT12	Grey Box	*E. moluccana*	80	14	25	60	1x 5-10cm trunk hollow (good quality), 1x 10-15cm trunk hollow, 1x 15-20cm branch (bee nest inside)
SHT13	Grey Box	*E. moluccana*	120	20	28	60	2x 10-15cm branch hollows, 1x 15-20cm branch, 1x 25-30cm broken trunk hollow (good quality)
SHT14	dead tree	stag	70	6	23	0	1x 10-15cm branch hollows, 1x 20-25cm broken trunk hollow
SHT15	Forest Red Gum	*E. tereticornis*	85	17	28	55	2x 10-15cm branch hollows

4.3.3 Local fauna matters

Regionally significant fauna species observed during survey and listed within the *Native Fauna of Western Sydney - Urban Bushland Biodiversity Survey* (NPWS 1997) include the Wedge-tailed Eagle, Peregrine Falcon, Bar-shouldered Dove, Swamp Wallaby and Smooth Toadlet.

The Wedge-tailed Eagle was observed as a breeding pair high in flight and likely nesting in the nearby locality. The steep northern portions of the site just off the ridgeline are suitable for nesting, however, no nests were observed during survey. Small raptor or corvid nests were observed and identified by GPS and located on Figure 3. These nests may be utilised by Peregrine Falcon. The Peregrine Falcon and Hobby Falcon were both observed utilising the two prominent dead trees (stags) located along the eastern boundary as a perching outlook point.

A number of individual Smooth Toadlets were located below a log in the vegetated area surrounding the south eastern dam indicating this area is utilised for breeding. The Swamp Wallaby was not observed, however, scats located on the suitable steep vegetated landscape in the northern portions were considered to be this species, particularly given its previous recording on the neighbouring site. The Bar-shouldered Dove was heard calling in the Cumberland Plain Woodland in the central portions of the site; it is likely that this species is nesting in this area.

In addition to these species, regionally significant fauna recorded on the neighbouring lands to the east and surveyed by *ERM* (2006) include White-winged Chough and Lace Monitor.

As none of the abovementioned species are threatened they are not likely to offer any real constraint to the proposal. These species will benefit from retention of larger remnants and restoring connectivity along riparian channels within the study area.

4.3.4 State legislative fauna matters

(a) Threatened species (NSW)

TSC Act – A search of the *Atlas of NSW Wildlife* (OEH, 2013) provided a list of threatened fauna species previously recorded within a 10km radius of the study area. These species are listed in Table A2.2 (Appendix 2) and are considered for potential habitat within the study area. Strictly estuarine and oceanic threatened species found within 10km have not been included as no marine / aquatic habitats occur within the study area.

Based on the habitat assessment within Appendix 2, it is considered that the study area provides varying levels of potential habitat for the following state listed threatened fauna species:

Table 4.5 – State listed threatened fauna species with suitable habitat present

Common name	*TSC Act*	Potential to occur
East-coast Freetail Bat	V	likely
Eastern Bentwing-bat	V	likely
Large-footed Myotis	V	likely
Little Eagle	V	suitable
Varied Sittella	V	suitable
Grey-headed Flying-fox	V	suitable
Greater Broad-nosed Bat	V	suitable
Little Lorikeet	V	low
Swift Parrot	E	low
Powerful Owl	V	low
Scarlet Robin	V	low
Flame Robin	V	low
Yellow-bellied Sheathtail-bat	V	low
Cumberland Plain Land Snail	E	low
Speckled Warbler	V	unlikely
Black-chinned Honeyeater	V	unlikely
Regent Honeyeater	E4A	unlikely
Diamond Firetail	V	unlikely
Spotted-tailed Quoll	V	unlikely
Koala	V	unlikely
Eastern Falsistrelle	V	unlikely
Little Bentwing-bat	V	unlikely

Note: Full habitat descriptions for these species are provided in Appendix 2

Three (3) state listed threatened fauna species, East-coast Freetail Bat (*Micronomus norfolkensis*), Eastern Bentwing-bat (*Miniopterus orianae oceansis*) and Large-footed Myotis (*Myotis macropus*), were recorded within the study area during surveys.

FM Act – No habitats suitable for threatened aquatic species were observed within the study area and as such the provisions of this act do not require any further consideration.

(b) Endangered populations (NSW)

There are no endangered fauna populations identified specifically to the Campbelltown LGA; however, the site does fall within the Sydney Metropolitan Catchment Management Authority area. An endangered population of White-fronted Chat (*Epthianura albifrons*) is identified to this area however this is made up of two (2) known isolated sub-populations; one (1) at Newington Nature Reserve on the Parramatta River and one (1) at Towra Point Nature Reserve in Botany Bay. The study area provides only marginally suitable habitat for this species which was not recorded present during survey. Therefore, this species is not likely to offer a constraint to habitat removal and development within the study area.

(c) SEPP 44 Koala Habitat Protection

SEPP 44 Koala Habitat Protection applies to land within LGAs listed under Schedule 1 of the policy. In addition, Part 2 of the policy outlines a three (3) step process to assess the likelihood of the land in question being potential Koala habitat (PKH) or core Koala habitat (CKH). Part 2 applies to land which has an area of greater than 1ha or has, together with any adjoining land in the same ownership, an area of more than 1ha.

The study area is required to be considered under SEPP 44 as it falls within the Campbelltown LGA, which is listed on Schedule 1 of this policy. In addition, the total area of the study area is greater than 1ha, hence Part 2 – Development Control of Koala Habitats, of the policy applies.

PKH is defined as land where at least 15% of the total number of trees in the upper or lower strata constitutes any of the tree species listed in Schedule 2 of the policy.

CKH is defined as an area of land with a resident population of Koalas, evidenced by attributes such as breeding females (i.e. females with young) and recent sightings of, and historical records of, a population.

Step 1 – Is the land PKH?

One (1) Koala food tree species, Forest Red Gum (*Eucalyptus tereticornis*) as listed on Schedule 2 of SEPP 44, was recorded within the study area. These trees comprised greater than 15% of the total number of trees within the woodland vegetation communities and therefore are classified under SEPP 44 as PKH.

Step 2 – Is the land CKH?

No Koalas were directly observed at the time of fauna survey, which included diurnal searches of trees and spotlighting. In addition, there was no secondary evidence of Koala habitation in the area including characteristic scratches on trees and scats beneath trees.

A search of the *Atlas of NSW Wildlife* (OEH 2013) found several hundred Koala records within 10km of the study area. With the exception of three (3) isolated records from Middleton Grange (approximately 8km to the north) all remaining records are from the well known and researched Koala population that occurs along the Georges River east of Campbelltown. There is no opportunity for connectivity of habitat between these records and the study area and no other nearby records. As such, the study area is not considered to comprise CKH as defined under SEPP 44 and the Koala will not likely offer a constraint to rezoning within the study area.

4.3.5 National environmental significance - fauna

(a) Threatened species (national)

EPBC Act – A review of the schedules of the *EPBC Act* identified a list of threatened fauna species or species habitat likely to occur within a 10km radius of the study area. These species have been listed in Table A2.2 (Appendix 2), and those with potential habitat within the study area are considered in the 7 part test of significance within Appendix 3.

Based on the habitat assessment within Appendix 2, it is considered that the study area provides varying levels of potential habitat for the following nationally listed threatened fauna species:

Table 4.6 – Nationally listed threatened fauna species with suitable habitat present

Common name	EPBC Act	Potential to occur
Grey-headed Flying-fox	V	likely
Swift Parrot	E	low
Regent Honeyeater	E	unlikely
Spotted-tailed Quoll	E	unlikely
Koala	V	unlikely

No nationally listed threatened fauna species were recorded within the study area during surveys. The flapping sound of what was assumed to be a flying-fox was heard during nocturnal survey, however, as no animal was spotlighted or heard call it was not identified as a Grey-headed Flying-fox (*Pteropus poliocephalus*). This species is the most likely nationally listed threatened species with potential to occur. There is no suitable habitat for roosting or breeding for flying-foxes and foraging habitat is well represented in the surrounding locality, therefore no nationally listed threatened fauna species are likely to offer a constraint to habitat removal and development.

(b) Protected migratory species (national)

The EPBC Act Protected Matters Report provides additionally listed terrestrial, wetland and marine migratory species of national significance likely to occur, or with habitat for these species likely to occur, within a 10km radius of the study area. These migratory species are considered for habitat suitability in Table A2.3 (Appendix 2). Threatened migratory species are assessed for habitat suitability in Table A2.2 (Appendix 2).

One (1) protected migratory species, the Cattle Egret (*Ardea ibis*) was recorded present during survey. No evidence of nesting was observed on site by this species however potential for nesting within the riparian vegetation fringing the existing dams cannot be ruled out. This species is not expected to offer a constraint to habitat removal and development, however, the retention and restoration of riparian habitats within the site will ensure this outcome.

4.3.6 Fauna constraints analysis

Threatened fauna species recorded, or with potential to occur, are not likely to offer a constraint to rezoning within the study area.

4.4 Vegetation connectivity and wildlife corridors

The vegetation along the steep northern slopes of the study area does continue into the local surrounding landscape and provides a refuge for locally occurring fauna, however, this connectivity eventually terminates before reaching any large regional conservation areas (as seen in Figure 4). Therefore, the vegetation within the study area is not part of any contiguous regional corridor.

Figure 4 – Local connectivity

The connectivity that exists within the combined local patch continues along nearby riparian channels, hillsides and other non-cleared rural landscapes. Typically, a corridor is valued to ensure wildlife can move between vegetation parcels that contain habitat characteristics suitable for each taxa and foraging opportunities for those taxa. In other words they need protection and food. They also need mating opportunity and, for some wildlife, movement opportunity is quite small as they are territorial whilst others are more opportunistic and migrate over larger areas.

For some wildlife, the dispersal (home) range is quite small whilst others migrate over larger areas. Where wildlife numbers, particularly some populations, and diversity are in large quantities and require movement to and from large areas (ecosystems) then a suitable large corridor linkage should be provided. Likewise, if a small quantity of wildlife is known to be present then a smaller corridor may accommodate these species / populations adequately.

Therefore, the local corridors are not expected to facilitate regional movement of large terrestrial native fauna but do still retain a valued function in the locality. For example, during survey the steep hillside woodland areas to the north was found to contain denning habitat for a local Sugar Glider population as well as roosting and possible nesting habitat for a local Barn Owl pair. Hobby and Peregrine Falcons hunt birds off the woodland fringes and utilise

the old tall trees and stags for outlooks. All these species are not likely well represented in the region and the combined total woodland areas of the site provide for a high overall diversity of native bird and bat species.

Despite the fragmented vegetation in the locality, connectivity will be enhanced as a result of protecting and restoring escarpment as well as habitats along riparian corridors. Future planning and corridor establishment will ensure the following local biodiversity values:

- Threatened species habitat – The higher quality areas of each of the natural vegetation communities present within the study area as well as the major riparian channel will become connected.

- Ecosystem variation – Different tree species flower during different seasons and the diversity of trees from hilltop to lower depressions provides more reliable year round foraging opportunity, particularly where these are all connected.

Ambrose (2007) advised that wildlife corridors allow movement of flora and fauna between patches of wildlife habitat (Soule & Gilpin 1991). The preservation or establishment of corridors to link habitats has been proposed as a practical conservation measure to ameliorate habitat loss and fragmentation effects (Bennett 1990). It is essential for a corridor to have the following characteristics in order to be effective:

- Vegetated corridors that comprise a mosaic of different habitats are considered more likely to contain the necessary food, shelter and nesting resources for fauna. Therefore, corridors that link patches over the entire ecological gradient from ridge to gully would conserve more species, especially those that have large home ranges and changing seasonal requirements (Lindenmayer *et al*. 1994).

- The quality of the habitat within the corridor is important. Some fauna would reluctantly utilise corridors of low quality, such as areas invaded by weeds or subject to frequent fires, or due to a reduction in the availability of essential resources (such as feeding, shelter, roosting and breeding sites).

- The size of the corridor is also important. For example, corridors with mature trees, but with little or no understorey may afford good habitat for birds, bats and some arboreal fauna, but not for ground dwelling fauna.

Thus, the restoration of selected corridors such as the riparian land and the escarpment will enhance connectivity through the site and ameliorate habitat loss as a result of any clearance of isolated or fragmented woodland areas.

4.5 Potential ecological impact

Over the life of the cemetery, approximately 150 years, the proposed cemetery concept will result in a maximum loss of:

- Loss of 1.14ha of moderate quality Cumberland Plain Woodland affecting four (4) vegetation remnants
- Potential loss of hollows suitable for hollow dependent threatened fauna.
- Potential loss of treed areas suitable for nesting and perching by birds of prey, particularly the threatened Little Eagle which is known in the locality.

4.6 Mitigation measures

Measures that can be put in place to mitigate the potential ecological impacts include:

- Avoid or minimise impacts on remnant vegetation;
- Provide suitable revegetation offsets within the riparian corridors as appropriate and implemented progressively throughout the life of the cemetery;
- Where possible, protection of any existing hollow bearing trees and, if any hollows are to be removed, they should be replaced with nest boxes with a defined proportion specifically designed for use by microbats.
- A process of supervising the removal of hollows by a fauna ecologist will also ensure that resident fauna, particularly threatened species, can be appropriately recovered and their roosting hollows can be effectively relocated instead of destroyed; and
- Progressively revegetate riparian corridors to provide connective habitat.

Conclusions 5

5.1 Conclusions

The document identifies potential ecological constraints for future assessment consideration under Section 5A of the *EP&A Act* and matters of national significance under the *EPBC Act*. Detailed assessments under these state and national legislations are required for development applications and rezonings to determine if a significant effect on threatened species, populations and / or EECs is likely to result. These assessments have been considered in the review of ecological constraints.

EP&A Act* and *TSC Act

In respect of matters required to be considered under the *EP&A Act* and relating to the species / provisions of the *TSC Act:*

- Three (3) threatened fauna species, East-coast Freetail Bat (*Micronomus norfolkensis*), Eastern Bentwing-bat (*Miniopterus orianae oceansis*) and Large-footed Myotis (*Myotis macropus*), were recorded within or in close proximity to the study area;
- No threatened flora species were recorded within the study area;
- Two (2) EECs, Cumberland Plain Woodland and Moist Shale Woodland were recorded within the study area; and
- No endangered populations have been observed within the study area.

EPBC Act

In respect of matters required to be considered under the *EPBC Act:*

- No threatened fauna species, were recorded within the study area:
- One (1) protected migratory fauna species listed under the *EPBC Act,* Cattle Egret (*Ardea ibis*), was recorded within the study area;
- No threatened flora species were recorded within the study area;
- Two (2) EECs, Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest and Western Sydney Dry Rainforest and Moist Woodland on Shale, were recorded within the study area; and
- No nationally listed populations occur within the study area.

FM Act

In respect of matters relative to the *FM Act,* no suitable habitat for threatened aquatic species was observed within the study area, and there are no matters requiring further consideration under this act.

5.2 Ecological constraints

The key ecological constraints (Figure 3) are as follows:

- **EECs –** Cumberland Plain Woodland, Moist Shale Woodland occur throughout the site in variable condition and Swamp Sclerophyll Forest on Coastal occurs on the adjoining crown lands, but no high quality remnants were observed because of grazing, clearing and dense infestations of African Olive. There is approximately 12.45ha of Cumberland Plain Woodland of which 2.76ha is of low condition. There is approximately 9.53ha of Moist Shale Woodland of which 3.05ha is of low condition. Cumberland Plain Woodland occurs on the gentle topography in the mid and lower slopes of the study area. Moist Shale Woodland occurs on the steeper south-facing slopes in the northern most part of the study area. Swamp Sclerophyll Forest on Coastal Floodplains occurs in very small fragmented patches on the lower floodplains within the adjoining crown land.

- **Hollow dependent threatened fauna species habitat** - Two (2) of the three (3) recorded threatened microbat species, East-coast Freetail Bat (*Micronomus norfolkensis*) and Large-footed Myotis (*Myotis macropus*), utilise hollows for roosting and breeding. The Large-footed Myotis is also known to utilise subterranean habitats and artificial structures for roosting. Given the recorded level of presence by these species and also considering that survey was undertaken during the low activity winter period, there is real potential that valuable roosting habitat is present within the site or nearby locality. Exact locations of roosting and breeding trees is difficult to determine without extensive target surveys and therefore assessment of these species is often dependent on the estimated loss of hollow bearing trees, the availability of other hollow resources in the locality and the creation of supplementary habitat (such as nest boxes) on site.

5.3 Potential ecological impacts

The rural nature of the landscape and highly fragmented vegetation has resulted in a low level impact on any vegetation and habitat within the site. Consequently, the impacts caused are not considered to be significant. The proposed cemetery landscape proposes to retain the majority of on site vegetation remnants and has clearly demonstrated an approach that avoids causing direct impacts.

Over the life of the cemetery, approximately 150 years, the proposed cemetery concept will result in a maximum loss of:

- 1.14ha of moderate quality Cumberland Plain Woodland affecting four (4) vegetation remnants
- Potential loss of hollows suitable for hollow dependent threatened fauna.

As the cemetery will be staged it is not expected to cause mass habitat loss at any point in time that cannot be compensated by revegetation works. Approximately 7.19ha of riparian lands are available to be used for restoration of Cumberland Plain Woodland.

Given a loss of 1.14ha of Cumberland Plain Woodland of low conservation value, a potential offset ratio of 6.3:1 can be achieved. This is a good biodiversity offset outcome that can be implemented progressively over the life of the cemetery.

Travers bushfire & ecology recommends that a vegetation management plan (VMP) to be prepared that stages the restoration works and outlines the vegetation and fauna habitat enrichment works that can be undertaken to achieve an overall positive biodiversity conservation outcome onsite.

Travers bushfire & ecology also advises that the insitu vegetation remnants, in particular the Moist Shale Woodland, has excess biodiversity offset value and should be considered to be a registered biobanking site in order to provide future funds to restore the escarpment lands. These lands can be retained under the ownership of the *Catholic Cemeteries* and managed as a BioBanking site.

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Fauna Survey Methodologies

A1

The fauna survey methods outlined within this Appendix are techniques employed by *Travers bushfire & ecology,* based on industry standards, as well as additional methods found to be effective for select fauna groups. The fauna survey techniques deployed for each specific site are outlined within the survey effort table in the main body of this report. The techniques selected will depend upon the site characteristics and extent of available habitat as well as restrictions such as available survey time and weather conditions.

If any additional or target survey techniques for fauna species are undertaken, beyond the methods outlined within this Appendix, the details of these will be described within the main body of this report.

1 Standard survey techniques

1.1 Diurnal birds

Diurnal birds are typically identified visually and / or by calls during diurnal surveys. Habitat searches to identify nests, feathers, eggs, or signs of foraging may be utilised more specifically for identifying threatened diurnal bird species.

Visual observations are made more accurate with the use of binoculars and where necessary or practical, with the use of a spotting scope. Binoculars are carried by the fauna surveyor at all times during nocturnal and diurnal fauna surveys. A birding field guide is always available in the field if required for verifications.

Calls are identified in the field by the fauna surveyor. If an unknown call is heard it is cross matched to comprehensive bird call reference libraries taken into the field. A call library of birds occupying the NSW coastal areas is also stored into a mobile phone for a quick reference. This phone is carried into the field at all times and may be used for call playback methods and recording calls for later analysis.

Diurnal bird census points may be undertaken at large sites where the total area may not be effectively covered during the survey period, or as a measure to ensure focused bird only survey.

1.2 Nocturnal birds

Searches for evidence of owl roosts, key perches and potential owl roosting / breeding hollows are made during diurnal site searches. Whitewash, feathers or regurgitated pellets give key information. Pellets are sent for analysis of contents to assist in identification where necessary.

The presence of nocturnal birds during the nocturnal period is first determined by quiet listening after dusk for calls by individuals emerging from diurnal roosts. Following this, and provided no calls are heard, call playback techniques are employed for threatened species with suitable habitat present.

Threatened nocturnal birds known to provide response to call playback techniques include Masked Owl (*Tyto novaehollandiae*), Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*), Sooty Owl (*Tyto tenebricosa*), Grass Owl (*Tyto capensis*), Black Bittern (*Ixobrychus flavicollis*), Australian Bittern (*Botaurus poiciloptilus*) and Bush Stone-curlew (*Burhinus grallarius*).

Each call is typically played for five minute periods with five minute intervals of quiet listening for a response. This is followed with spotlighting and periods of quiet listening throughout the nocturnal survey.

Separation distances between broadcasting stations during a single night of survey are advised for different species within survey guidelines. These include 1km between owl calls and 3km between Bush Stone-curlew calls. Subsequent to this, separate broadcasting stations will be deployed on the same night where sites of significant size are surveyed. Separations for bitterns are not advised and these may be broadcast at a number of stations along suitable habitat areas.

Stag watching will be undertaken where suitable large hollows for owl nesting / roosting show signs of activity or are located within development areas. Stag watching of nesting trees should be undertaken during the recognised nesting period for owls with potential to occur.

1.3 Arboreal mammals

Arboreal mammals may be surveyed using *Elliott* type A, B and / or C traps, small and / or large hair tubes, spotlighting, call playback techniques, scat searches or searches for other signs of activity.

Baiting and layout for *Elliott* trapping and hair tubing are typically incorporated into terrestrial trapping and hair tubing effort, unless where target survey is undertaken. Standard baiting and layout is therefore described in Section A1.3.2 below within terrestrial survey methods. Where gliders are targeted, the standard bait mix may be additionally laced with a nectarivor powder mix used for feeding captive birds. Where Brush-tailed Phascogales are targeted the standard bait mix may be additionally laced with an insectivore powder mix. Where Eastern Pygmy Possum is targeted, the bait mix will be more heavily laced with honey.

Elliott traps for arboreal captures are placed onto tree mounted platforms that are attached to the trunk 2-3m above the ground, at an incline to facilitate drainage during inclement weather. Plastic sleeves are placed around or over traps when wet weather is forecast. Arboreal hair tubes are attached to the trunk of trees using rubber bands with the tube entry facing down, preventing water entry.

For all arboreal traps and hair tubes, a mixture of honey and water is sprayed onto the trunk up to 8m above the trap and around the trap as a lure. Where Eastern Pygmy Possum is targeted, a high concentrate honey water mix is also sprayed from the base of trunk up and along connective branches.

Arboreal traps and hair tubes are placed in trees selected to bias target species. These are often flowering or sap flow trees for gliders, rough-barked trees for the Brush-tailed Phascogale and Banksias for the Eastern Pygmy Possum.

Where habitat is suitable, the presences of Koala (*Phascolactos cinereus*), Yellow-bellied Glider (*Petaurus australis*) and Squirrel Glider (*Petaurus norfolcensis*) may be targeted by call-playback techniques. Calls are played for five minute periods during nocturnal surveys. This is followed by quiet listening and spotlighting.

1.3.1 Koala survey

Koala survey is undertaken where the site is considered to provide PKH habitat under the definitions of SEPP 44 - Koala Habitat Protection, or in the presence of feed trees listed in Appendix 1 of the Recovery Plan for the Koala. Habitat may also be defined according to locally prepared Koala plans of management.

SEPP 44 is applied to land within LGAs listed under Schedule 1 of the policy. Part 2 is applied to land which has an area of greater than 1ha or has, together with any adjoining land in the same ownership, an area of more than 1ha.

To determine PKH under the definitions of SEPP 44, an estimate of the percentage density of each tree species within vegetation communities is determined by averaging the percentage of stems counted. PKH is defined as land where at least 15% of the total number of trees in the upper or lower strata constitutes any of the tree species listed in Schedule 2 of the policy.

Where Koala habitat is considered to be present, the site will be surveyed on foot, with known Koala food trees being inspected for signs of use. Trees are inspected for characteristic scratch and claw marks on the trunk and scats around the base of each tree. Koalas may also be targeted during nocturnal survey involving call playback techniques and spotlighting.

For large sites, Koala search quadrats may be employed within portions of communities where feed trees are present at suitable densities. All Koala feed trees within quadrats are searched for signs of activity including characteristic claw marks on the trunk and faecal pellets around the base. Pellet searches are undertaken according to the tree base search methods described in Phillips & Callaghan (2008). Search quadrats are less labour intensive than the spot assessment technique (SAT) described below but may only be an initial survey effort to determine presence / absence.

Where any Koala activity is recorded the complete SAT described by Phillips & Callaghan (2008) may be undertaken as a measure of Koala activity. This technique may also be employed in the first instance as an indicator of presence / absence, particularly where a site has potential Koala activity based on previous records.

For any survey technique, the location and density of Koala droppings, if found, are documented.

1.4 Terrestrial mammals

Various traps may be used to survey for the presence of terrestrial mammals. These include *Elliott* trapping, medium and large cage trapping, small and large hair tubing and pitfall traps. Other survey methods for terrestrial mammals include the use of camera surveillance, spotlighting and activity searches.

Arboreal and terrestrial *Elliott* traps and hair tubes are placed in grids, or more commonly along trap lines of 5-10 traps separated by distances of 20-50m, depending on site size and variation of habitat. Trap or hair tube sizes selected at each trap station may alternate or may have an emphasis on certain sizes according to target species.

Selection of terrestrial *Elliott* trap, cage trap, hair tube or pitfall trap locations has an emphasis on nearby foliage, runways, shelters and signs of activity.

Standard bait mix for all *Elliott* traps, medium cage traps and hair tubes is a mixture of rolled oats, honey and peanut butter. Standard bait mix may be supplemented with sardines in large hair tubes or cage traps to simultaneously target Spotted-tailed Quoll. Cage traps may also be baited solely with meat or roadkill to target Spotted-tailed Quoll. Where Potoroos or Bandicoots are targeted, truffle oil may be used to lace the standard bait mix or used on its own.

Where difficult to access, sensitive or extended trapping periods are undertaken, surveillance cameras can be used in terrestrial mammal surveys. The surveillance camera is mounted on a tree and directed towards a closed baited cage trap. Surveillance cameras may also be used to detect use or monitor activity at burrows, hollows, nests, etc.

During diurnal site searches, assessment is made of found scats, markings, diggings, runways and scratches located. Any scats or pellets not readily identifiable (particularly predator scats) may be collected and sent to Barbara Triggs, identification expert, for identification of contents, hair or bone fragments.

1.5 Bats

Micro-chiropteran bats are surveyed by echolocation using *Anabat* detectors or trapped using harp (*Constantine*) traps, mist nets or trip lines. Microchiropteran bats are also surveyed by searches of subterranean habitats such as caves, tunnels or shafts where present, or by searching structures such as under bridges and abandoned buildings or wall / ceiling cavities, where entry is possible.

Anabat Mk 2 and SD-1 detectors are used in fixed passive monitoring positions and / or during active nocturnal monitoring. Active monitoring is used in conjunction with spotlighting or during stag watching for greater accuracy of recorded call identification.

Bat call recordings are interpreted through *Anabat* V and *Anabat* CF Storage and Interface Module ZCAIM devices and analysed using *Anabat* 6 and *Analook* 3.3q computer software packages.

Harp traps and mist nets are placed along suitable flyways such as along open narrow road / river corridors to maximise the likelihood of captures. Traps may be purpose set to capture bats emerging from roosts by being placed at the entry of tunnels / caves or draped over the edge of bridges. Trip lines are placed over water to trip low flying drinking bats into the water. These bats are collected as they swim to the waters edge.

Harp traps are checked during early nocturnal survey, as well as each morning. Mist nets and trip lines require constant monitoring. Captured bats are identified using field identification guides. Bats are released at the point of capture after dusk or placed under trunk bark / splits of nearby trees.

Mega-chiropteran bat species, such as Grey-headed Flying-fox, are surveyed by targeting flowering / fruiting trees during spotlighting activities and by listening to distinctive vocalisations. Suitable roosting habitat is searched for presence of small or large established camps during diurnal survey periods.

1.6 Amphibians

Amphibians are surveyed by vocal call identification, call playback, spotlighting along the edge of water-bodies, pitfall trapping, funnel trapping, by driving along sealed roads near waterways, habitat searches and collection of tadpoles.

Calls are identified in the field by the fauna surveyor. For similar calling species, or if an unknown male call is heard, it is cross matched to frog call reference libraries taken into the field. A call library of frogs occupying the NSW coastal areas is also stored into a mobile phone for a quick reference. This phone is carried into the field at all times and may be used for call-playback methods and recording calls for later analysis.

All threatened frog species may be targeted by use of call playback techniques where suitable habitat exists, with some species more reliable than others in providing a response. Red-crowned Toadlet may also be targeted by clapping and loud retort along suitable habitat drainages in order to evoke a call response.

Any amphibians found are visually identified and, when required to be examined, are handled with latex gloves and kept moist until release. Any tadpoles requiring capture are collected with a scoop net and placed within a snap lock clear plastic bag for analysis of colour and morphological features.

Amphibian survey yields best results during or following wet periods with seasonal breeding and subsequent male calling varying according each species. Targeted survey is thus undertaken in appropriate seasons.

1.7 Reptiles

Reptiles are surveyed opportunistically during diurnal site visit(s), but also by habitat searches, pitfall trapping, funnel trapping, by driving along roads on humid nights and by camera surveillance at burrows.

Habitat searches for reptiles are undertaken in likely localities such as under logs, rocky slabs on rock surfaces, under sheet debris, under bark exfoliations and leaf litter at the base of trees and along the edge of wetlands. Aspect and land surface thermal properties are considered to determine best search locations particularly along rocky escarpments.

During warmer months spotlighting may assist survey effort particularly during humid conditions.

1.8 Invertebrates

Target survey is undertaken for the Cumberland Plain Land Snail (*Meridolum corneovirens*) when in proximity to previous *Atlas of NSW Wildlife* (OEH 2013) records and particularly where its typical host vegetation community is present. The most appropriate areas of observed habitat are searched. Dense areas of leaf litter with likely moisture retaining properties are scraped using a three pronged rake. Logs, stumps, artificial refuse and rocks are also turned over. In large survey areas, search quadrats are undertaken evenly across highest quality habitat areas to estimate population size.

The top (spiral side), side (showing aperture) and underside (showing umbilicus) of snail specimens found are photographed and sent to Michael Shea of the *Australian Museum Malacology Unit* for confirmation of identification.

2 Habitat Trees

Hollow bearing tree surveys use a *Trimble* handheld GPS unit to log both field reference location as well as tree data. Data such as hollow types, hollow size, tree species, diameter at breast height, canopy spread and overall height are documented. A metal tag with the tree number is placed on the trunk for field relocation purposes. Other habitat features such as nests and significant sized mistletoe for foraging are also noted.

3 Survey Effort Table Descriptors:

Target - Where effort is specifically concentrated towards an individual species. Selected target species will be identified within the survey effort table and where necessary described within the report.

Opportunistic - Where birds are identified by observation, call or indirect methods as the opportunity arises.

Habitat search - Where suitable areas of habitat for selected fauna groups such as frogs, reptiles and invertebrates are specifically searched.

Diurnal bird census point(s) - Are bird surveys undertaken within a specified area surrounding a point (or in a quadrat) for a specified amount of time. Size and time will be specified in the survey effort table. These are more typically undertaken across larger sites where the total area cannot be effectively covered during the survey period. Subsequently census points are selected to adequately represent each of the habitat areas present and particularly areas designated for proposed development. Often census points are commenced at locations where bird activity is noticeably high.

Spotting-scope outlook - A *Nikon* spotting scope with 16~47 zoom at x60 magnification on a mounted tripod is used for distant inspections of diurnal birds. This is undertaken at wetlands for viewing waterfowl and waders but also other difficult to access areas. It may also be used for inspecting activity at nests, hollows and combined with spotlight for a panoramic search in open areas.

Call playback - This involves broadcasting recorded calls through a 15 watt Toa *Faunatech* amplifier to evoke a response from species known to reply. Species selected for call-playback will be indicated in the survey effort table.

Spotlighting - Is carried out using a hand held 55 watt spotlight powered by a 12 volt rechargeable battery. This technique involves walking amongst the woodland areas, forest fringes, along roads, trails and fence lines so that a maximum number of trees can be observed. Spotlighting around water-bodies and particularly along the shallow fringes is used for finding frogs. Spotlighting is used in combination with binoculars or spotting scope for closer night inspections.

Stag watching - Involves watching hollows in the dusk period approximately 15 minutes prior to dark until 30 minutes following dark. Placement of the observer on the ground allows for a silhouette of any emerging fauna to be seen against the lighter sky background such that a spotlight is not required, which would likely to disrupt emergence behaviour. Where any movement is observed, a spotlight may then be used for identification purposes.

Search quadrats - Are undertaken within a specified area surrounding a point (or in a quadrat) for a specified amount of time. These are more typically undertaken across larger sites where the total area cannot be effectively covered during the survey period. Subsequently quadrats are selected to adequately represent each of the suitable habitat areas present and particularly areas designated for proposed development. The use of this technique simply as an initial time-effective suitable indicator of presence / absence of Koalas has been discussed with Koala expert, Stephen Phillips.

Koala spot assessment technique (SAT) - Method outlined by Phillips & Callaghan (2008) and accepted by the Australian Koala Foundation to determine Koala activity levels. Activity levels are calculated from the proportion of trees showing signs of Koala use as indicated by the presence of scats as well as site location within the state.

***Elliott* trapping** - Using *Elliott* type A (33x10x10cm) and Type B (45x15x15cm), B and / or Type C traps for trapping small sized mammals. Trapping nights' effort will be indicated in the survey effort table. Trapping layout, trap sizes, baiting and trapping period will be outlined within the site specific methodology section.

Medium cage trapping - Using medium sized cage traps (17x17x45cm foldout cages with tread-plate mechanism or 22x25x58cm rigid cage with tread-plate mechanism) for trapping up to cat/bandicoot sized mammals. Trapping layout, target species, baiting and trapping period will be outlined within the site specific methodology section.

Large cage trapping - Using large sized cage traps (25x25x50cm foldout cages with pull lever (meat) mechanism, 28x28x60cm foldout cages with tread-plate mechanism or 30x30x70cm rigid cage with tread-plate mechanism) for trapping up to quoll sized mammals. Trapping layout, target species, baiting and trapping period will be outlined within the site specific methodology section.

Hair tubing - Using small (40mm diameter x 120mm long) and/or large (90mm diameter x 200mm long) PVC pipe sections for collecting mammal hair samples. At one end of each tube is an enclosed chamber where the bait is placed and capped. Small drill holes in the inside face of the chamber allow the smell of the bait to permeate out through the tube without allowing access to the bait. At the other open entry end, double-sided tape is attached around the inner rim so hair samples of animals entering the tube are collected. Hair samples collected are sent to identification expert, Barbara Triggs, for identification. Trapping layout, tube sizes, baiting and trapping period will be outlined within the site specific methodology section.

Pitfall trapping - Is used to survey for small terrestrial mammals, frogs, reptiles and invertebrates. Pitfall trapping involves the use of 15cm diameter and 60cm long PVC stormwater pipe sections placed vertically into pre dug holes. The pipe is placed and set firm with surrounding soil so that the top rim is level with the ground surface. Drift fences made of damp-proof-course 270mm wide are held tight and upright by wooden and steel pegs and run along the length of each trap-line. Drift fences are run over the middle of each pit in the trap line ensuring at least 5m of fencing is run along each side of each pit. Ground fauna passing beyond the pitfall transect are diverted towards the pits along the fence line.

Funnel trapping - Is used to survey mainly for frogs and reptiles. Funnel traps are 18cm x 18cm x 75cm long and constructed of shade cloth with an internal spring and wire frame in a similar design to yabby traps. At each end an inward facing funnel directs fauna through a 4cm hole and into the trap. Herpetofauna search the walls and corners for an exit and discover it difficult to re-find the internal exit hole. As with pitfall traps, funnel traps are used with drift fences that divert fauna towards the trap entry. At least 5m of fencing is run between each funnel trap which may be placed on either side of the fence. Trapping layout, target species, fence lengths and trapping period will be outlined within the site specific methodology section.

Passive *Anabat* monitoring - Involves leaving the bat recorder in a fixed mounted position to record call-sequences of passing bats. Recording locations are determined in order to represent different available foraging structures for various micro-chiropteran bat species. Dams, cleared flyways, high insect activity areas, forest edges and ecotones are particularly targeted.

Active *Anabat* monitoring - Is a method of active microbat recording during stag-watching or during complete nocturnal survey. Active monitoring involves an SD-1 recorder allied with a PDA for viewing call-sequences in real-time. When calls are heard the transducer microphone is actively directed towards the calling animal with the aid of a spotlight, so longer and clearer call sequences may be recorded. When calls of a potential threatened species are observed on the PDA screen a view by spotlight of the bat size and wing morphology is attempted for greater identification accuracy.

Active vehicle *Anabat* monitoring - Is a method of active microbat recording deployed when large distances need to be covered in a nocturnal survey period. A Hi-mic extension cable allows the transducer microphone to be placed on a bracket on the roof of a travelling vehicle so calls may be viewed whilst driving. The vehicle travels at no more than 40km/h to

prevent wind interference. When calls of a potential threatened species are observed on the dash mounted PDA screen active spotlighting is undertaken.

Harp trapping - Is used to capture microchiropteran bats. Harp traps have an aluminium frame with a two-bank 4.2m^2 area and calico capture bag set along the base area.

Mist netting - Is used to capture microchiropteran bats. The mist net capture area is 2.4m high and 9m wide and supported by two 3.5m poles which are braced with ropes and pegs. Design is a 0.08mm ultrafine nylon monofilament thread arranged in a 14x14mm mesh, with four horizontal capture pockets. These features are specific for the use to capture micro-chiropteran bat species and are provided from the only known supplier in Poland.

Trip lining - Is used to capture microchiropteran bats. Fishing line is strung tight on pegs in a zig-zag pattern across open water-bodies just above the water surface to trip drinking bats into the water.

Camera surveillance - Is used to monitor activity at burrows, hollows, etc. or to survey for species presence at baited stations. A *Reconyx* Hyperfire digital weatherproof camera is used with a passive infrared motion detector and a night time infrared illuminator. The camera is mounted on a tree or tripod and takes three (3) consecutive photo frames on the detection of movement up to 30m away or the detection of a heat / cold source different to the ambient temperature.

Weather conditions - Survey effort for each fauna group accounting for methods undertaken, duration, and weather conditions are provided in the survey effort table. Weather details are documented for all survey techniques and include:

- Air temperature
- Cloud cover
- Rain (e.g. none, light drizzle, heavy drizzle, heavy rain)
- Recent rain events (where relevant)
- Wind strength e.g. calm, light (leaves rustle), moderate (moves branches), strong (moves tree crowns)
- Wind direction
- Moon (where relevant) (e.g. none, 1/4 moon, 1/2 moon, 3/4 moon, full moon)

Threatened & Migratory Species Habitat Assessment

A2

Table A2.1 provides an assessment of potential habitat within the study area for state and nationally listed threatened flora species recorded within 10km on the *Atlas of NSW Wildlife* (OEH 2013) or indicated to have potential habitat present within 10km on the *EPBC Protected Matters Tool.*

Table A2.1 – Threatened flora habitat assessment

Scientific name DATABASE SOURCE	***TSC Act***	***EPBC Act***	**Growth form and habitat requirements**	**Recorded on site (✓)**	**If not recorded on-site**				**7 Part test required (✓)**
					Suitable habitat present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**	
Acacia pubescens OEH EPBC	V	V	Spreading shrub 1-4m high open sclerophyll growing in open forest and woodlands on clay soils. Distribution limits N-Bilpin S-Georges River.	x	marginal	✓	✓	unlikely	x
Allocasuarina glareicola EPBC	E1	E	Small shrub 1-2m high growing in open sclerophyll forest on lateritic soils derived from tertiary alluviums. Distribution limits Castlereagh NR region.	x	x	-	-	x	x
Asterolasia elegans EPBC	-	E	Erect shrub 1-3m high growing in moist sclerophyll forests on Hawkesbury sandstone slopes hillsides. Distribution limits Maroota region.	x	x	-	-	x	x

Table A2.1 – Threatened flora habitat assessment

Scientific name DATABASE SOURCE	***TSC Act***	***EPBC Act***	**Growth form and habitat requirements**	**Recorded on site (✓)**	**If not recorded on-site**				**7 Part test required (✓)**
					Suitable habitat present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**	
Callistemon linearifolius OEH	V	-	Shrub to 4m high. Dry sclerophyll forest on coast and adjacent ranges. Distribution limits N-Nelson Bay S-Georges River.	x	x	-	-	x	x
Cryptostylis hunteriana EPBC	V	V	Saprophytic orchid. Grows in swamp heath on sandy soils. Distribution limits N-Gibraltar Range S-south of Eden.	x	x	-	-	x	x
Cynanchum elegans OEH EPBC	E1	E	Climber or twiner to 1m. Grows in rainforest gullies, scrub & scree slopes. Distribution limits N-Gloucester S-Wollongong.	x	✓	✓	✓	Moist Shale Woodland – low	✓
Dillwynia tenuifolia OEH	V	V	Erect shrub 0.6-1m high. Grows in Woodlands and Open Forest on sandstone shale or laterite. Distribution limits N-Howes Valley S-Cumberland Plain.	x	x	-	-	x	x
Diuris aequalis OEH	E1	V	Terrestrial orchid which occurs in montane Eucalypt forest with grassy-heathy understorey. Very rare apart from Boyd Plateau. Distribution limits N-Blue Mountains S-Braidwood.	x	x	-	-	x	x
Eucalyptus nicholii OEH	V	-	This species is widely planted as an urban street tree and in gardens but is quite rare in the wild. It is confined to the New England Tablelands of NSW, where it occurs from Nundle to north of Tenterfield, largely on private property.	x	x	-	-	x	x

Table A2.1 – Threatened flora habitat assessment

Scientific name DATABASE SOURCE	***TSC Act***	***EPBC Act***	**Growth form and habitat requirements**	**Recorded on site (✓)**	**If not recorded on-site**				**7 Part test required (✓)**
					Suitable habitat present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**	
Eucalyptus scoparia OEH	E1	V	Smooth-barked tree only known from vicinity of Bald Rock.	x	x	-	-	x	x
Genoplesium baueri OEH	E1	-	A terrestrial orchid that grows in sparse sclerophyll forest and moss gardens over sandstone. Distribution limits N – Hunter Valley S – Nowra	x	x	-	-	x	x
Grevillea parviflora subsp. *parviflora* EPBC	V	V	Open to erect shrub to 1m. Grows in woodland on light clayey soils Distribution limits N-Cessnock S-Appin.	x	marginal	x	x	low	✓
Gyrostemon thesioides OEH	E1	-	Multi-stemmed shrub to 70cm. Grows on hillsides and riverbanks. Confined to Georges and Nepean Rivers and believed extinct.	x	x	-	-	x	x
Lepidium hyssopifolium EPBC	E1	E	Perennial herb recorded west of the Great Dividing Range in grasslands or woodlands with a grassy understorey. Recorded previously at Bathurst, Bungendore, Crookwell and Cooma.	x	marginal	-	-	unlikely	x
Melaleuca deanei OEH EPBC	V	V	Shrub to 3m high. Grows in heath on sandstone. Distribution limits N-Gosford S-Nowra.	x	x	-	-	x	x
Pelargonium sp. Striatellum EPBC	E1	E	Herb to 90cm tall which grows in damp places especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance. Varied distribution from SE NSW to QLD.	x	x	-	-	x	x

Table A2.1 – Threatened flora habitat assessment

Scientific name DATABASE SOURCE	***TSC Act***	***EPBC Act***	**Growth form and habitat requirements**	**Recorded on site (✓)**	**If not recorded on-site**				**7 Part test required (✓)**
					Suitable habitat present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**	
Persoonia bargoensis EPBC	E1	V	Erect shrub to 1m high. Grows in woodland to Dry sclerophyll forest, on sandstone and laterite. Restricted to the Bargo area.	x	x	-	-	x	x
Persoonia hirsuta OEH EPBC	E1	E	Erect to decumbent shrub. Grows in dry sclerophyll forest and woodland on Hawkesbury sandstone with infrequent fire histories. Distribution limits N-Glen Davis S-Hill Top.	x	x	-	-	x	x
Persoonia nutans OEH EPBC	E1	E	Erect to spreading shrub. Grows in dry sclerophyll forest and woodland on laterite and alluvial sands. Distribution limits Cumberland Plain.	x	x	-	-	x	x
Pimelea curviflora var. *curviflora* EPBC	V	V	Woody herb or sub-shrub to 0.2-1.2m high. Grows on Hawkesbury sandstone near shale outcrops. Distribution Sydney.	x	x	-	-	x	x
Pimelea spicata EPBC	E1	E	Decumbent or erect shrub to 0.5m high. Occurs principally in woodland on soils derived from Wianamatta Shales. Distribution limits N-Lansdowne S-Shellharbour.	x	✓	✓	✓	Cumberland Plain Woodland - low	✓
Pomaderris brunnea EPBC	V	V	Shrub to 3m high. Confined to Upper Nepean and Colo Rivers where it grows in open forest.	x	x	-	-	x	x

Table A2.1 – Threatened flora habitat assessment

Scientific name DATABASE SOURCE	***TSC Act***	***EPBC Act***	**Growth form and habitat requirements**	**Recorded on site (✓)**	**If not recorded on-site**				**7 Part test required (✓)**
					Suitable habitat present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**	
Pterostylis gibbosa EPBC	E1	E	Terrestrial orchid which occurs near Wollongong and in Hunter Valley in sclerophyll forest, sometimes with paperbarks.	x	x	-	-	x	x
Pterostylis nigricans OEH	V	-	Terrestrial orchid. Prefers coastal heathland with Heath Banksia (Banksia ericifolia), and lower-growing heath with lichen-encrusted and relatively undisturbed soil surfaces, on sandy soils. The Dark Greenhood occurs in north-east NSW north from Evans Head, and in Queensland.	x	x	-	-	x	x
Pterostylis saxicola OEH EPBC	E1	E	Terrestrial orchid. Grows in shallow sandy soil above rock shelves, usually near Wianamatta / Hawkesbury transition. Distribution limits N-Hawkesbury River S-Campbelltown.	x	x	-	-	x	x
Pultenaea parviflora OEH EPBC	E1	V	Erect shrub. Grows in dry sclerophyll forest at the intergrade between Tertiary Alluviums and Wianamatta Shales. Distribution limits Cumberland Plain.	x	x	-	-	x	x
Pultenaea pedunculata OEH	E1	-	Prostrate shrub. Grows in dry sclerophyll forest and disturbed sites. Confined to Prestons and Villawood in NSW.	x	x	-	-	x	x
Streblus pendulinus EPBC	-	E	Tree or large shrub to 6m tall. Coastal species along watercourses in warmer rainforest area.	x	x	-	-	x	x

Table A2.1 – Threatened flora habitat assessment

Scientific name DATABASE SOURCE	***TSC Act***	***EPBC Act***	**Growth form and habitat requirements**	**Recorded on site (✓)**	**If not recorded on-site**				**7 Part test required (✓)**
					Suitable habitat present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**	
Syzygium paniculatum OEH	V	V	Small tree. Subtropical and littoral rainforest on sandy soil. Distribution limits N-Forster S-Jervis Bay.	x	x	-	-	x	x
Thelymitra sp. 'Kangaloon' EPBC	-	Critic. E	A terrestrial orchid with dark blue flowers, presented in mid-late spring. Only known from the Robertson area in the Southern Highlands. Often in association with the endangered ecological community *Temperate Highland Peat Swamps on Sandstone.*	x	x	-	-	x	x
Thesium australe OEH	V	V	Erect herb to 0.4m high. Root parasite. Grassland or woodland often damp. Distribution limits N-Tweed Heads S-south of Eden.	-	-	-	-	-	-

OEH	- Denotes species listed within 10km of the study area on the *Atlas of NSW Wildlife* (OEH 2013)
EPBC	- Denotes species listed within 10km of the study area in the *EPBC Act* habitat search
TBE	- Denotes additional species considered by *Travers bushfire & ecology* to have potential habitat based on regional knowledge and other records
V	- Denotes vulnerable listed species under the relevant act
E or E1	- Denotes endangered listed species under the relevant act
NOTE:	1. This field is not considered if no suitable habitat is present within the study area 2. 'records' refer to those provided by the *Atlas of NSW Wildlife* (OEH 2013) 3. 'nearby' or 'recent' records are species specific accounting for home range, dispersal ability and life cycle

Table A2.2 provides an assessment of potential habitat within the study area for state and nationally listed threatened fauna species recorded within 10km on the *Atlas of NSW Wildlife* (OEH 2013) or indicated to have potential habitat present within 10km on the *EPBC Protected Matters Tool.*

Table A2.2 – Threatened fauna habitat assessment

COMMON NAME ***Scientific name*** DATABASE SOURCE	***TSC Act***	***EPBC Act***	**PREFERRED HABITAT** ***Distribution limit***	**RECORDED ON SITE (✓)**	**IF NOT RECORDED ON-SITE**				**CONSIDERED IN 7 PART TEST (✓)**
					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**	
Giant Burrowing Frog *Heleioporus australiacus* OEH EPBC	V	V	Inhabits open forests and riparian forests along non-perennial streams, digging burrows into sandy creek banks. *Distribution Limit: N-Near Singleton S-South of Eden.*	×	×	-	-	×	×
Giant Barred Frog *Mixophyes iteratus* EPBC	E	E	Terrestrial inhabitant of rainforest and open forests. *Distribution Limit: N-Border Ranges National Park. S-Narooma.*	×	×	-	-	×	×
Red-crowned Toadlet *Pseudophryne australis* OEH	V	-	Prefers sandstone areas, breeds in grass and debris beside non-perennial creeks or gutters. Individuals can also be found under logs and rocks in non-breeding periods. *Distribution Limit: N-Pokolbin. S-near Wollongong.*	×	×	-	-	×	×
Green and Golden Bell Frog *Litoria aurea* OEH EPBC	E	V	Prefers the edges of permanent water, streams, swamps, creeks, lagoons, farm dams and ornamental ponds. Often found under debris. *Distribution Limit: N-Byron Bay S-South of Eden.*	×	marginal	×	-	Not likely	×

Table A2.2 – Threatened fauna habitat assessment

COMMON NAME ***Scientific name*** DATABASE SOURCE	***TSC Act***	***EPBC Act***	**PREFERRED HABITAT** ***Distribution limit***	**RECORDED ON SITE (✓)**	**IF NOT RECORDED ON-SITE**				**CONSIDERED IN 7 PART TEST (✓)**
					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**	
Littlejohn's Tree Frog *Litoria littlejohnii* OEH EPBC	V	V	Found in wet and dry sclerophyll forest associated with sandstone outcrops at altitudes 280-1,000m on eastern slopes of Great Dividing Range. Prefers flowing rocky streams. *Distribution Limit: N-Hunter River S-Eden.*	×	×	-	-	×	×
Southern Bell Frog *Litoria raniformis* EPBC	E	V	Prefers the edges of permanent water, streams, swamps, creeks, lagoons, farm dams and ornamental ponds. Often found under debris. *Distribution Limit: N-ACT Bay. S-Albury.*	×	marginal	×	-	Not likely	×
Broad-headed Snake *Hoplocephalus bungaroides* OEH EPBC	E	V	Sandstone outcrops, exfoliated rock slabs and tree hollows in coastal and near coastal areas. *Distribution Limit: N-Mudgee Park. S-Nowra.*	×	×	-	-	×	×
Freckled Duck *Stictonetta naevosa* OEH	V	-	Occurs mainly within the Murray-Darling basin and the channel country within large cool temperate to sub-tropical swamps, lakes and floodwaters with cumbungi, lignum or melaleucas. *Distribution Limit: N- Tenterfield. S-Albury.*	×	marginal	×	-	Not likely	×

Table A2.2 – Threatened fauna habitat assessment

COMMON NAME ***Scientific name*** DATABASE SOURCE	*TSC Act*	*EPBC Act*	PREFERRED HABITAT ***Distribution limit***	RECORDED ON SITE (✓)	IF NOT RECORDED ON-SITE				CONSIDERED IN 7 PART TEST (✓)
					Suitable Habitat Present (✓)	Nearby and/or high number of record(s) (✓) *Notes 1,2 & 3*	Record(s) from recent years (✓) *Notes 1,2 & 3*	Potential to occur	
Black-necked Stork *Ephippiorhynchus asiaticus* OEH	E	-	Occurs in tropical to warm temperate terrestrial wetlands, estuarine and littoral habitats such as mangroves, tidal mudflats, floodplains, open woodlands, irrigated lands, bore drains, sub-artesian pools, farm dams and sewerage ponds. *Distribution Limit: N-Tweed Heads. S-Nowra.*	×	marginal	×	-	Not likely	×
Australasian Bittern *Botaurus poiciloptilus* EPBC	E	E	Found in or over water of shallow freshwater or brackish wetlands with tall reedbeds, sedges, rushes, cumbungi, lignum and also in ricefields, drains in tussocky paddocks, occasionally saltmarsh, brackish wetlands. *Distribution Limit: N-North of Lismore. S- Eden.*	×	marginal	×	-	Not likely	×
Black Bittern *Ixobrychus flavicollis* TBE	V	-	Found in shadowy, leafy waterside trees such as callistemons, casuarinas, paperbarks, eucalypts, mangroves and willows along tidal creeks, freshwater and brackish streams and ponds, sheltered mudflats and oyster slats. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	marginal	×	-	Not likely	×

Table A2.2 – Threatened fauna habitat assessment

COMMON NAME *Scientific name* DATABASE SOURCE	*TSC Act*	*EPBC Act*	PREFERRED HABITAT *Distribution limit*	RECORDED ON SITE (✓)	IF NOT RECORDED ON-SITE				CONSIDERED IN 7 PART TEST (✓)
					Suitable Habitat Present (✓)	Nearby and/or high number of record(s) (✓) *Notes 1,2 & 3*	Record(s) from recent years (✓) *Notes 1,2 & 3*	Potential to occur	
Spotted Harrier *Circus assimilis* OEH	V	-	Utilises grassy plains, crops and stubblefields; saltbush, spinifex associations; scrublands, mallee, heathlands; open grassy woodlands. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	marginal	×	-	Not likely	×
Little Eagle *Hieraaetus morphnoides* OEH	V	-	Utilises plains, foothills, open forests, woodlands and scrublands; river red gums on watercourses and lakes. *Distribution Limit - N-Tweed Heads. S-South of Eden.*	×	✓	✓	✓	✓	✓
Red Goshawk *Erythrotriorchis radiatus* EPBC	E	V	Inhabits tall open forests and woodlands. Breeds in tall trees adjacent to watercourses of wetlands. *Distribution Limit: N-Border Ranges National Park. S-Foster.*	×	×	-	-	×	×
Black Falcon *Falco subniger* OEH	V	-	Inhabits plains, grasslands, foothills, timbered watercourses, wetland environs, crops; occasionally over towns and cities. *N-Tweed Heads. S-South of Eden*	×	×	-	-	×	×
Bush Stone-curlew *Burhinus grallarius* OEH	E	-	Utilises open forests and savannah woodlands, sometimes dune scrub, savannah and mangrove fringes. *Distribution Limit: N-Border Ranges National Park. S-Near Nowra.*	×	marginal	×	-	Not likely	×

Table A2.2 – Threatened fauna habitat assessment

COMMON NAME ***Scientific name*** DATABASE SOURCE	***TSC Act***	***EPBC Act***	**PREFERRED HABITAT** ***Distribution limit***	**RECORDED ON SITE (✓)**	**IF NOT RECORDED ON-SITE**				**CONSIDERED IN 7 PART TEST (✓)**
					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**	
Australian Painted Snipe *Rostratula australis* EPBC	E	V	Most numerous within the Murray-Darling basin and inland Australia within marshes and freshwater wetlands with swampy vegetation. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	marginal	×	-	Not likely	×
Gang-gang Cockatoo *Callocephalon fimbriatum* OEH	V	-	Prefers wetter forests and woodlands from sea level to > 2,000m on the Great Dividing Range, timbered foothills and valleys, timbered watercourses, coastal scrubs, farmlands and suburban gardens. *Distribution Limit: mid north coast of NSW to western Victoria.*	×	marginal	×	-	Not likely	×
Glossy Black-Cockatoo *Calyptorhynchus lathami* OEH	V	-	Open forests with *Allocasuarina* species and hollows for nesting. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	×	-	-	×	×
Little Lorikeet *Glossopsitta pusilla* OEH	V	-	Inhabits forests, woodlands; large trees in open country; timbered watercourses, shelterbeds, and street trees. *Distribution Limit: N-Tweed Heads. S-South of Eden*.	×	✓	×	-	low	✓

Table A2.2 – Threatened fauna habitat assessment

COMMON NAME ***Scientific name*** DATABASE SOURCE	*TSC Act*	*EPBC Act*	PREFERRED HABITAT ***Distribution limit***	RECORDED ON SITE (✓)	IF NOT RECORDED ON-SITE				CONSIDERED IN 7 PART TEST (✓)
					Suitable Habitat Present (✓)	Nearby and/or high number of record(s) (✓) *Notes 1,2 & 3*	Record(s) from recent years (✓) *Notes 1,2 & 3*	Potential to occur	
Swift Parrot *Lathamus discolour* OEH EPBC	E	E	Inhabits eucalypt forests and woodlands with winter flowering eucalypts. *Distribution Limit: N-Border Ranges National Park. S-South of Eden*.	×	✓	×	×	low	✓
Barking Owl *Ninox connivens* OEH	V	-	Inhabits principally woodlands but also open forests and partially cleared land and utilises hollows for nesting. *Distribution Limits: N-Border Ranges National Park. S-Eden.*	×	marginal	×	-	Not likely	×
Powerful Owl *Ninox strenua* OEH	V	-	Forests containing mature trees for shelter or breeding and densely vegetated gullies for roosting. *Distribution Limits: N-Border Ranges National Park. S-Eden.*	×	Sub-optimal	×	✓	low	✓
Masked Owl *Tyto novaehollandiae* TBE	V	-	Open forest and woodlands with cleared areas for hunting and hollow trees or dense vegetation for roosting. *Distribution Limit: N-Border Ranges National Park. S-Eden.*	×	Sub-optimal	×	×	Not likely	×
Brown Treecreeper *Climacteris picumnus victoriae* TBE	V	-	Occupies Eucalypt woodlands, open woodland lacking a dense understorey with fallen dead timber. *Distribution Limit:(Sub species victoriae) Central NSW west of Great Div. Cumberland Plains, Hunter Valley, Richmond, Clarence, and Snowy River Valleys.*	×	✓	none	-	unlikely	×

Table A2.2 – Threatened fauna habitat assessment

COMMON NAME ***Scientific name*** DATABASE SOURCE	*TSC Act*	*EPBC Act*	PREFERRED HABITAT ***Distribution limit***	RECORDED ON SITE (✓)	IF NOT RECORDED ON-SITE				CONSIDERED IN 7 PART TEST (✓)
					Suitable Habitat Present (✓)	Nearby and/or high number of record(s) (✓) *Notes 1,2 & 3*	Record(s) from recent years (✓) *Notes 1,2 & 3*	Potential to occur	
Eastern Bristlebird *Dasyornis brachypterus* OEH EPBC	E	E	Coastal woodlands, dense scrubs and heathlands, especially where low heathland borders taller woodland or dense tall tea-tree. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	×	-	-	×	×
Speckled Warbler *Chthonicola sagittata* OEH	V	-	Found in temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts. *Distribution Limit: N-Urbanville. S-Eden.*	×	✓	One distant	-	unlikely	✓
Painted Honeyeater *Grantiella picta* TBE	V	-	A nomadic bird occurring in low densities within open forest, woodland and scrubland feeding on mistletoe fruits. Inhabits primarily Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. *Distribution Limit: N-Boggabilla. S-Albury with greatest occurrences on the inland slopes of the Great Dividing Range.*	×	✓	none	-	unlikely	×
Black-chinned Honeyeater *Melithreptus gularis gularis* OEH	V	-	Found in woodlands containing box-ironbark associations and River Red Gums, also drier coastal woodlands of the Cumberland Plain and Hunter Richmond and Clarence. *Distribution Limit: N-Cape York Pen. Qld. S-Victor H. Mt Lofty Ra & Flinders Ra. SA.*	×	✓	three distant	-	unlikely	✓

Table A2.2 – Threatened fauna habitat assessment

COMMON NAME ***Scientific name*** DATABASE SOURCE	***TSC Act***	***EPBC Act***	**PREFERRED HABITAT** ***Distribution limit***	**RECORDED ON SITE (✓)**	**IF NOT RECORDED ON-SITE**				**CONSIDERED IN 7 PART TEST (✓)**
					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**	
Regent Honeyeater *Xanthomyza Phrygia* OEH EPBC	E4A	E	Found in temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts. *Distribution Limit: N-Urbanville. S-Eden.*	×	✓	One distant	-	unlikely	✓
Varied Sittella *Daphoenositta chrysoptera* OEH	V	-	Open eucalypt woodlands / forests (except heavier rainforests); mallee, inland acacia, coastal tea-tree scrubs; golf courses, shelterbelts, orchards, parks, scrubby gardens. *Distribution Limit: N-Border Ranges National Park. S-South of Eden*.	×	Sub-optimal	✓	✓	✓	✓
Hooded Robin *Melanodryas cucullata cucullata* OEH	V	-	Found in Eucalypt woodlands, *Acacia* scrubland, open forest, and open areas adjoining large woodland blocks, with areas of dead timber. *Distribution Limit: N-Central Qld. S-Spencer Gulf SA.*	×	✓	none	-	unlikely	×
Scarlet Robin *Petroica boodang* OEH	V	-	Found in foothill forests, woodlands, watercourses; in autumn-winter, more open habitats: river red gum woodlands, golf courses, parks, orchards, gardens. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	✓	×	-	low	✓

Table A2.2 – Threatened fauna habitat assessment

COMMON NAME *Scientific name* DATABASE SOURCE	*TSC Act*	*EPBC Act*	PREFERRED HABITAT *Distribution limit*	RECORDED ON SITE (✓)	IF NOT RECORDED ON-SITE				CONSIDERED IN 7 PART TEST (✓)
					Suitable Habitat Present (✓)	Nearby and/or high number of record(s) (✓) *Notes 1,2 & 3*	Record(s) from recent years (✓) *Notes 1,2 & 3*	Potential to occur	
Flame Robin *Petroica phoenicea* OEH	V	-	Summer: forests, woodlands, scrubs, from sea-level to *c.* 1800 m. Autumn-winter: open woodlands, plains, paddocks, golf courses, parks, orchards. *Distribution Limit: N northern NSW tablelands. S-South of Eden.*	×	✓	×	-	low	✓
Diamond Firetail *Stagonopleura guttata* OEH	V	-	Found in Eucalypt woodlands, forests and mallee where there is grassy understorey west of the Great Div. also drier coastal woodlands of the Cumberland Plain and Hunter Richmond and Clarence River Valleys. *Distribution Limit: N-Rockhampton Q. S-Eyre Pen Kangaroo Is. SA.*	×	✓	×	-	unlikely	✓
Spotted-tailed Quoll *Dasyurus maculatus* OEH EPBC	V	E	Dry and moist open forests containing rock caves, hollow logs or trees. *Distribution Limit: N-Mt Warning National Park. S-South of Eden.*	×	Sub-optimal	×	-	unlikely	✓
Southern Brown Bandicoot *Isoodon obesulus* EPBC	E	E	Utilises a range of habitats containing thick ground cover - open forest, woodland, heath, cleared land, urbanised areas and regenerating bushland. *Distribution Limit: N-Kempsey. S-South of Eden.*	×	×	-	-	×	×

Table A2.2 – Threatened fauna habitat assessment

COMMON NAME ***Scientific name*** DATABASE SOURCE	***TSC Act***	***EPBC Act***	**PREFERRED HABITAT** ***Distribution limit***	**RECORDED ON SITE (✓)**	**IF NOT RECORDED ON-SITE**				**CONSIDERED IN 7 PART TEST (✓)**
					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**	
Koala *Phascolarctos cinereus* OEH EPBC	V	V	Inhabits both wet and dry eucalypt forest on high nutrient soils containing preferred feed trees. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	✓	×	-	unlikely	✓
Squirrel Glider *Petaurus norfolcensis* OEH	V	-	Mixed aged stands of eucalypt forest & woodlands including gum barked & high nectar producing species & hollow bearing trees. *Distribution Limit: N-Tweed Heads. S-Albury.*	×	Sub-optimal	×	-	Not likely	×
Long-nosed Potoroo *Potorous tridactylus* EPBC	V	V	Coastal heath and dry and wet sclerophyll forests with a dense understorey. *Distribution Limit: N-Mt Warning National Park. S-South of Eden.*	×	×	-	-	×	×
Brush-tailed Rock-wallaby *Petrogale penicillata* EPBC	E	V	Found in rocky gorges with a vegetation of rainforest or open forests to isolated rocky outcrops in semi-arid woodland country. *Distribution Limit: N-North of Tenterfield. S-Bombala.*	×	×	-	-	×	×

Table A2.2 – Threatened fauna habitat assessment

COMMON NAME ***Scientific name*** DATABASE SOURCE	*TSC Act*	*EPBC Act*	PREFERRED HABITAT ***Distribution limit***	RECORDED ON SITE (✓)	IF NOT RECORDED ON-SITE				CONSIDERED IN 7 PART TEST (✓)
					Suitable Habitat Present (✓)	Nearby and/or high number of record(s) (✓) *Notes 1,2 & 3*	Record(s) from recent years (✓) *Notes 1,2 & 3*	Potential to occur	
Grey-headed Flying-fox *Pteropus poliocephalus* OEH EPBC	V	V	Found in a variety of habitats including rainforest, mangroves, paperbark swamp, wet and dry open forest and cultivated areas. Forms camps commonly found in gullies and in vegetation with a dense canopy. *Distribution Limit: N-Tweed Heads. S-Eden.*	×	✓	✓	✓	✓	✓
Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris* OEH	V	-	Rainforests, sclerophyll forests and woodlands. *Distribution Limit: N-North of Walgett. S-Sydney.*	×	✓	×	-	low	✓
East-coast Freetail Bat *Micronomus norfolkensis* OEH	V	-	Inhabits open forests and woodlands foraging above the canopy and along the edge of forests. Roosts in tree hollows, under bark and buildings. *Distribution Limit: N-Woodenbong. S-Pambula.*	✓	-	-	-	-	✓
Large-eared Pied Bat *Chalinolobus dwyeri* OEH EPBC	V	V	Warm-temperate to subtropical dry sclerophyll forest and woodland. Roosts in caves, tunnels and tree hollows in colonies of up to 30 animals. *Distribution Limit: N-Border Ranges National Park. S-Wollongong.*	×	marginal	×	-	Not likely	×

Table A2.2 – Threatened fauna habitat assessment

COMMON NAME ***Scientific name*** DATABASE SOURCE	*TSC Act*	*EPBC Act*	PREFERRED HABITAT ***Distribution limit***	RECORDED ON SITE (✓)	IF NOT RECORDED ON-SITE				CONSIDERED IN 7 PART TEST (✓)
					Suitable Habitat Present (✓)	Nearby and/or high number of record(s) (✓) *Notes 1,2 & 3*	Record(s) from recent years (✓) *Notes 1,2 & 3*	Potential to occur	
Eastern Falsistrelle *Falsistrellus tasmaniensis* OEH	V	-	Recorded roosting in caves, old buildings and tree hollows. *Distribution Limit: N-Border Ranges National Park. S-Pambula.*	×	marginal	×	-	unlikely	✓
Little Bentwing-bat *Miniopterus australis* OEH	V	-	Roosts in caves, old buildings and structures in the higher rainfall forests along the south coast of Australia. *Distribution Limit: N-Border Ranges National Park. S-Sydney.*	×	✓	none	-	unlikely	✓
Eastern Bentwing-bat *Miniopterus orianae oceansis* OEH	V	-	Prefers areas where there are caves, old mines, old buildings, stormwater drains and well-timbered areas. *Distribution Limit: N-Border Ranges National Park. S-South of Eden.*	✓	-	-	-	-	✓
Large-footed Myotis *Myotis macropus* OEH	V	-	Roosts in caves, mines, tunnels, buildings, tree hollows and under bridges. Forages over open water. *Distribution limits: N-Border Ranges National Park. S-South of Eden.*	✓	-	-	-	-	✓

Table A2.2 – Threatened fauna habitat assessment

COMMON NAME ***Scientific name*** DATABASE SOURCE	***TSC Act***	***EPBC Act***	PREFERRED HABITAT ***Distribution limit***	RECORDED ON SITE (✓)	IF NOT RECORDED ON-SITE				CONSIDERED IN 7 PART TEST (✓)
					Suitable Habitat Present (✓)	Nearby and/or high number of record(s) (✓) *Notes 1,2 & 3*	Record(s) from recent years (✓) *Notes 1,2 & 3*	Potential to occur	
Greater Broad-nosed Bat *Scoteanax rueppellii* OEH	V	-	Inhabits areas containing moist river and creek systems, especially tree lined creeks. *Distribution Limit: N-Border Ranges National Park. S-Pambula.*	×	✓	✓	×	✓	✓
New Holland Mouse *Pseudomys novaehollandiae* EPBC	-	V	Occurs in heathlands, woodlands, open forest and paperbark swamps and on sandy, loamy or rocky soils. Coastal populations have a marked preference for sandy substrates, a heathy understorey of leguminous shrubs less than 1m high and sparse ground litter. Recolonise of regenerating burnt areas. *Distribution Limit: N-Border Ranges National Park. S-South of Eden.*	×	×	-	-	×	×
Cumberland Plain Land Snail *Meridolum corneovirens* OEH	E	-	Inhabits remnant eucalypt woodland of the Cumberland Plan. Shelters under logs, debris, clumps of grass, around base of trees and burrowing into loose soil. *Distribution Limit: Cumberland Plain of Sydney Basin Region.*	×	Sub-optimal	✓	✓	low	✓

Table A2.2 – Threatened fauna habitat assessment

COMMON NAME ***Scientific name*** DATABASE SOURCE	***TSC Act***	***EPBC Act***	**PREFERRED HABITAT** ***Distribution limit***	**RECORDED ON SITE (✓)**	**IF NOT RECORDED ON-SITE**				**CONSIDERED IN 7 PART TEST (✓)**
					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**	
Macquarie Perch *Macquaria australasica* EPBC	V (*FM Act*)	E	Occurs in south east Australia at moderate to high altitudes in rivers and reservoirs. Historical records show the species was widespread and abundant in the upper reaches of the Lachlan, Murrumbidgee and Murray Rivers and their tributaries. Allen (1989) states that introduced populations are present in Nepean River and water supply dams in the Sydney area. Occurs in lakes and flowing streams, usually in deep holes.	×	×	-	-	×	×
Australian Greyling *Prototroctes maraena* EPBC	Part 2, Section 19 – Protected Fish (*FM Act*)	V	Clear, moderate to fast flowing water in the upper reaches of rivers (sometimes to altitudes above 1,000m). Typically found in gravel bottom pools. Often forming aggregations below barriers to upstream movement (e.g. weirs, waterfalls).	×	×	-	-	×	×

OEH	-	Denotes species listed within 10km of the study area on the *Atlas of NSW Wildlife* (OEH 2013)
EPBC	-	Denotes species listed within 10km of the study area in the *EPBC Act* habitat search
TBE	-	Denotes additional species considered by *Travers bushfire & ecology* to have potential habitat based on regional knowledge and other records
V	-	Denotes vulnerable listed species under the relevant act
E	-	Denotes endangered listed species under the relevant act
NOTE:	1.	This field is not considered if no suitable habitat is present within the study area
	2.	'records' refer to those provided by the *Atlas of NSW Wildlife* (OEH 2013)
	3.	'nearby' or 'recent' records are species specific accounting for home range, dispersal ability and life cycle

Table A2.3 provides an assessment of potential habitat within the study area for nationally *protected* migratory fauna species recorded within 10km on the *EPBC Protected Matters Tool*. Nationally threatened migratory species are considered in Table A2.2.

Table A2.3 – Migratory fauna habitat assessment

COMMON NAME ***Scientific name***	**PREFERRED HABITAT** ***Migratory breeding***	**Suitable habitat present (✓)**	**Recorded on site (✓)**	**COMMENTS**
White-bellied Sea Eagle (*Haliaeetus leucogaster*)	Coasts, islands, estuaries, inlets, large rivers, inland lakes, reservoirs. *Sedentary; dispersive.*	Sub-optimal	×	-
White-throated Needletail (*Hirundapus caudacutus*)	Airspace over forests, woodlands, farmlands, plains, lakes, coasts, towns; companies forage often along favoured hilltops and timbered ranges. *Breeds Siberia, Himalayas, east to Japan. Summer migrant to eastern Australia.*	✓	×	-
Rainbow Bee-eater (*Merops ornatus*)	Open woodlands with sandy, loamy soil; sandridges, sandspits, riverbanks, road cuttings, beaches, dunes, cliffs, mangroves, rainforest, woodlands, golf courses. *Breeding resident in northern Australia. Summer breeding migrant to south east and south west Australia.*	×	-	-
Black-faced Monarch (*Monarcha melanopsis*)	Rainforests, eucalypt woodlands; coastal scrubs; damp gullies in rainforest, eucalypt forest; more open woodland when migrating. *Summer breeding migrant to coastal south east Australia, otherwise uncommon*.	×	-	-
Spectacled Monarch (*Monarcha trivirgatus*)	Understorey of mountain / lowland rainforest, thickly wooded gullies, waterside vegetation, mostly well below canopy. *Summer breeding migrant to south-east Qld and north-east NSW down to Port Stephens from Sept/Oct to May. Uncommon in southern part of range.*	×	-	-
Satin Flycatcher (*Myiagra cyanoleuca*)	Heavily vegetated gullies in forests, taller woodlands, usually above shrub-layer; during migration, coastal forests, woodlands, mangroves, trees in open country, gardens. *Breeds mostly south east Australia and Tasmania over warmer months, winters in north east Qld.*	×	-	-
Rufous Fantail (*Rhipidura rufifrons*)	Undergrowth of rainforests / wetter eucalypt forests / gullies; monsoon forests, paperbarks, sub-inland and coastal scrubs; mangroves, watercourses; parks, gardens. On migration, farms, streets buildings. *Breeding migrant to south east Australia over warmer months. Altitudinal migrant in north east NSW in mountain forests during warmer months.*	Sub-optimal	×	-

Table A2.3 – Migratory fauna habitat assessment

COMMON NAME *Scientific name*	PREFERRED HABITAT *Migratory breeding*	Suitable habitat present (✓)	Recorded on site (✓)	COMMENTS
Great Egret (*Ardea alba*)	Shallows of rivers, estuaries; tidal mudflats, freshwater wetlands; sewerage ponds, irrigation areas, larger dams, etc. *Dispersive; cosmopolitan.*	✓	×	-
Cattle Egret (*Ardea ibis*)	Stock paddocks, pastures, croplands, garbage tips, wetlands, tidal mudflats, drains. *Breeds in summer in warmer parts of range including NSW*.	✓	✓	Two individual Cattle Egrets were recorded during survey foraging with cattle as a host. The study area provides suitable foraging, roosting and nesting habitat. This habitat is otherwise well represented in the locality and previous nesting activity was not observed during survey. Development within the open landscape and removal of cattle as a foraging host will reduce overall foraging habitat and reduce the potential for occurrence, however this species is not likely to offer a constraint to development. Retention of drainages and dams and restoration of riparian habitat will improve suitability for breeding habitat but again will be less likely utilised in the absence of cattle and large foraging areas.

Table A2.3 – Migratory fauna habitat assessment

COMMON NAME *Scientific name*	PREFERRED HABITAT *Migratory breeding*	Suitable habitat present (✓)	Recorded on site (✓)	COMMENTS
Latham's Snipe (*Gallinago hardwickii*)	Soft wet ground or shallow water with tussocks and other green or dead growth; wet parts of paddocks; seepage below dams; irrigated areas; scrub or open woodland from sea-level to alpine bogs over 2,000m; samphire on saltmarshes; mangrove fringes. *Breeds Japan. Regular summer migrant to Australia. Some overwinter.*	✓	×	-
Fork-tailed Swift (*Apus pacificus*)	Aerial: over open country, from semi-arid deserts to coasts, islands; sometimes over forests, cities. *Breeds Siberia, Himalayas, east to Japan south east Asia. Summer migrant to east Australia. Mass movements associated with late summer low pressure systems into east Australia. Otherwise uncommon.*	✓	×	-