Cardup Brickworks

Level 1 Fauna Survey and Targeted Cockatoo habitat survey 2019

Cardup Brook in the study area

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Executive Summary

Introduction

Austral Bricks proposed to expand their Cardup Brickworks, necessitating some clearing of native vegetation in the vicinity of Cardup Brook. Land Insights commissioned Western Wildlife on behalf of Austral Bricks, to carry out a level 1 vertebrate fauna survey and targeted cockatoo habitat survey of the vegetated area along the brook.

Methods

The fauna survey was undertaken in accordance with the *Statement of environmental principles, factors and objectives* (Environmental Protection Authority (EPA) 2016a), *Environmental factor guideline – terrestrial fauna* (EPA 2016b), *Technical guidance – terrestrial fauna surveys* (EPA 2016c), the *Technical Guide: terrestrial vertebrate fauna surveys for environmental impact assessment* (EPA and DEC 2010) and relevant State and Federal Guidelines on surveying conservation significant fauna.

The field survey was carried out on the 5th September 2019, and included:

- Habitat identification.
- Habitat tree identification, specifically trees that are potential black-cockatoo breeding habitat.
- Recording any signs of foraging, roosting or breeding by black-cockatoos.
- Keeping opportunistic records of all vertebrate fauna observed.

Species of conservation significance were classified as: **Threatened** if listed as Extinct in the Wild, Critically Endangered, Endangered or Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and/or *Biodiversity Conservation Act 2016* (BC Act); **Migratory** if listed as Migratory under the EPBC Act and/or BC Act, excluding those species also listed as threatened; **Specially Protected** if listed as Other Specially Protected Species or Conservation Dependent Fauna under the BC Act; **Priority** if listed as Priority by DBCA and **Locally Significant** if considered by the author to potentially be of local significance.

Results and Discussion

Two fauna habitats were identified:

- Eucalypt Forest
- Riparian Channel

The habitats in the Study Area are common and widespread in the subregion. The Riparian Channel habitat around Cardup Brook may have some local importance as refugia for fauna, where permanently damp areas are likely to be present all year. As a whole, the habitats are likely to provide an ecological linkage function as part of a regionally significant contiguous bushland/wetland linkage identified by Bush Forever (Government of Western Australia 2000). On a local scale, the habitats are likely to provide linkage east-west along Cardup Brook.

The study area has the potential to support up to ten frog, 43 reptile, 91 bird and 23 mammal (17 native and five introduced) species. A total of 43 fauna species of conservation significance have the potential to occur in the study area:

Threatened species
Four threatened species potentially occur in the Study Area, of which two were recorded:

- Forest Red-tailed Black-cockatoo (*Calyptorhynchus latirostris banksii*) – EPBC Act (Vulnerable), BC Act (Vulnerable) - **Recorded**
- Carnaby's Black-cockatoo (*Calyptorhynchus latirostris*) – EPBC Act (Endangered), BC Act (Endangered)
- Baudin's Black-cockatoo (*Calyptorhynchus baudinii*) – EPBC Act (Vulnerable), BC Act (Vulnerable) – **Recorded**
- Chuditch (*Dasyurus geoffroii*) – EPBC Act (Vulnerable), BC Act (Vulnerable)

All three black-cockatoo species are likely to be foraging visitors to the study area, with foraging by Baudin's Black-cockatoo and the Forest Red-tailed Black-cockatoo confirmed. The Eucalypt Forest habitat contains Marri, a favoured food plant for all species, however, the area of foraging habitat present is small at about 0.66ha. The Riparian Channel habitat is unlikely to be important for foraging. Although potential breeding habitat is present, only four trees with possible large hollows were recorded and it is unlikely that black-cockatoos currently breed in the study area. No signs of black-cockatoo roosting were detected. The Chuditch is known from the surrounding area. As Chuditch have large home ranges, the study area is too small to support even a single individual, but may be a dispersal corridor for the species.

Migratory species
One Migratory species potentially occurs in the Study Area:

- Fork-tailed Swift (*Apus pacificus*) – EPBC Act (Migratory), BC Act (Migratory)

The Fork-tailed Swift is a Migratory species that is thought to be almost entirely aerial when visiting Australia, so the Study Area is not likely to provide important habitat for this species.

Specially Protected species
Two Specially Protected species potentially occur in the Study Area:

- Peregrine Falcon (*Falco peregrinus*) – BC Act (Other Specially Protected)
- Brush-tailed Phascogale (*Phascogale tapoatafa*) – BC Act (Conservation Dependent)

The Study Area is unlikely to be important for the Peregrine Falcon, as its population is large and secure, and its favoured breeding habitat is absent. The Brush-tailed Phascogale may possibly disperse through the study area, but is unlikely to be resident.

Priority species
Six Priority species potentially occur in the Study Area, of which one was recorded:

- Southern Death Adder (*Acanthophis antarcticus*) – Priority 3
- Dell's Ctenotus (*Ctenotus delli*) – Priority 4
- Quenda (*Isoodon fusciventer*) – Priority 4 - **Recorded**
- Western Brush Wallaby (*Notamacropus irma*) – Priority 4
- Western False Pipistrelle (*Falsistrellus mackenziei*) – Priority 4
- Water-rat (*Hydromys chrysogaster*) – Priority 4

The Quenda was recorded during the site visit, and is likely to be resident in the dense weedy vegetation in the Riparian Channel habitat. The Western False Pipistrelle may occur, roosting in tree hollows, as it is known from the region. The remaining species have only a low likelihood of occurrence, as the understory vegetation is weedy and degraded.

Locally significant species

There are 30 locally significant species that may occur, 29 birds and a reptile; the Carpet Python (*Morelia spilota imbricata*). Although some of these species may occur, it is likely that the importance of the study area for many species is as an ecological linkage.

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1. Introduction

Austral Bricks proposed to expand their Cardup Brickworks, necessitating some clearing of native vegetation in the vicinity of Cardup Brook. Land Insights commissioned Western Wildlife on behalf of Austral Bricks, to carry out a level 1 vertebrate fauna survey and targeted cockatoo habitat survey of the vegetated area along the brook.

The aims of the level 1 vertebrate fauna survey were to:

- Identify the fauna habitats present in the study area.
- List the vertebrate fauna that were recorded in the study area and/or have the potential to occur in the study area.
- Identify species of conservation significance, or habitats of particular importance for fauna, that may occur in the study area.

This report details the findings of the fauna survey conducted in September 2019.

1.1 The Study Area

The study area consists of vegetation along the Cardup Brook on parts of Lot 50 and Lot 10 Kiln Rd, Cardup, in the Shire of Serpentine-Jarrahdale (Figure 1). It is 3.6 ha, consisting mainly of native vegetation in the riparian zone of Cardup Brook, but also includes trees around on-site drainage channels. The western part of the study area overlaps with Bush Forever Site 271; 'Cardup Brook Bushland'.

Although situated in a cleared landscape used predominately for pasture, the brook is relatively well vegetated in a narrow strip along its length, providing a narrow linkage between vegetation on the scarp and vegetation on the Swan Coastal Plain, including Cardup Nature Reserve, an 86.2 ha Bush Forever Site (Government of Western Australia 2000). As a whole, Cardup Brook Bushland is part of a regionally significant contiguous bushland/wetland linkage, and it is adjacent to the regionally significant but not contiguous link that runs north-south along the railway line (Government of Western Australia 2000).

The study area is on the eastern edge of the Swan Coastal Plain subregion of the Swan Coastal Plain Bioregion according to the Interim Biogeographic Regionalisation for Australia (IBRA) (DEWHA 2004). The Swan Coastal Plain subregion is characterised by a Warm Mediterranean climate, with around 600 to 1000mm of rain annually (Mitchell *et al*. 2002). The primary land-uses are diverse, namely dry-land agriculture, conservation, unallocated Crown land, Crown reserves, urban, rural residential, cultivation (irrigated horticulture, agriculture and plantations), plantation forestry, roads and other infrastructure and grazing on improved pastures (Mitchell *et al*. 2002). Natural vegetation of the subregion consists generally of heath or Tuart woodland on limestone, Banksia or Jarrah/Banksia woodlands on Quaternary dune systems and Marri on colluvial or alluvial soils. The subregion also includes seasonal wetlands and islands such as Rottnest Island (Mitchell *et al*. 2002). The Northern Jarrah Forest subregion of the Jarrah Forest Bioregion lies just to the east of the study area.

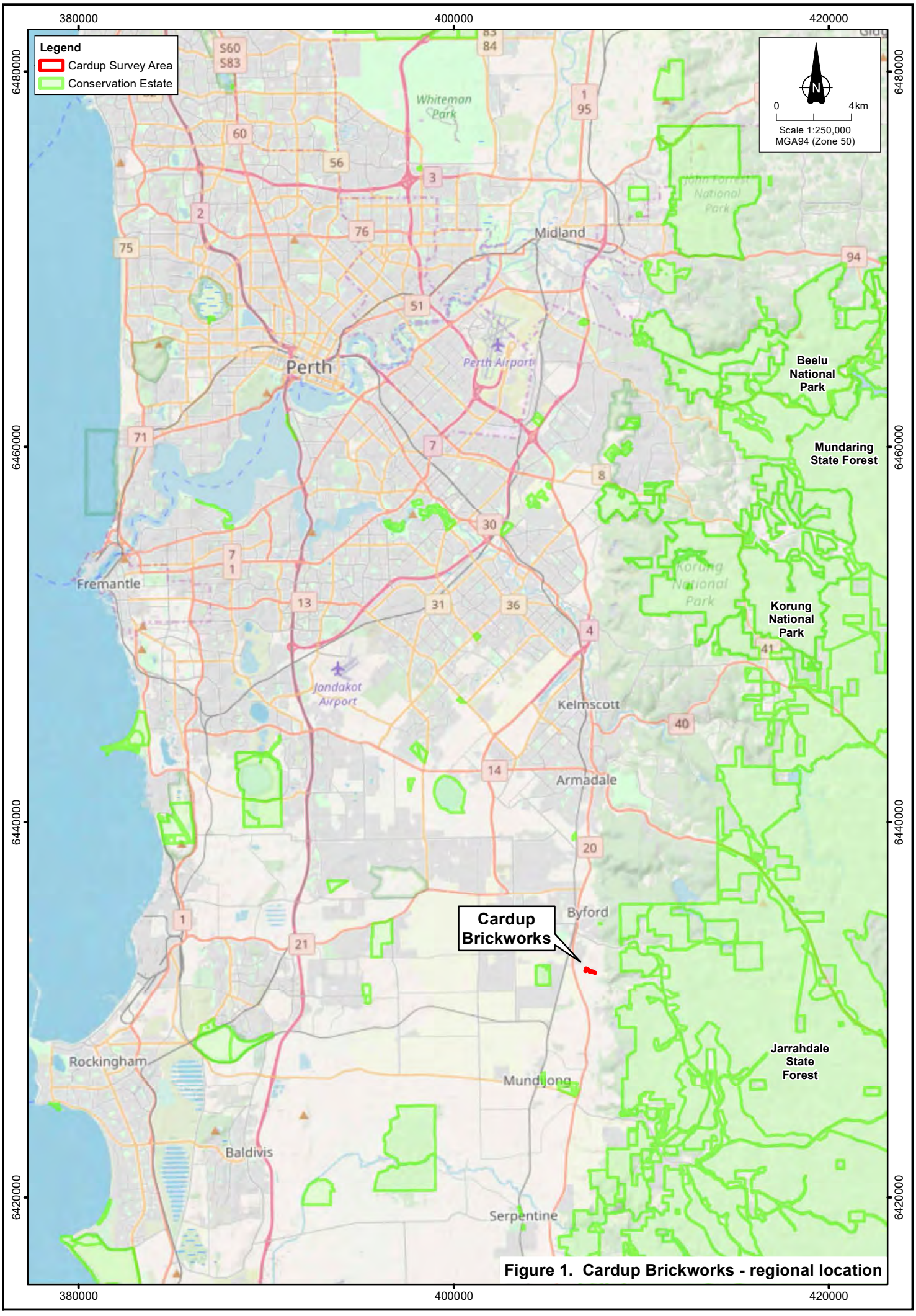

Figure 1. Cardup Brickworks - regional location

Drawn: CAD Resources ~ Tel 9246 3242 ~ URL www.cadresources.com.au ~ October 2019 ~ A4 ~ Rev: A ~ CAD Ref: a2741Fa001

Figure 2. Cardup Brickworks - study area

2. Methods

2.1 Overview

The survey conducted was a Level 1 fauna survey and targeted black-cockatoo habitat survey. This was the level of assessment commissioned by the client. The survey includes a search of available literature and databases (a 'desktop' study), and a site visit. The site visit serves to put the desk-top study into context, as well as allowing for the identification of fauna habitats and likely fauna assemblages of the site.

2.2 Guidance Documents

The fauna survey was conducted with reference to the following documents:

- Statement of environmental principles, factors and objectives (Environmental Protection Authority (EPA) 2016a)
- Environmental factor guideline – terrestrial fauna (EPA 2016b)
- Technical guidance – terrestrial fauna surveys (EPA 2016c)
- Technical Guide: terrestrial vertebrate fauna surveys for environmental impact assessment (EPA and DEC 2010)
- Referral Guidelines for Three Threatened Black-Cockatoo Species (DSEWPaC 2012)

2.3 Personnel

Ms Jenny Wilcox (*BSc.Biol./Env.Sci., Hons.Biol.*) from Western Wildlife carried out the site visit and prepared the report. Jenny Wilcox has 19 years' experience in carrying out fauna surveys in Western Australia.

2.4 Taxonomy and Nomenclature

Taxonomy and nomenclature for fauna species used in this report follow the Western Australian Museum checklists, last updated in April 2019.

2.5 Habitat Mapping

Fauna habitat mapping was undertaken using observations made by fauna personnel in the field and interpretation of aerial photography. CAD Resources produced the maps from information provided by Western Wildlife.

2.6 Literature Review

Lists of fauna expected to occur in the study area were produced using information from a number of sources. These included publications that provide information on general patterns of distribution of frogs (Tyler *et al*. 2000), reptiles (Wilson and Swan 2017, Storr *et al*. 1983, 1990, 1999 and 2002), birds (Barrett *et al*. 2003; Johnstone and Storr 1998; Johnstone and Storr 2004) and mammals (Churchill 2007, Menkhorst and Knight 2004; Van Dyck and Strahan 2008).

The databases in Table 1 were searched for fauna records in and around the study area. Some species may occur on database results that are not likely to be present in the study area, usually due either to lack of suitable habitat or that the study area is outside the known range of the species as presented in the literature (i.e. erroneous records). These species are not included in lists of expected fauna.

Table 1. Databases used in the preparation of this report.

Database	Type of records held on database	Area searched
Western Australian Museum Specimen Databases (DBCA 2007-)	Records of specimens held in the WA Museum. Includes historical data.	5km surrounding 32° 14' 39" S, 116° 00' 56" E.
Fauna Survey Returns Database (DBCA 2007-)	Records of fauna captured, observed or inferred from secondary evidence during fauna surveys.	5km surrounding 32° 14' 39" S, 116° 00' 56" E.
Birds Australia Atlas Database (DBCA 2007-)	Records of bird observations in Australia, 1998-2009.	5km surrounding 32° 14' 39" S, 116° 00' 56" E.
Birdata (DBCA 2007-)	Records of bird observations in Australia, 2010-2018.	5km surrounding 32° 14' 39" S, 116° 00' 56" E.
Quenda Community Survey Database (DBCA 2007-)	Survey of community sightings of Quenda.	5km surrounding 32° 14' 39" S, 116° 00' 56" E.
DBCA's Threatened and Priority Fauna Database (DBCA 2019)	Records of Threatened and Priority species in Western Australia, also drawing from the databases above.	10km surrounding 50H 407250 E, 6432050 N
EPBC Protected Matters Search Tool	Records on matters protected under the EPBC Act, including threatened species.	1km surrounding 32° 14' 39" S, 116° 00' 56" E.

2.7 Field Studies

2.7.1 Level 1 Fauna Survey

The field study component of a Level 1 fauna survey aims to inventory, so far as possible, the habitats and vertebrate fauna present on the site. As no trapping is undertaken, observations of fauna are restricted to larger diurnal species such as birds, and evidence of other species such as tracks, scats and diggings. The site was visited for the morning on the 5th September 2019. All vertebrate fauna encountered were recorded and notes were made on the fauna habitats present on the site.

2.7.2 Targeted Black-Cockatoo Habitat Survey

Vegetated parts of the study area were walked and assessed for the potential to support one or more of the following species:

- Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*)
- Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*)
- Baudin's Black-Cockatoo (*Calyptorhynchus baudinii*)

The study area was examined for the presence of vegetation types or plant species known to constitute black-cockatoo foraging habitat and any evidence of foraging such as chewed fruits or flowers.

The diameter at breast height (DBH) was recorded for all Wandoo (*Eucalyptus wandoo*), Flooded Gum (*Eucalyptus rudis*) Jarrah (*Eucayptus marginata*) and/or Marri (*Corymbia calophylla*) trees that had a DBH ≥ 50cm (Flooded Gum, Marri and Jarrah) or a DBH ≥ 30cm (Wandoo). These trees are considered to have a high potential to have or develop hollows and support the breeding of black-cockatoos in the long term (DSEWPaC 2012). Trees were also examined from the ground for the presence of existing hollows. Hollows were classified as 'large' if they had some potential to support black-cockatoo breeding and 'small' if considered too small for black-cockatoos, but of potential use by other bird species such as parrots and pardalotes. All trees identified were recorded with a GPS location. Any evidence of hollow use (e.g. chewing around the entrance of the hollow) was also recorded, as were the presence of Feral Bees (*Apis mellifera*).

2.8 Assessment of Conservation Significance

2.8.1 Legislative Protection for Fauna

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) is the Commonwealth Government's primary piece of environmental legislation. Listed under Part 3 of the EPBC Act are 'Matters of National Environmental Significance' (MNES); these include threatened species, threatened ecological communities and migratory species. Threatened fauna species are assessed against categories based on International Union for Conservation of Nature (IUCN) criteria.

The migratory species listed under the EPBC Act are those recognised under international agreements. These agreements are the China-Australia Migratory Bird Agreement (CAMBA), the Japan-Australia Migratory Bird Agreement (JAMBA), the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA), or species listed under the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) for which Australia is a range state.

Matters of National Environmental Significance (MNES) include the following categories:

- **Extinct in the wild (EW)**: Taxa known to survive only in captivity.
- **Critically Endangered (Cr)**: Taxa facing an extremely high risk of extinction in the wild in the immediate future.
- **Endangered (En)**: Taxa facing a very high risk of extinction in the wild in the near future.
- **Vulnerable (Vu)**: Taxa facing a very high risk of extinction in the wild in the medium-term future.
- **Migratory (Mi):** Taxa listed under international agreements to which Australia is a party.

Reports on the conservation status of most vertebrate fauna species have been produced by the federal Department of Environment and Energy (DoEE) in the form of Action Plans. An Action Plan is a review of the conservation status of a taxonomic group against IUCN categories. Action Plans have been prepared for amphibians (Tyler 1998), reptiles (Cogger *et al*. 1993), birds (Garnett *et al*. 2011) and mammals (Woinarski *et al*. 2014). These publications also use categories similar to those used by the EPBC Act. The information presented in some of the earlier Action Plans may be out of date due to changes since publication.

The *Biodiversity Conservation Act 2016* (BC Act) is State legislation that aims to conserve and protect biodiversity and biodiversity components in Western Australia, including threatened fauna. It is administered by the Department of Biodiversity, Conservation and Attractions (DBCA). In addition to threatened fauna, the BC Act has scope to protect threatened ecological communities and important habitats.

Fauna species are listed under the BC Act as threatened species using IUCN categories, or as specially protected species, as described below.

Threatened Species:

- **Extinct in the wild (EW)**: Taxa known to survive only in captivity.
- **Critically Endangered (Cr)**: Taxa facing an extremely high risk of extinction in the wild in the immediate future.
- **Endangered (En)**: Taxa facing a very high risk of extinction in the wild in the near future.
- **Vulnerable (Vu)**: Taxa facing a very high risk of extinction in the wild in the medium-term future.

Specially Protected Species:

- **Migratory (Mi)**: A subset of the migratory fauna that are known to visit Western Australia that are protected under the international agreements or treaties, excluding species that are listed as Threatened species.
- **Conservation dependent fauna (CD):** Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened
- **Other specially protected species (OS):** fauna in need of special protection to ensure their conservation.

The BC Act supersedes the *Western Australian Wildlife Conservation Act 1950* (WC Act).

Priority species are not listed under State or Commonwealth Acts. In Western Australia, DBCA maintains a list of Priority Fauna made up of species that are possibly Threatened but do not meet adequacy of survey requirements or are otherwise data deficient. There are four levels of Priority as defined by DBCA, as listed below.

- **Priority 1:** Poorly known species (on threatened lands)
- **Priority 2:** Poorly known species in few locations (some on conservation lands)
- **Priority 3:** Poorly known species in several locations (some on conservation lands)
- **Priority 4:** Rare, near threatened and other species in need of monitoring

2.8.2 Levels of Conservation Significance in this report

Five levels of conservation significance are used within this report to indicate the level of significance of fauna species, according to the following criteria:

- **Threatened (T):** Taxa listed as Extinct in the Wild, Critically Endangered, Endangered or Vulnerable under the EPBC Act and/or BC Act. These species are grouped as they are all species considered to be at risk of extinction, are often rare and are likely to be subject to on-going threatening processes.
- **Migratory (Mi):** Taxa listed as Migratory under the EPBC Act and/or BC Act, excluding those species also listed as threatened. These species are grouped as they are not necessarily rare, but may be dependent on specific habitats for a portion of their life-cycle. For these species, loss of important foraging, breeding or stop-over sites may have a disproportionately large impact on populations.
- **Specially Protected (Sp):** Taxa listed as Other Specially Protected Species or Conservation Dependent Fauna under the BC Act. These species are not necessarily rare, but may be dependent on on-going conservation to ensure their protection.
- **Priority (P):** Taxa listed as Priority by DBCA. These species are grouped as they are either conservation dependent or data deficient and in need of further survey.

- **Locally Significant (LS):** Locally significant taxa are not listed under State or Commonwealth Acts or in publications on threatened fauna or as Priority species by DBCA, but are considered by the author to potentially be of local significance because they are at the limit of their distribution in the area, they have a very restricted range or they occur in breeding colonies (e.g. some waterbirds). This level of significance has no legislative recognition and is based on interpretation of information on the species patterns of distribution. For example, the Government of Western Australia (2000) used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of Bush Forever. Recognition of such species is consistent with the aim of preserving regional biodiversity.

2.9 Likelihood of Occurrence

Fauna of conservation significance were assessed and ranked for their likelihood of occurrence in the study area, according to the following criteria:

- **Very Low:** The study area is outside the current known distribution of the species as presented in the literature; no suitable habitat was identified as being present during the field survey; for some species, individuals may occur occasionally as vagrants, especially if suitable habitat is located nearby, but the study area itself would not support the species; includes species generally accepted as being locally extinct.

- **Low:** The study area is within or just outside the current known distribution of the species, as presented in the literature; any habitat present is either limited in extent or of marginal quality at best; no recent or nearby records of the species on databases; the species is generally known to be less common in the vicinity of the study area (e.g. for inland sites, where the species usually occurs on the coast).

- **Moderate:** The study area is within the current known distribution of the species, as presented in the literature; habitat of reasonable quality was identified as being present during the field survey; some recent and/or nearby records of the species of databases;

- **High:** The study area is well within the current known distribution of the species, as presented in the literature; habitat of good quality was identified as being present during the field survey; many recent and nearby records of the species on databases.

- **Known to Occur:** The species was positively identified in the study area during this field survey, or recorded as occurring in the study area on previous recent field surveys. Note that for a species 'known to occur', the habitat may still be marginal and therefore the population may be small or the species may visit the site irregularly.

3. Survey Limitations

All fauna surveys have limitations, and not all fauna species present on the site are likely to be sampled during a survey. Fauna may not be recorded because they are rare, they are difficult to trap or observe, or because they are only present on the site for part of the year. In the case of the study area, there were no major limitations other than those in common with all surveys of this type. The key limitation of this survey was with the identification of tree hollows, in that it is not possible to ascertain hollow depth from a ground-level survey.

Table 2. Fauna survey limitations.

Potential Limitation	Extent of limitation for the fauna survey	
Competency /experience of the team carrying out the survey	Not limiting	Supervising zoologist has 19 years' experience with fauna surveys in Western Australia.
Proportion of fauna identified, recorded and/or collected.	Not limiting	No trapping was undertaken as this was a Level 1 and targeted cockatoo survey. This restricts fauna records to opportunistic observations, but this is usual for a Level 1 survey.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data	Not limiting	Fauna of the southwest are relatively well-known, and there are many records on databases for the area surrounding the study area.
Timing/weather/season/cycle	Not limiting	Weather during the field survey was warm and dry. Weather conditions are unlikely to affect the outcomes of a Level 1 fauna survey.
Disturbances (e.g. fire, flood, accidental human intervention etc.), which affected results of survey	Not limiting	No disturbances were present to affect the survey outcome.
Intensity (in retrospect, was the intensity adequate)	Not limiting	The entire site was surveyed.
Completeness (e.g. was relevant area fully surveyed)	Not limiting	All habitats present were surveyed during the fauna survey.
Resources (e.g. degree of expertise available in animal identification to taxon level)	Minor limitation	No issues with identification were encountered. Targeted cockatoo habitat survey was undertaken according to the published guidelines, however, as hollows were observed from the ground only, hollow depth could not be ascertained.
Remoteness and/or access problems	Not limiting	Entire site accessible on foot.
Availability of contextual (e.g. biogeographic) information on the region	Not limiting	Moderate to high amount of fauna information available on databases and in the literature, as areas near Perth are generally well-surveyed.

4. Fauna Habitats of the Study Area

Two broad fauna habitats were identified in the study area during the site visit:

- Eucalypt Forest
- Riparian Channel

Each habitat is described below and presented in Figure 3. There is disturbance to all of the habitats from weed invasion. Along the riparian channel in particular, the understorey consisted almost entirely of weedy species.

4.1 Riparian Channel

The riparian channel consists of a Flooded Gum (*Eucalyptus rudis*) canopy over a weedy understorey. The drainage channel leading into the brook has been included within this habitat, as the vegetation is similar and a similar suite of fauna are likely to be supported. Common weeds include patches of blackberry (*Rubus sp.)* and Arum Lily (*Zantedeschia aethiopica*). Some of the larger trees contain hollows that may be suitable for nesting and roosting fauna, and the patches of dense weedy understorey, where present, may be shelter for some ground-dwelling fauna, including the Quenda (*Isoodon fusciventer*). The brook and drainage channel leading into the brook provide damp habitats for native frog species.

4.2 Eucalypt Forest

The eucalypt forest is restricted to a few small areas along the edges of the riparian channel, representing the uncleared remnants of the upland vegetation (Plates 3 and 4). The canopy is mostly Marri (*Corymbia calophylla*) and Jarrah (*Eucalyptus marginata*), with small patches of Wandoo (*Eucalyptus wandoo*). The understorey ranges from mixed low native shrubs (including *Xanthorrhoea* sp.) to exotic weeds. Some of the larger trees contain hollows that may be suitable for nesting and roosting fauna, and the dense shrub understorey, where present, is nesting habitat for birds and shelter for ground-dwelling fauna.

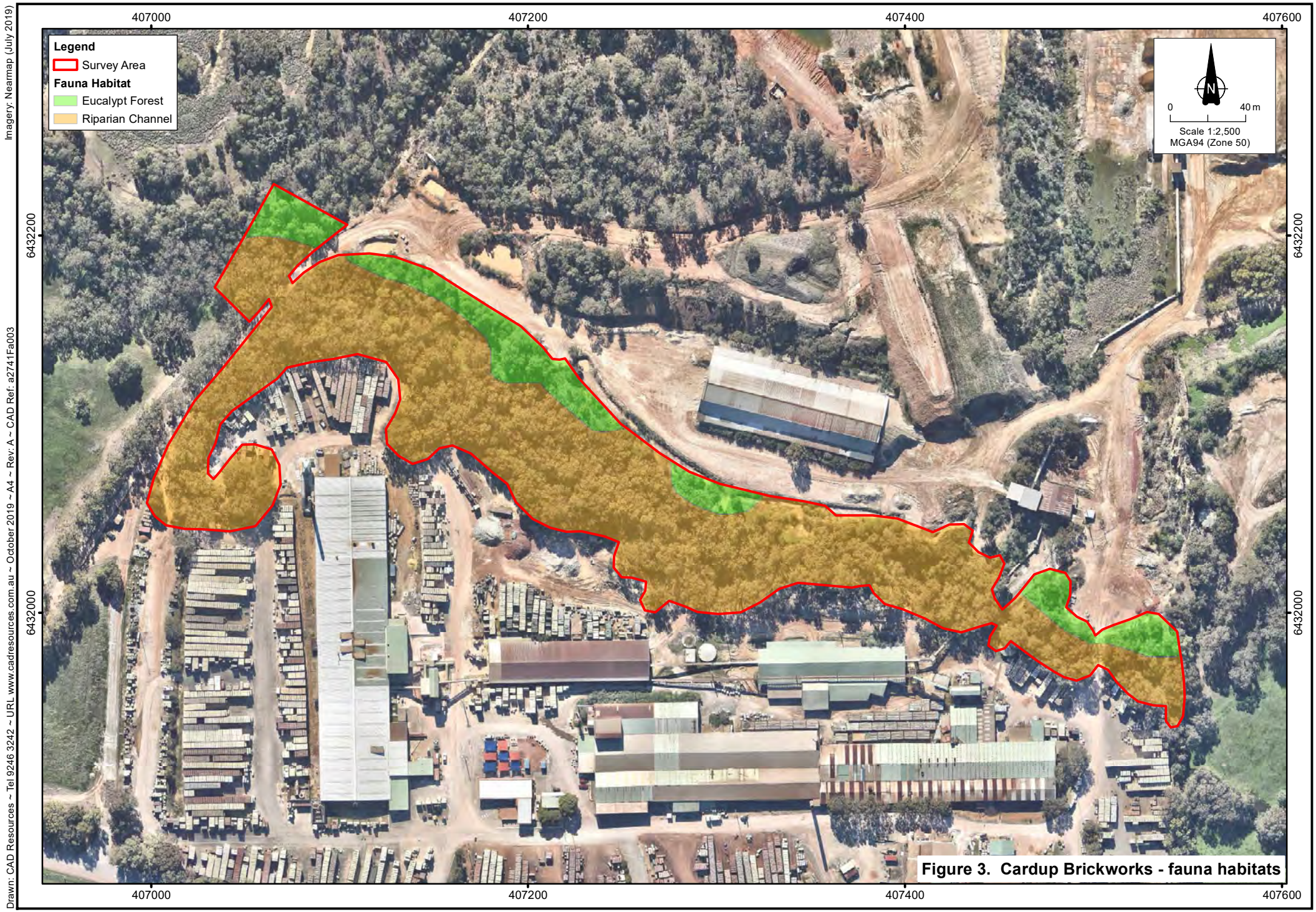

Figure 3. Cardup Brickworks - fauna habitats

Plate 1. Riparian channel.

Plate 2. Drainage channel.

Plate 3. Eucalypt forest.

Plate 4. Eucalypt forest.

4.3 Habitat Trees

A total of 97 habitat trees were identified and recorded with a GPS location. Of these, four were outside the study area boundary. All the trees recorded are listed in Appendix 1 and shown in Figure 4.

Most of the trees recorded were Flooded Gums. Of the trees identified, only four had a possible large hollow, potentially large enough for black-cockatoos, visible from the ground (Plate 5). One of these was outside the survey area. Sixteen trees had small hollows and the remainder had no visible hollows (Table 3).

Table 3. Summary of Habitat Trees.

Tree species	Tree hollows observed			Total
	None visible	Possible large hollow	Small hollows	
Marri - *Corymbia calophylla*	2	1		3
Jarrah - *Eucalyptus marginata*		1		1
Flooded Gum - *Eucalyptus rudis*	62	2	15	79
Wandoo - *Eucalyptus wandoo*	11		1	12
Planted eucalypt (?)	2			2
Total:	**77**	**4**	**16**	**97**

Plate 5. Habitat trees with possible large hollows.

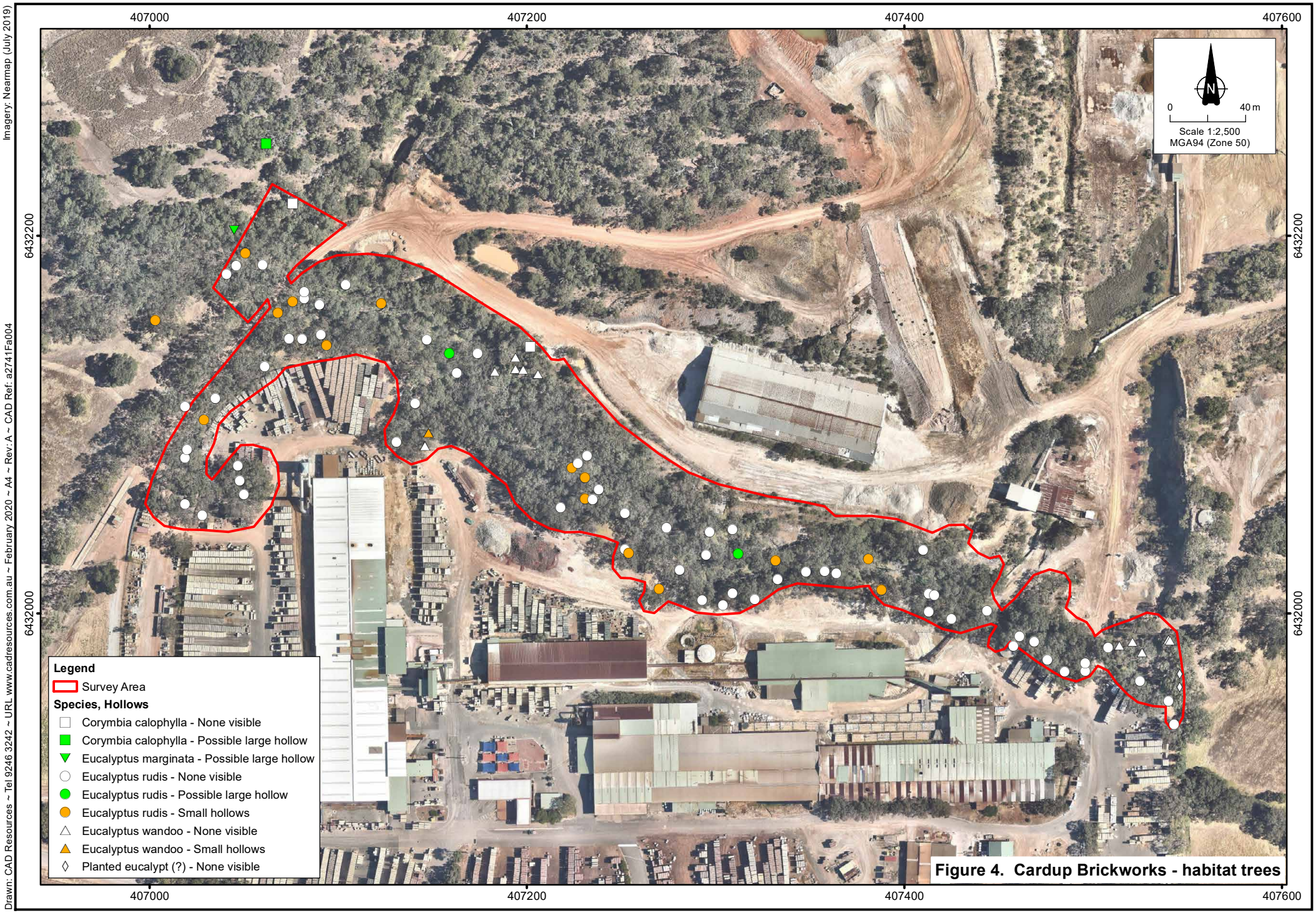

Figure 4. Cardup Brickworks - habitat trees

5. Vertebrate Fauna of the Study Area

The results of the literature review and field survey were combined to create a list of all the vertebrate fauna potentially occurring in the Survey Area (Appendices 2 - 5). Indicated in the fauna lists are all the species observed during the fauna surveys, those recorded previously in the Survey Area and those recorded in the region as part of the literature review (see Table 1 for search areas).

The potentially occurring faunal assemblage is summarised in Table 4. The overall vertebrate faunal assemblage is likely to be somewhat depauperate in comparison to similar habitats in better condition, mainly due to the weedy understory and small overall size of the remnant vegetation area.

Table 4. Summary of vertebrate fauna potentially occurring in the study area.

Taxon	Total species	Introduced species	Conservation significant species				
			Threatened	Migratory	Specially Protected	DBCA Priority	Locally Significant
Amphibians	10	0	-	-	-	-	-
Reptiles	43	0	-	-	-	2	1
Birds	91	5	3	1	1	-	29
Mammals	23	5	1	-	1	4	-
Totals:	**167**	**10**	**4**	**1**	**2**	**6**	**30**

Conservation significant fauna recorded within 10km of the Survey Area on DBCA's Threatened and Priority Fauna Database are shown in Figure 5. Note that some of the points shown have been generalized by DBCA to protect the exact location of protected species. Figure 6 shows areas of breeding sites for black-cockatoos within 12km of the study area. Note that this is from a static dataset, last updated in 2010, and the confirmed and potential breeding sites are buffered by 6km.

Records of conservation significant fauna made on this survey are shown in Figure 7. Conservation significant fauna potentially occurring in the Survey Area are discussed in the following sections and summarised in Table 5. The results of the EPBC Act Protected Matters search are given in Appendix 6.

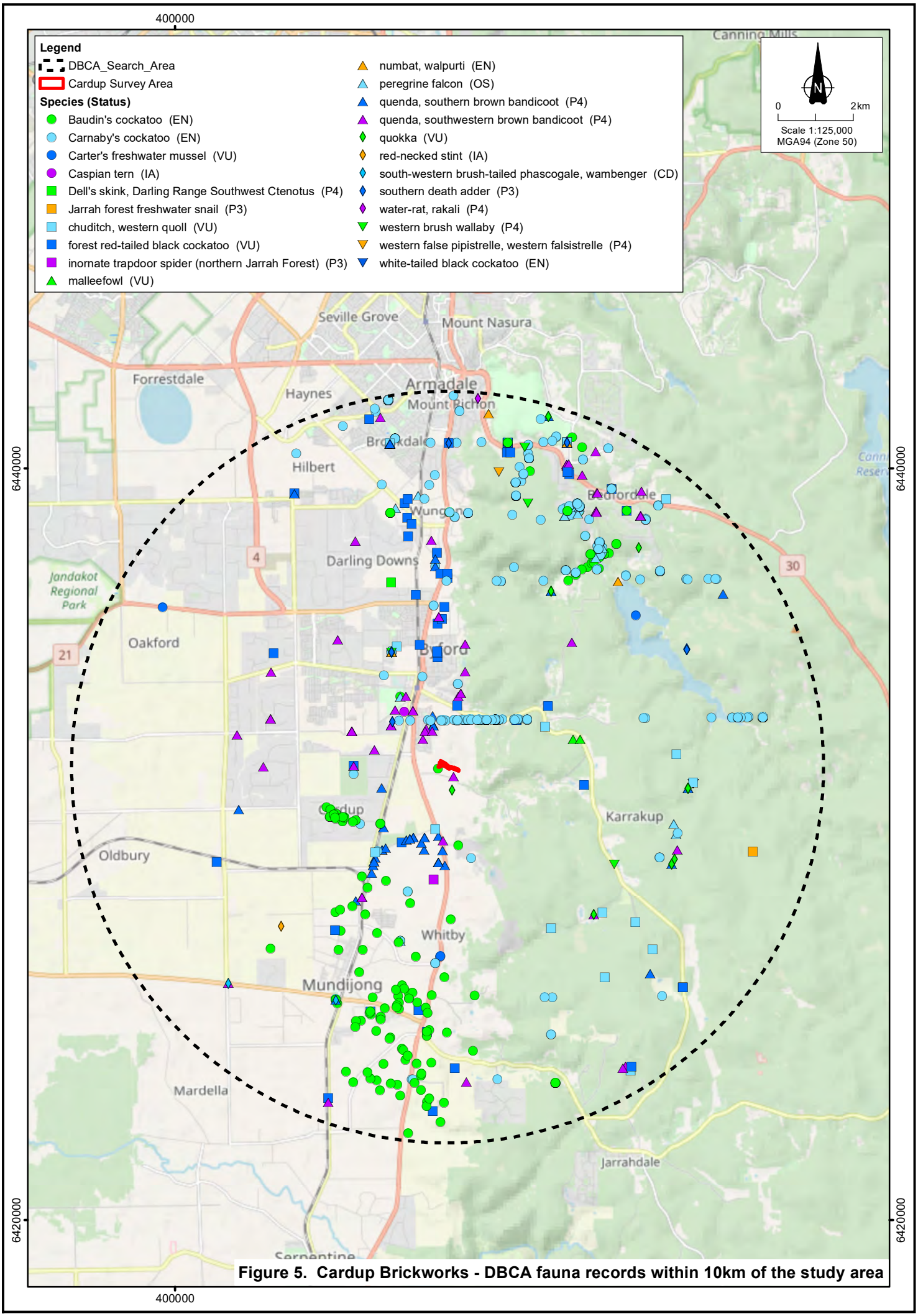

Figure 5. Cardup Brickworks - DBCA fauna records within 10km of the study area

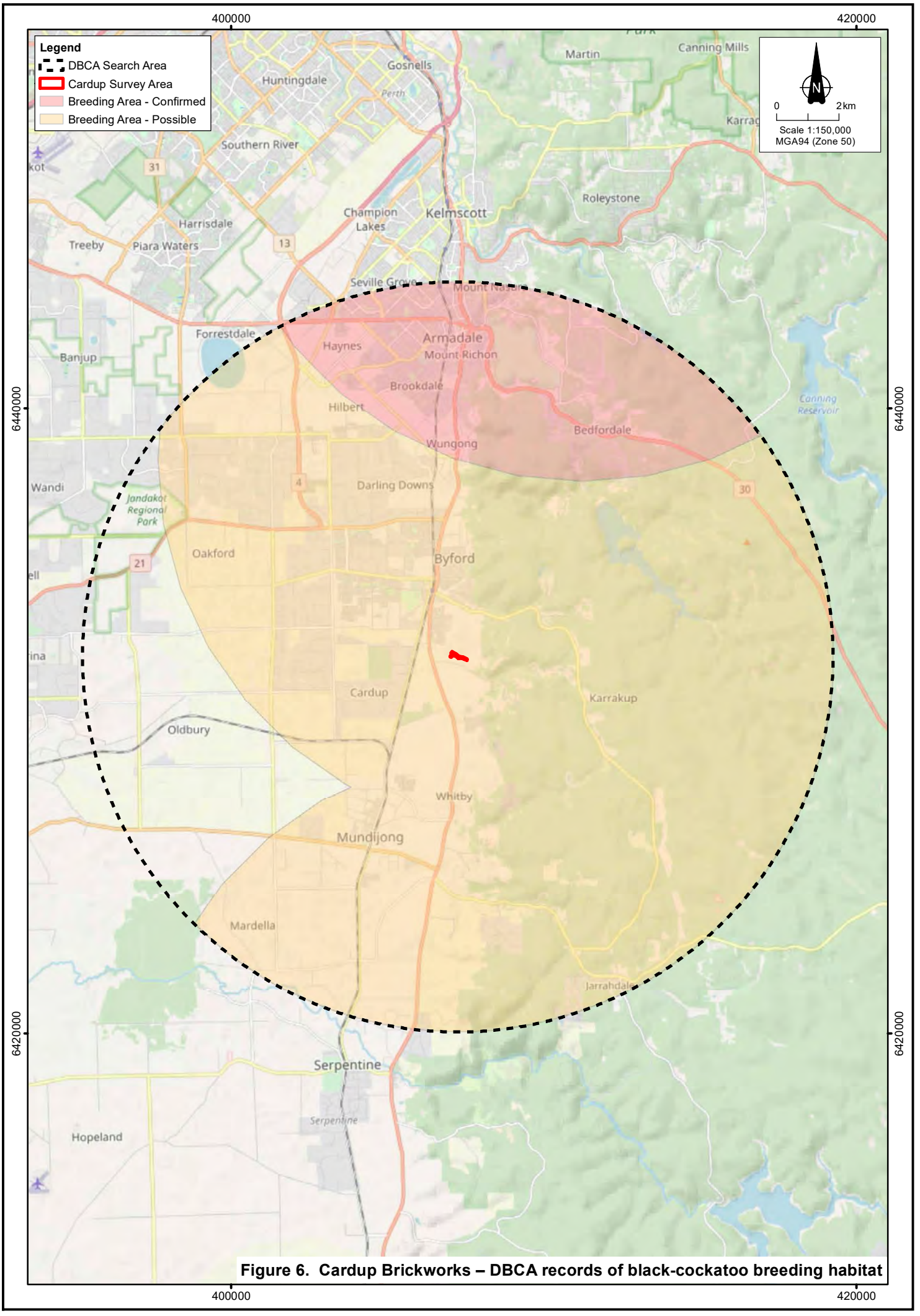

Figure 6. Cardup Brickworks – DBCA records of black-cockatoo breeding habitat

Drawn: CAD Resources ~ Tel 9246 3242 ~ URL www.cadresources.com.au ~ October 2019 ~ A4 ~ Rev: A ~ CAD Ref: a2741Fa006

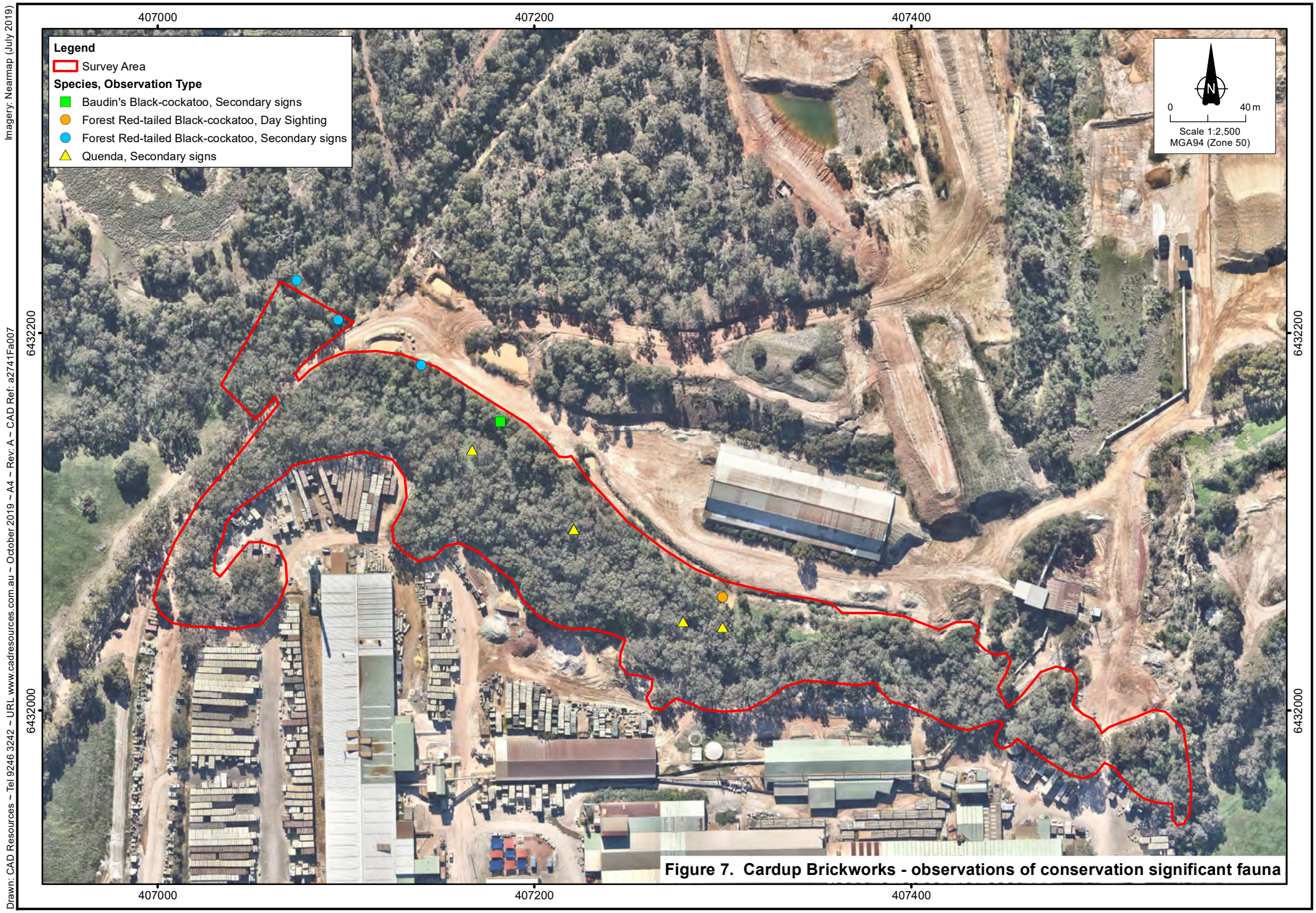

Figure 7. Cardup Brickworks - observations of conservation significant fauna

5.1 Amphibians

Ten species of frog potentially occur in the study area (Appendix 2). Two frogs were recorded opportunistically in the study area during the site visit. Cardup Brook is likely to provide breeding and foraging habitat for frogs. The drainage channel into the brook is also likely to provide habitat. Some frog species, such as the Slender Tree Frog (*Litoria adelaidensis*) and Motorbike Frog (*Litoria moorei*) require permanent water or permanently damp situations, and are likely to be restricted to the brook, if present. Burrowing Frogs such as the Moaning Frog (*Heleioporus eyrei*) and Banjo Frog (*Limnodynastes dorsalis*) breed around seasonal water, but can range widely in terrestrial habitats during the non-breeding season.

5.1.1 Amphibians of Conservation Significance

No frogs of conservation significance are likely to be present in the study area.

5.2 Reptiles

Although 43 species of reptile have been listed as potentially occurring in the study area, it is likely that the actual number of species present is much smaller (Appendix 3). The study area is unlikely to support an intact reptile assemblage as the site is relatively small and the understorey is mostly weedy. The list in Appendix 3 remains relatively large, as it is not possible to ascertain which of the potentially occurring species do or do not occur, as they all occur in the local area. The two species observed opportunistically, the Fence Skink (*Cryptoblepharus buchananii*) and Bobtail (*Tiliqua rugosa*) are both generalist species that can tolerate disturbed habitats. Reptiles forage and shelter under fallen timber, in tree crevices, under loose bark on trees, and in leaf litter.

5.2.1 Reptiles of Conservation Significance

There are three reptiles of conservation significance that may occur in the study area. Each species is listed and discussed below.

Priority Fauna

Southern Death Adder *Acanthophis antarcticus*
This species is listed as Priority 3 by DBCA.

Dell's Ctenotus *Ctentotus delli*
This species is listed as Priority 4 by DBCA.

The **Southern Death Adder** has been recorded nearby on DBCA's Threatened and Priority Fauna Database (Figure 5). In the vicinity of the study area, this species is locally restricted to the Darling Range in a small area between Mt Helena and Jarrahdale. An ambush predator, it shelters under leaf litter and low vegetation, favouring woodlands near granite outcrops and densely vegetated creeks (Bush *et al*. 2010). Although the habitat in the study area may once have been suitable for this species, the understorey may now be too degraded to support the Southern Death Adder.

There is a single record of **Dell's Ctenotus** within 10km of the study area on DBCA's Threatened and Priority Fauna Database (Figure 5), from the Wungong River in 1969. This lizard is absent from the Swan Coastal Plain, occurring uncommonly in the Darling Range where it inhabits Jarrah and Marri woodlands (Bush *et al*. 2010). Although the Eucalypt Forest habitat is potentially suitable, the patch of habitat remaining is small and degraded, and the study area is at the western edge of this species' range. This species has a very low likelihood of occurring.

Locally Significant

Carpet Python (southwest pop[n]) *Morelia spilota imbricata*

The **Carpet Python** occurs in a range of habitats, though it appears to require large tracts of bushland in order to persist (Bush *et al*. 2007). Although it potentially occurs in the general area, it is possible that this species is locally extinct in the remnant vegetation that remains in the study area. There are no records of the Carpet Python in the local area on DBCA's Threatened and Priority Fauna Database.

4.3 Birds

There are 91 species of bird that have the potential to occur in the study area, of which 22 were recorded during the site visit (Appendix 4). Although 91 species are listed, the small size of the study area means that only a smaller subset are likely to be present at any one time. For wide-ranging species, such as many birds of prey, the study area would represent only a small portion of a much larger home-range.

Many birds are highly mobile, and will move into and out of the study area on a daily or seasonal basis. For example, when flowering, the eucalypt canopy is likely to attract honeyeaters. Trees with hollows may support nesting parrots, pardalotes, kingfishers or owls. Although many waterbirds are known from the region, only the most common have been included in Appendix 4. The Riparian Channel is likely to support just a few common species, and does not provide habitat for shorebirds or for birds that favour dense beds of rushes.

4.3.1 Birds of Conservation Significance

There are 33 birds of conservation significance that have either been recorded or may potentially occur in the study area. Each species is listed in the boxes below, and discussed. A number of bird species occur on databases but would not occur in the study area, as their habitats are absent, and these have been excluded from the list in Appendix 4. These include shorebirds (such as sandpipers and stints) and seabirds. The Malleefowl is represented by two records on DBCA's Threatened and Priority Fauna Database (Figure 5), but has not been included in the discussion below, as it is locally extinct in the area.

Threatened Species

Forest Red-tailed Black-Cockatoo *Calyptorhynchus banksii naso*
This cockatoo is listed as Vulnerable under the BC Act and the EPBC Act.

Baudin's Black-Cockatoo *Calyptorhynchus baudinii*
This cockatoo is listed as Vulnerable under the BC Act and the EPBC Act.

Carnaby's Black-Cockatoo *Calyptorhynchus latirostris*
This cockatoo is listed as Endangered under the BC Act and EPBC Act.

The **Forest Red-tailed Black-Cockatoo** is endemic to the southwest of Western Australia. It occurs in Jarrah, Marri and Karri forests between about Gingin to the north, Albany to the south, and east to Mt Helena, North Bannister and Rocky Gully (Johnstone and Storr 1998). This species also ranges irregularly onto the Swan Coastal Plain to feed on the seeds of the introduced Cape Lilac (*Melia azerdarach*). It is patchily distributed through its range (Johnstone and Storr 1998). The population size is estimated to be 15,000 birds (Johnstone and Kirkby 1999). The Forest Red-tailed Black-Cockatoo inhabits the Jarrah, Marri and Karri forests of the southwest, where the annual rainfall is on average 600mm or more. It may also occur in other woodlands, including Tuart, Wandoo and Flooded Gum (*Eucalyptus rudis*). Groups of up to 50 birds roost in trees overnight, dispersing into smaller flocks when ranging out to forage during the day. Roosts may be on roadsides, paddocks or forested areas (Johnstone and Kirkby 1999). Forest Red-tailed Black Cockatoos feed primarily on the seeds of Marri and Jarrah, but also feed on the seeds of Blackbutt (*Eucalyptus patens*), Forest Sheoak (*Allocasuarina fraseriana*), Snottygobble (*Persoonia longifolia*) and Cape Lilac (Johnstone and Storr 1998).

Unlike Carnaby's Black-Cockatoo, this species does not undertake regular seasonal movements. Instead, this species exhibits irregular population fluctuations, perhaps as a response to food availability. The Forest Red-tailed Black Cockatoo nests in hollows in Karri (*Eucalyptus diversicolor*), Marri, Jarrah, Bullich (*Eucalyptus megacarpa*) and Wandoo (*Eucalyptus wandoo*) (Johnstone and Storr 1998, DSEWPaC 2012). However, they have generally been found to prefer nesting in large (mean DBH of 90cm) Marri trees (Johnstone *et al*. 2013). Eggs are laid in October and November (Johnstone and Storr 1998). Evidence of this species foraging in the study area was recorded during the site visit (Plate 6), and this species was also observed during the site visit (Figure 7). Although possible, it is very unlikely that this species currently breeds in the study area. The Forest Red-tailed Black-Cockatoo is confirmed as foraging in the study area, and there is the potential that birds breeding nearby may forage in the study area.

Plate 6. Marri nuts chewed by Forest Red-tailed Black-Cockatoos.

Carnaby's Black-Cockatoo is endemic to the southwest of Western Australia, occurring mostly in the wheatbelt but also on the Swan Coastal Plain and wetter southwest (Johnstone and Storr 1998). The population size is estimated to be 40,000 birds (or possibly between 10,000 – 60,000) (Garnett *et al*. 2011). Typically, Carnaby's Black-Cockatoo breeds in the wheatbelt region of Western Australia, nesting in large hollows in smooth-barked eucalypts such as the Salmon Gum (*Eucalyptus salmonophloia)* and Wandoo (*Eucalyptus wandoo*). However, it has started breeding in areas further west and south than its traditional breeding range, including areas in the Darling Range and on the Swan Coastal Plain (Johnstone *et. al*. 2005, Johnstone *et al*. 2011). Breeding has been recorded from areas such as Baldivis, Lake Clifton, Yanchep and near Bunbury, with these nests always in Tuart (*Eucalyptus gomphocephala*)(Johnstone *et al*. 2011). Eggs are laid from early July to mid-October (Johnstone and Storr 1998). Some of the Carnaby's Black-Cockatoo population is resident (particularly in wetter areas) and some of the population moves west and south towards the coast after breeding (Johnstone and Storr 1998). Between February and September, large flocks of birds aggregate in feeding flocks on the northern Swan Coastal Plain (Johnstone *et al*. 2011). These birds are foraging mainly in heaths, *Banksia* woodlands and pine plantations, and can be in large numbers of up to 7,000 birds (Johnstone e*t al*. 2011). On the southern Swan Coastal Plain flocks are smaller (200 – 1,200 birds) and these birds forage on vegetation over a wide area (Johnstone *et al*. 2011).

Vegetation on the Swan Coastal Plain and adjacent escarpment is an important resource, with 8,000 – 10,000 birds estimated to use the area during the non-breeding season (Burnham *et al*. 2010). Carnaby's Black-Cockatoo forage on the seeds of a range of plant species, but are particularly attracted to proteaceous heaths, *Banksia* and *Eucalyptus* woodlands and pine plantations (Johnstone and Storr 1998). On the Swan Coastal Plain, important food plants include *Banksia attenuata*, *B. menziesii*, *B. grandis*, *B. ilicifolia*, *B. sessilis*, *B. prionotes*, Marri (*Corymbia calophylla*) and Jarrah (*Eucalyptus marginata*) (Shah 2006). In breeding areas it is important to have sufficient foraging resources in close proximity to nest hollows. Carnaby's Black-Cockatoo generally roosts in tall native or introduced eucalypts or pines in riparian habitats or near permanent water (DEE 2017, Burnham *et al*. 2010). Although not recorded during the site visit, there are many records of this species on DBCA'S Threatened and Priority Fauna Database (Figure 5). Carnaby's Black-Cockatoo is highly likely to forage in the Eucalypt Forest habitat, favouring Marri. Although possible, it is very unlikely that this species currently breeds in the study area.

Baudin's Black-Cockatoo is endemic to the southwest of Western Australia and is more common in the deep south-west (Johnstone and Storr 1998). The population size is estimated to be 10,000 - 15,000 birds (Garnett *et al*. 2011). Baudin's Black-Cockatoo has declined primarily due to persecution by orchardists and loss of habitat due to wildfires and vegetation clearance in their range (Johnstone and Storr 1998). Baudin's Black-Cockatoos breed in forests of Karri, Marri and Jarrah in the deep southwest, where the annual rainfall is on average more than 750mm. Breeding occurs in late winter to spring (about August to November), using a large hollow in a eucalypt, generally in Karri, Marri or Wandoo (Johnstone and Storr 1998). The hollows used are usually 30 - 40cm in diameter and more than 30cm deep. Breeding occurs as far north as Lowden (near Donnybrook), with an isolated breeding record from Serpentine (Johnstone and Kirkby 2008).

Outside of the breeding season Baudin's Black-Cockatoo may gather into large foraging flocks. In the non-breeding season this species ranges more widely, foraging primarily in habitats that contain Marri, and their distribution is probably defined by where Marri trees occur. Baudin's Black-Cockatoos feed mainly on the seeds of eucalypts, with the majority of their diet consisting of Marri seeds. They also feed on seeds from other plants (e.g. Jarrah, *Banksia*, *Hakea* or commercial orchard crops such as apples and pears) and take some invertebrate material by stripping bark from trees (Johnstone and Storr 1998, Johnstone *et al*., 2005). Roosting habitat is generally in the tallest trees in riparian habitats, near permanent water or in sheltered gullies (Johnstone and Kirkby 2008). Although unlikely to breed in the study area, this species was recorded foraging on Marri during the site visit (Plate 7, Figure 7). Baudin's Black-cockatoo is likely to be a seasonal foraging visitor to the study area.

Plate 7. Marri nuts chewed by Baudin's Black-Cockatoo.

Specially Protected Species

Peregrine Falcon *Falco peregrinus*
This falcon is listed as Other Specially Protected Fauna under the BC Act.

The **Peregrine Falcon** is a widespread bird of prey. This falcon nests mainly on ledges on cliffs, rocky outcrops and quarries, and it may also use tall trees (Johnstone and Storr 1998). The Peregrine Falcon has been recorded within 10km at Wungong Gorge and Bungendore Park on DBCA's Threatened and Priority Fauna Database (Figure 5). If present, the Peregrine Falcon may forage on the forest edges, however, the study area is unlikely to be important for this species unless a pair were found to be nesting.

Migratory Species

Fork-tailed Swift *Apus pacificus*
This species is listed as migratory under the BC Act and EPBC Act.

The **Fork-tailed Swift** is a non-breeding visitor to Australia between September and April (Boehm 1962). While it can be common further north, in southwest Australia this species is generally scarce (Johnstone and Storr 1998). The bird is primarily observed foraging for insects in proximity to cyclonic weather (Boehm 1962). Although a migratory species, the Fork-tailed Swift has a large range, a large population that appears to be stable Birdlife International 2019). The Fork-tailed Swift is a largely an aerial species and is unlikely to be affected by changes to the study area.

Locally Significant Fauna

Square-tailed Kite	*Hamirostra isura*
Whistling Kite	*Haliastur sphenurus*
Brown Goshawk	*Accipiter fasciatus*
Collared Sparrowhawk	*Accipiter cirrocephalus*
Little Eagle	*Aquila morphnoides*
Wedge-tailed Eagle	*Aquila audax*
Brown Falcon	*Falco berigora*
Painted Button-Quail	*Turnix varia*
Common Bronzewing	*Phaps chalcoptera*
Splendid Fairy-wren	*Malurus splendens*
Red-winged Fairy-wren	*Malurus elegans*
White-browed Scrubwren	*Sericornis frontalis*
Weebill	*Smicrornis brevirostris*
Inland Thornbill	*Acanthiza apicalis*
Western Thornbill	*Acanthiza inornata*
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*
White-naped Honeyeater	*Melithreptus chloropsis*
New Holland Honeyeater	*Phylidonyris novaehollandiae*
White-cheeked Honeyeater	*Phylidonyris nigra*
Tawny-crowned Honeyeater	*Phylidonyris melanops*
Yellow-plumed Honeyeater	*Ptilotula ornata*
Western Wattlebird	*Anthochaera lunulata*
Scarlet Robin	*Petroica multicolor*
Varied Sittella	*Daphoenositta chrysoptera*
Golden Whistler	*Pachycephala pectoralis*
Grey Shrike-Thrush	*Colluricincla harmonica*
Black-faced Woodswallow	*Artamus cinereus*
Dusky Woodswallow	*Artamus cyanopterus*
Grey Currawong	*Strepera versicolor*

There are 29 bird species of local significance that potentially occur in the study area. These birds are listed in Bush Forever and considered to be of significance on the Swan Coastal Plain (Government of Western Australia 2000). The species may be either wide-ranging species with a reduced population on the Swan Coastal Plain, or habitat specialists with a reduced distribution on the Swan Coastal Plain (Government of Western Australia 2000). Of these locally significant species, only the Weebill was recorded during the site visit (Appendix 4). Seven birds of prey are listed above. Even if present, birds of prey would only use the study area as part of a much larger home-range.

Many of these locally significant species are common in other parts of their distribution, but populations on the Swan Coastal Plain have decreased in abundance due to habitat loss (Government of Western Australia 2000). Any future development of the study area is likely to result in habitat loss for some of these species.

5.4 Mammals

There are 23 species of mammal that have the potential to occur in the study area, of which 18 are native and five introduced (Table 7). Two native species, the Western Grey Kangaroo (*Macropus fuliginosus*) and the Quenda (*Isoodon fusciventer*) were recorded during the site visit. A large proportion of the mammal species on the list in Table 6 are bats. Bats may roost in crevices and loose bark of *Banksia* trees, or in hollows in Eucalypt trees. The Common Brushtail Possum (*Trichosurus vulpecula*) is also likely to use tree hollows in the study area for shelter. A suite of small and medium-sized mammals are likely to be locally extinct.

5.4.1 Mammals of Conservation Significance

There are five mammals of conservation significance that may occur in the study area. Each species is listed and discussed below. There are several mammals listed on DPAW's Threatened and Priority Fauna Database for the area that have been excluded from the discussion below, as they are locally extinct in the area. This includes the Numbat (*Myrmecobius fasciatus*), Woylie (*Bettongia penicillata*) and Quokka (*Setonyx brachyurus*). Some of these species may occur in populations nearby on the more heavily-forested Darling Range, but are not likely to occur in the study area.

Threatened Fauna

Chuditch *Dasyurus geoffroii*
This species is listed as Vulnerable under the BC Act and the EPBC Act.

The **Chuditch** used to occur across much of the continent, but is now restricted to the southwest of Western Australia. It is vulnerable to predation by foxes, and increases in areas where fox control in undertaken (Burbidge 2004). Although they used to occupy a range of habitats, the majority of Chuditch now occur in the Jarrah forest with some wheatbelt populations in drier woodlands, heath and mallee shrublands (Van Dyck and Strahan 2008; Orrell and Morris 1994). There are several records within 10km on DBCA's Threatened and Priority Database (Figure 5), the most recent from 2010. It is likely that a population of Chuditch is present in the region, however, this species is unlikely to be resident in the study area. If present, it is likely to occur as an occasional dispersing visitor between larger areas of native vegetation to the east and west.

Specially Protected Fauna

Brush-tailed Phascogale *Phascogale tapoatafa*
This species is listed as Conservation Dependent under the BC Act.

The **Brush-tailed Phascogale** is a nocturnal carnivore that occurs in open forests and woodlands with a sparse understorey (Van Dyck and Strahan 2008). It has declined due to habitat loss and fragmentation. Females have been found to have non-overlapping home ranges of about 20 – 40 ha, and males have or 100 ha home ranges that may overlap with other males or females (Van Dyck and Strahan 2008). Nest sites include tree hollows and stumps, and within a year an individual phascogale may use up to 40 different sites. There are two records of this species from Mundijong on DBCA's Threatened and Priority Fauna Database (Figure 5). The study area is unlikely to regularly support this species, but individuals may disperse through on occasion.

Priority Fauna

Quenda (Southern Brown Bandicoot) *Isoodon fusciventer*
This species is listed as Priority 4 by DBCA.

Western Brush Wallaby *Notamacropus irma*
This wallaby is listed as Priority 4 by DBCA.

Western False Pipistrelle *Falsistrellus mackenziei*
This bat is listed as Priority 4 by DBCA.

Water-rat *Hyrdomys chrysogaster*
This species is listed as Priority 4 by DBCA.

The **Quenda** is generally common in the local area, and has been recorded from multiple nearby sites on DBCA's Threatened and Priority Fauna Database (Figure 5). The characteristic diggings of this species were recorded in the study area during the site visit (Figure 7). It favours areas with dense understorey, including weedy vegetation, and is often particularly common in dense wetland vegetation. The Quenda is likely to be resident in the study area, with individuals in the study area likely to be part of a larger population, extending into other remnant vegetation in the local area.

The **Western Brush Wallaby** occurs in areas of forest or woodland where there is a dense, shrubby understorey. The Western Brush Wallaby has been recorded nearby on DBCA's Threatened and Priority Fauna Database (Figure 5). The home-range size of one individual has been estimated at about 9.9ha for males and 5.3ha for females (Bamford and Bamford 1999), indicating that even if present, the study area would support less than one individual. However, it is likely that the understory vegetation is too degraded to support this species, although it may occasionally disperse through the site.

The **Western False Pipistrelle** is a small insectivorous bat that inhabits forests and woodlands, including Tuart forest, Jarrah forest and *Banksia* woodland (Churchill 2007). These bats roost in groups in tree hollows (Churchill 1998). There is a single record of this species within 10km of the study area on DBCA's Threatened and Priority Fauna Database (Figure 5), however, records of bats are generally few as sampling for them requires a specialised approach. This bat potentially forages or roosts in the woodlands of the study area.

The **Water-Rat** generally occurs around permanent water, where it forages on a variety of prey including fish, large crustaceans and insects (Van Dyck and Strahan 2008). There are three records of this species within 10km on DBCA's Threatened and Priority Fauna Database (Figure 5), including one from 2004 in Armadale. It is possible that this species occurs in the study area on occasion.

5.5 Invertebrates

This report is primarily concerned with vertebrate fauna. In general, the invertebrate fauna is far less well known than the vertebrate fauna, while being far more numerous. No survey for invertebrate fauna was undertaken, however, three invertebrates of conservation significance was listed on DBCA's Threatened and Priority Database within 10km of the study area (Figure 5).

5.5.1 Invertebrates of Conservation Significance

Three invertebrates of conservation significance was listed on DBCA's Threatened and Priority Database within 10km of the study area, as listed and discussed below.

Threatened Fauna

Carter's Freshwater Mussel *Westralunio carteri*
This species is listed as Vulnerable under the BC Act and EPBC Act.

Carter's Freshwater Mussel has been recorded nearby on DBCA's Threatened and Priority Fauna Database (Figure 5), including in the Harvey River and Mandejal Brook at Whitby, and the Serpentine River in Oakford. This long-lived species has a declining population, principally due to a decline in its river habitats. It is unknown but possible that this species occurs in Cardup Brook, or downstream of Cardup Brook in the study area.

Priority Fauna

Inornate Trapdoor Spider *Euoplos inornatus*
This species is listed as Priority 3 by DBCA.

Jarrahdale Freshwater Snail *Glacidorbis occidentalis*
This species is listed as Priority 3 by DBCA.

The **Inornate Trapdoor Spider** occurs on the eastern edge of Swan Coastal Plain, with most records from the Darling Scarp. Although it is possible that this species occurs in the eucalypt forest habitat, much of the understory vegetation is disturbed and weedy, with the leaf litter required for burrow construction absent. There is a single record within 10km of the study area on DBCA's Threatened and Priority Fauna Database, at Whitby in 2006 (Figure 5).

The **Jarrahdale Freshwater Snail** is a tiny snail of up to 1.2mm, that inhabits the gravel riffle sections of intermittent streams (Ponder *et al*. 2019). There is a single record within 10km of the study area on DBCA's Threatened and Priority Fauna Database, at Jarrahdale in 1982 (Figure 5). It is possible that this species occurs in Cardup Brook, however, the brook habitat within the study area lacks gravel riffle zones.

6. Conclusions

6.1 Faunal Assemblage

The predicted faunal assemblage includes up to ten frogs, 43 reptiles, 91 birds and 18 native mammals and 5 introduced mammals. As the study area is small and the understory degraded, the actual number of species present is likely to be a smaller subset of this.

6.2 Conservation Significant Fauna

Forty-three conservation significant fauna have been recorded or potentially occur in the Study Area, and have been summarised in Table 5. The species have been grouped into their conservation significance categories and discussed below.

1. Threatened species.

Four threatened species potentially occur in the Study Area, of which two were recorded:

- Forest Red-tailed Black-cockatoo (*Calyptorhynchus latirostris banksii*) - **Recorded**
- Carnaby's Black-cockatoo (*Calyptorhynchus latirostris*)
- Baudin's Black-cockatoo (*Calyptorhynchus baudinii*) – **Recorded**
- Chuditch (*Dasyurus geoffroii*)

Threatened species are those that are considered in danger of extinction as their populations have declined and/or are still declining, and their total population size is small and/or fragmented and/or geographically restricted. Sites that support these species may be important for their long-term conservation, particularly if the site supports a resident breeding population.

All three black-cockatoo species are likely to be foraging visitors to the study area, with foraging by Baudin's Black-cockatoo and the Forest Red-tailed Black-cockatoo confirmed. The Eucalypt Forest habitat contains Marri, a favoured food plant for all species, however, the area of foraging habitat present is small at about 0.66ha. The Riparian Channel habitat is unlikely to be important for foraging. Although potential breeding habitat is present, only four trees with possible large hollows were recorded and it is unlikely that black-cockatoos currently breed in the study area. No signs of black-cockatoo roosting were detected.

The Chuditch is known from the surrounding area. As Chuditch have large home ranges, the study area is too small to support even a single individual, but may be a dispersal corridor for the species.

2. Migratory species.

One Migratory species potentially occurs in the Study Area:

- Fork-tailed Swift (*Apus pacificus*)

Migratory species are not always present at a site, but a particular site may have significance as a seasonal or ephemeral foraging, breeding or shelter area. Impacts to these sites may then impact the population both within the site and further afield.

The Fork-tailed Swift is a Migratory species that is thought to be almost entirely aerial when visiting Australia, so the Study Area is not likely to provide important habitat for this species.

3. Specially Protected species.

Two Specially Protected species potentially occur in the Study Area:

- Peregrine Falcon (*Falco peregrinus*)
- Brush-tailed Phascogale (*Phascogale tapoatafa*)

The Peregrine Falcon is likely to occur as a foraging visitor. The Study Area is unlikely to be important for this species as its population is large and secure, and its favoured breeding habitat is absent. The Brush-tailed Phascogale may possibly disperse through the study area, but is unlikely to be resident.

4. Priority species

Six Priority species potentially occur in the Study Area, of which one was recorded:

- Southern Death Adder (*Acanthophis antarcticus*)
- Dell's Ctenotus (*Ctenotus delli*)
- Quenda (*Isoodon fusciventer*) - **Recorded**
- Western Brush Wallaby (*Notamacropus irma*)
- Western False Pipistrelle (*Falsistrellus mackenziei*)
- Water-rat (*Hydromys chrysogaster*)

The Quenda was recorded during the site visit, and is likely to be resident in the dense weedy vegetation in the Riparian Channel habitat. The Western False Pipistrelle may occur, roosting in tree hollows, as it is known from the region. The remaining species have only a low likelihood of occurrence, as the understory vegetation is weedy and degraded.

5. Locally significant species

There are 30 locally significant species that may occur, 29 birds and a reptile; the Carpet Python (*Morelia spilota imbricata*) (Table 5). One of the birds, the Weebill (*Smicrornis brevirostris*) was recorded during the site visit. Although some of these species may occur, it is likely that the importance of the study area for many species is as an ecological linkage.

6.3 Important Habitats

All habitats have some importance in that they support native fauna, however, habitats may be of particular importance if they:

- support very diverse or unique faunal assemblages
- are restricted or rare in the region (and thus the faunal assemblages are restricted or rare)
- are refugia (e.g. from drought or fire)
- provide ecological linkage
- support conservation significant fauna

The habitats in the Study Area are common and widespread in the subregion. The Riparian Channel habitat around Cardup Brook may have some local importance as refugia for fauna, where permanently damp areas are likely to be present all year. As a whole, the habitats are likely to provide an ecological linkage function as part of a regionally significant contiguous bushland/wetland linkage identified by Bush Forever (Government of Western Australia 2000). On a local scale, the habitats are likely to provide linkage east-west along Cardup Brook.

Baudin's Black-cockatoo and the Forest Red-tailed Black-cockatoo were recorded foraging in the Eucalypt Forest habitat. Although this habitat type is important for foraging black-cockatoos, the overall size of the area is small at less than 1ha. It is unlikely that black-cockatoos currently nest in the study area, and only four trees with possible large hollows were identified.

Table 5. Summary of conservation significant fauna.

Key to status: Cr = Critically Endangered, En = Endangered, Vu = Vulnerable, Mi = Migratory, OS = Other Specially Protected, CD = Conservation Dependent, P1 – P4 = Priority 1 – 4, LS = Locally Significant.

Species	Conservation Status				Records within 10km (DBCA 2018, see also Figure 5)	Likelihood of Occurrence	Likely Status in Study Area	Potential habitat use in the Study Area
	EPBC Act	BC Act	DBCA Priority	Locally significant				
Threatened Species								
Calyptorhynchus banksii naso **Forest Red-tailed Black Cockatoo**	Vu	Vu	-	-	**Recorded on site visit.** Many records on DBCA database.	Known to occur	Foraging visitor	• All habitats
Calyptorhynchus latirostris **Carnaby's Black-Cockatoo**	En	En	-	-	Many records on DBCA database.	High	Seasonal foraging visitor	• All habitats
Calyptorhynchus baudinii **Baudin's Black-Cockatoo**	Vu	Vu	-	-	**Recorded on site visit.** Many records on DBCA database.	Known to occur	Seasonal foraging visitor	• All habitats
Dasyurus geoffroii **Chuditch**	Vu	Vu	-	-	16 records; including Armadale (1974), Gordon (1980 – 1995) and Byford (1995).	Moderate	Occasional dispersing visitor	• All habitats
Migratory Species								
Apus pacificus **Fork-tailed Swift**	Mi	Mi	-	-	No records within 10km.	Moderate	Non-breeding visitor	• All habitats
Specially Protected Fauna								
Falco peregrinus **Peregrine Falcon**	-	OS	-	-	13 records; including Bedfordale (1998, 2000, 2011), Wungong (2000) and Karrakup (1998).	Moderate	Foraging visitor	• All habitats
Phascogale tapoatafa **Brush-tailed Phascogale**	-	CD	-	-	2 records; Mundijong (2003 and undated).	Low	Occasional dispersing visitor	• All habitats

Table 5. (cont.)

Species	Conservation Status				Records within 10km (DBCA 2018, see also Figure 5)	Likelihood of Occurrence	Likely Status in Study Area	Potential habitat use in the Study Area
	EPBC Act	BC Act	DBCA Priority	Locally significant				
DBCA Priority Species								
Acanthophis antarcticus **Southern Death Adder**	-	-	P3	-	22 records; including Byford (1957, 1960), Bedfordale (1958, 1982) and Karrakup (1966).	Low	Resident (if present)	• All habitats
Ctenotus delli **Dell's Ctenotus**	-	-	P4	-	1 record; Darling Downs (1969).	Low	Resident (if present)	• Eucalypt Forest
Isoodon obesulus **Quenda**	-	-	P4	-	**Recorded on site visit.** Many records on DBCA database.	Known to occur	Breeding resident	• All habitats
Notamacropus irma **Western Brush Wallaby**	-	-	P4	-	4 records; Karrakup (2017), Bungendore Park (2002), Byford (1959) and Bedfordale (2007).	Low	Occasional dispersing visitor	• All habitats
Falsistrellus mackenziei **Western False Pipistrelle**	-	-	P4	-	1 record; Bedfordale (2013).	Moderate	Resident (if present)	• All habitats
Hydromys chrysogaster **Water-rat**	-	-	P4	-	3 records; Armadale (2004), Canning River (1924) and Karrakup (undated).	Low	Occasional visitor	• Riparian Channel
Locally Significant Fauna								
Morelia spilota imbricata **Carpet Python**	-	-	-	LS	No records within 10km.	Low	Occasional visitor	• All habitats
29 species of locally significant bird	-	-	-	LS	Several species recorded within 5km (see Appendix 4).	High	Dependent on species.	• All habitats

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Appendix 1. Habitat Trees.

Waypoint Name	Easting	Northing	Tree Species	DBH (cm)	Comment	Hollows
Ca001	407019	6432058	*Eucalyptus rudis*	70		None visible
Ca002	407028	6432052	*Eucalyptus rudis*	70		None visible
Ca003	407019	6432082	*Eucalyptus rudis*	70		None visible
Ca004	407020	6432087	*Eucalyptus rudis*	95		None visible
Ca005	407019	6432110	*Eucalyptus rudis*	50		None visible
Ca006	407194	6432136	*Eucalyptus wandoo*	55		None visible
Ca007	407202	6432141	*Corymbia calophylla*	50		None visible
Ca008	407194	6432130	*Eucalyptus wandoo*	45		None visible
Ca009	407198	6432129	*Eucalyptus wandoo*	35		None visible
Ca010	407206	6432127	*Eucalyptus wandoo*	50		None visible
Ca011	407232	6432083	*Eucalyptus rudis*	55		None visible
Ca012	407274	6432045	*Eucalyptus rudis*	55		None visible
Ca013	407295	6432031	*Eucalyptus rudis*	70		None visible
Ca014	407312	6432032	*Eucalyptus rudis*	60		Possible large hollow
Ca015	407332	6432028	*Eucalyptus rudis*	70		Small hollows
Ca016	407410	6432033	*Eucalyptus rudis*	50		None visible
Ca017	407309	6432044	*Eucalyptus rudis*	50		None visible
Ca018	407297	6432043	*Eucalyptus rudis*	80		None visible
Ca019	407076	6432217	*Corymbia calophylla*	60		None visible
Ca020	407062	6432249	*Corymbia calophylla*	100	Dead tree, feral bees	Possible large hollow
Ca021	407045	6432203	*Eucalyptus marginata*	90		Possible large hollow
Ca022	407046	6432184	*Eucalyptus rudis*	50		None visible
Ca023	407051	6432191	*Eucalyptus rudis*	70		Small hollows
Ca024	407041	6432180	*Eucalyptus rudis*	55		None visible
Ca025	407003	6432155	*Eucalyptus rudis*	80		Small hollows
Ca026	407060	6432185	*Eucalyptus rudis*	50		None visible
Ca027	407068	6432159	*Eucalyptus rudis*	60		Small hollows
Ca028	407076	6432165	*Eucalyptus rudis*	50		Small hollows
Ca029	407082	6432167	*Eucalyptus rudis*	50		None visible
Ca030	407082	6432170	*Eucalyptus rudis*	75		None visible
Ca031	407090	6432163	*Eucalyptus rudis*	55		None visible
Ca032	407091	6432147	*Eucalyptus rudis*	50		None visible
Ca033	407094	6432142	*Eucalyptus rudis*	100		Small hollows
Ca034	407081	6432145	*Eucalyptus rudis*	60		None visible
Ca035	407074	6432145	*Eucalyptus rudis*	50		None visible
Ca036	407061	6432131	*Eucalyptus rudis*	60		None visible
Ca037	407035	6432114	*Eucalyptus rudis*	55		None visible
Ca038	407029	6432102	*Eucalyptus rudis*	60		Small hollows

Appendix 1. (cont.)

Waypoint Name	Easting	Northing	Tree Species	DBH (cm)	Comment	Hollows
Ca039	407047	6432078	*Eucalyptus rudis*	60		None visible
Ca040	407048	6432070	*Eucalyptus rudis*	50		None visible
Ca041	407050	6432063	*Eucalyptus rudis*	90		None visible
Ca042	407104	6432174	*Eucalyptus rudis*	55		None visible
Ca043	407123	6432164	*Eucalyptus rudis*	70		Small hollows
Ca044	407147	6432145	*Eucalyptus rudis*	60		None visible
Ca045	407159	6432138	*Eucalyptus rudis*	70	Feral bees	Possible large hollow
Ca046	407163	6432127	*Eucalyptus rudis*	60		None visible
Ca047	407174	6432138	*Eucalyptus rudis*	70		None visible
Ca048	407183	6432128	*Eucalyptus wandoo*	40		None visible
Ca049	407224	6432077	*Eucalyptus rudis*	70		Small hollows
Ca050	407227	6432079	*Eucalyptus rudis*	50		None visible
Ca051	407231	6432072	*Eucalyptus rudis*	70		Small hollows
Ca052	407231	6432061	*Eucalyptus rudis*	70		Small hollows
Ca053	407235	6432060	*Eucalyptus rudis*	60		None visible
Ca054	407238	6432066	*Eucalyptus rudis*	60		None visible
Ca055	407252	6432053	*Eucalyptus rudis*	55		None visible
Ca056	407252	6432034	*Eucalyptus rudis*	60		None visible
Ca057	407254	6432032	*Eucalyptus rudis*	85	Hollow in use, parrot (?)	Small hollows
Ca058	407281	6432023	*Eucalyptus rudis*	50		None visible
Ca059	407270	6432013	*Eucalyptus rudis*	60		Small hollows
Ca060	407293	6432007	*Eucalyptus rudis*	50		None visible
Ca061	407304	6432004	*Eucalyptus rudis*	50		None visible
Ca062	407309	6432010	*Eucalyptus rudis*	50		None visible
Ca063	407321	6432007	*Eucalyptus rudis*	80		None visible
Ca064	407333	6432018	*Eucalyptus rudis*	55		None visible
Ca065	407348	6432022	*Eucalyptus rudis*	55		None visible
Ca066	407358	6432022	*Eucalyptus rudis*	65		None visible
Ca067	407364	6432021	*Eucalyptus rudis*	65	Trunk split low	None visible
Ca068	407381	6432029	*Eucalyptus rudis*	75		Small hollows
Ca069	407388	6432012	*Eucalyptus rudis*	100		Small hollows
Ca070	407413	6432010	*Eucalyptus rudis*	50		None visible
Ca071	407416	6432009	*Eucalyptus rudis*	60		None visible
Ca072	407413	6432001	*Eucalyptus rudis*	50		None visible
Ca073	407425	6431997	*Eucalyptus rudis*	65		None visible
Ca074	407458	6431983	*Eucalyptus rudis*	60		None visible
Ca075	407461	6431988	*Eucalyptus rudis*	55		None visible
Ca076	407469	6431985	*Eucalyptus rudis*	60		None visible

Appendix 1. (cont.)

Waypoint Name	Easting	Northing	Tree Species	DBH (cm)	Comment	Hollows
Ca077	407476	6431975	*Eucalyptus rudis*	55		None visible
Ca078	407485	6431969	*Eucalyptus rudis*	50		None visible
Ca079	407496	6431969	*Eucalyptus rudis*	60		None visible
Ca080	407496	6431973	*Eucalyptus rudis*	60		None visible
Ca081	407525	6431964	*Eucalyptus rudis*	60		None visible
Ca082	407540	6431953	*Eucalyptus rudis*	60		None visible
Ca083	407543	6431941	*Eucalyptus rudis*	60		None visible
Ca084	407508	6431982	*Eucalyptus rudis*	50		None visible
Ca085	407514	6431983	*Eucalyptus wandoo*	50		None visible
Ca086	407521	6431985	*Eucalyptus wandoo*	30		None visible
Ca087	407526	6431979	*Eucalyptus wandoo*	40		None visible
Ca088	407546	6431968	*Planted eucalypt (?)*	55		None visible
Ca089	407546	6431961	*Planted eucalypt (?*	50		None visible
Ca090	407540	6431986	*Eucalyptus wandoo*	40		None visible
Ca091	407541	6431986	*Eucalyptus wandoo*	30		None visible
Ca092	407444	6432001	*Eucalyptus rudis*	50		None visible
Ca093	407218	6432056	*Eucalyptus rudis*	60		None visible
Ca094	407148	6432096	*Eucalyptus wandoo*	30		Small hollows
Ca095	407146	6432089	*Eucalyptus wandoo*	30		None visible
Ca096	407131	6432091	*Eucalyptus rudis*	60		None visible
Ca097	407141	6432111	*Eucalyptus rudis*	80		None visible

Appendix 2. Frogs that Potentially Occur in the Study Area.

Site visit 2019 = species records from this survey.
WAM = species records from the Western Australian Museum Database (see Table 1).
FSDB = species records from the Fauna Survey Database (see Table 1).
DBCA = species records from the DBCA Threatened and Priority Species Database (see Table 1).
EPBC = species & species habitat from the EPBC Protected Matters Search Tool (see Table 1).

Species		Status	Records					
			Site visit 2019	Mandogalup	WAM	FSDB	DBCA	EBPC
Limnodynastidae (burrowing frogs)								
Moaning Frog	*Heleioporus eyrei*				+			
Sand Frog	*Heleioporus psammophilus*				+			
Pobblebonk or Banjo Frog	*Limnodynastes dorsalis*							
Myobatrachidae (ground frogs)								
Quacking Frog	*Crinia georgiana*		+		+			
Glauert's Froglet	*Crinia glauerti*		+		+	+		
Sandplain Froglet	*Crinia insignifera*				+			
Humming Frog	*Neobatrachus pelobatoides*				+			
Guenther's Toadlet	*Pseudophryne guentheri*				+			
Hylidae (tree frogs)								
Slender Tree Frog	*Litoria adelaidensis*							
Motorbike Frog	*Litoria moorei*							
# frog species potentially occurring in the study area:		**10**						

Appendix 3. Reptiles that Potentially Occur in the Study Area.

Site visit 2019 = species records from this survey.
WAM = species records from the Western Australian Museum Database (see Table 1).
FSDB = species records from the Fauna Survey Database (see Table 1).
DBCA = species records from the DBCA Threatened and Priority Species Database (see Table 1).
EPBC = species & species habitat from the EPBC Protected Matters Search Tool (see Table 1).

Species		Status	Records					
			Site visit 2019	Mandogalup	WAM	FSDB	DBCA	EBPC
Cheluidae (freshwater turtles)								
Long-necked Turtle	*Chelodina colliei*					+		
Carphodactylidae (knob-tailed geckoes)								
Southern Barking Gecko	*Underwoodisaurus milii*							
Diplodactylidae (ground geckos)								
Speckled Stone Gecko	*Diplodactylus lateroides*				+			
Gekkonidae (geckoes)								
Southern Spiny-tailed Gecko	*Strophurus spinigerus*							
Marbled Gecko	*Christinus marmoratus*							
Pygopodidae (legless lizards)								
Sand-Plain Worm-Lizard	*Aprasia repens*				+			
Fraser's Legless Lizard	*Delma fraseri*							
Gray's Legless Lizard	*Delma grayii*							
Burton's Legless Lizard	*Lialis burtonis*				+			
Common Scaleyfoot	*Pygopus lepidopodus*							
Agamidae (dragon lizards)								
Bearded Dragon	*Pogona minor*				+			
Ornate Crevice-dragon	*Ctenophorus ornatus*				+			
Scincidae (skink lizards)								
South-West Cool Skink	*Acritoscincus trilineatus*				+			
Fence Skink	*Cryptoblepharus buchananii*		+		+	+		
Darling Range Ctenotus	*Ctenotus delli*	P				+	+	
West Coast Ctenotus	*Ctenotus fallens*				+			
Odd-striped Ctenotus	*Ctenotus impar*				+			
	Ctenotus labillardieri				+			
King's Skink	*Egernia kingii*							
Crevice Skink	*Egernia napoleonis*							
	Hemiergis initialis							
	Lerista distinguenda				+			
West Coast Four-toed Lerista	*Lerista elegans*				+			
Dwarf Skink	*Menetia greyii*				+			
West Coast Morethia	*Morethia lineoocellata*							
Dusky Morethia	*Morethia obscura*				+			
Western Bluetongue	*Tiliqua occipitalis*							
Bobtail	*Tiliqua rugosa*		+			+		

Appendix 3. (cont.)

Species		Status	Records					
			Site visit 2019	Mandogalup	WAM	FSRD	DBCA	EBPC
Varanidae (monitors or goannas)								
Gould's Goanna	*Varanus gouldii*				+			
Rosenberg's Goanna	*Varanus rosenbergi*							
Black-headed Tree Goanna	*Varanus tristis*							
Typhlopidae (blind snakes)								
Southern Blind Snake	*Anilios australis*				+			
Pythonidae (pythons)								
South-West Carpet Python	*Morelia spilota imbricata*	LS						
Elapidae (front-fanged snakes)								
Southern Death Adder	*Acanthophis antarcticus*	P			+		+	
Southern Shovel-nosed Snake	*Brachyurophis semifasciatus*							
Yellow-faced Whip-Snake	*Demansia psammophis*							
Crowned Snake	*Elapognathus coronatus*							
Black-naped Snake	*Neelaps bimaculatus*							
Western Tiger Snake	*Notechis scutatus*				+			
Gould's Snake	*Parasuta gouldii*					+		
	Parasuta nigriceps				+			
Dugite	*Pseudonaja affinis*				+			
Jan's Banded Snake	*Simoselaps bertholdi*							
# reptile species potentially occurring in the study area::		**43**						

Appendix 4. Birds that Potentially Occur in the Study Area.

Site visit 2019 = species records from this survey.
Birdata = species records from the Birdata Database (see Table 1).
BA = species records from the Bird Australia Atlas Database (see Table 1).
WAM = species records from the Western Australian Museum Database (see Table 1).
FSDB = species records from the Fauna Survey Database (see Table 1).
DBCA = species records from the DBCA Threatened and Priority Species Database (see Table 1).
EPBC = species & species habitat from the EPBC Protected Matters Search Tool (see Table 1).
Int = introduced species.

Species		Status	Records						
			Site visit 2019	Birdata	BA	WAM	FSRD	DBCA	EBPC
Anatidae (ducks and swans)									
Grey Teal	*Anas gracilis*				+				
Pacific Black Duck	*Anas superciliosus*		+	+	+	+			
Australian Wood Duck	*Chenonetta jubata*			+	+		+		
Australian Shelduck	*Tadorna tadornoides*		+	+	+				
Phasianidae (pheasants and quails)									
Stubble Quail	*Coturnix pectoralis*				+				
Brown Quail	*Coturnix ypsilophora*								
Threskiornithidae (ibis and spoonbills)									
Australian White Ibis	*Threskiornis moluccus*			+	+		+		
Straw-necked Ibis	*Threskiornis spinicollis*		+	+	+				
Accipitridae (kites, hawks and eagles)									
Black-shouldered Kite	*Elanus caeruleus*				+				
Square-tailed Kite	*Hamirostra isura*	LS			+				
Whistling Kite	*Haliastur sphenurus*	LS		+					
Brown Goshawk	*Accipiter fasciatus*	LS		+	+		+		
Collared Sparrowhawk	*Accipiter cirrocephalus*	LS		+	+				
Wedge-tailed Eagle	*Aquila audax*	LS		+	+				
Little Eagle	*Aquila morphnoides*	LS		+	+				
Falconidae (falcons)									
Brown Falcon	*Falco berigora*	LS							
Peregrine Falcon	*Falco peregrinus*	OS			+			+	
Australian Hobby	*Falco longipennis*			+					
Australian Kestrel	*Falco cenchroides*			+	+		+		
Turnicidae (button-quails)									
Painted Button-quail	*Turnix varia*	LS			+				
Columbidae (pigeons and doves)									
Rock Dove (feral pigeon)	*Columba livia*	Int.		+	+				
Spotted Turtle-Dove	*Streptopelia chinensis*	Int.		+					
Laughing Turtle-Dove	*Streptopelia senegalensis*	Int.		+	+		+		
Common Bronzewing	*Phaps chalcoptera*	LS		+	+		+		
Crested Pigeon	*Ocyphaps lophotes*			+	+		+		

Appendix 4. (cont.)

Species		Status	Records						
			Site visit 2019	Birdata	BA	WAM	FSRD	DBCA	EBPC
Cacatuidae (cockatoos)									
Forest Red-tailed Black-Cockatoo	*Calyptorhynchus banksii*	T	+	+	+		+	+	+
Baudin's Black-Cockatoo	*Calyptorhynchus baudini*	T	+	+	+			+	+
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	T		+	+	+	+	+	+
Western Long-billed Corella	*Cacatua pastinator*			+					
Little Corella	*Cacatua sanguinea*				+		+		
Galah	*Cacatua roseicapilla*		+		+		+		
Psittacidae (lorikeets and parrots)									
Rainbow Lorikeet	*Trichoglossus haematodus*	Int.		+					
Western Rosella	*Platycercus icterotis*		+	+					
Red-capped Parrot	*Platycercus spurius*		+		+		+		
Australian Ringneck	*Platycercus zonarius*		+		+	+	+		
Regent Parrot	*Polytelis anthopeplus*			+	+				
Elegant Parrot	*Neophema elegans*			+	+				
Cuculidae (cuckoos)									
Pallid Cuckoo	*Cuculus pallidus*			+	+				
Fan-tailed Cuckoo	*Cacamantis flabelliformis*			+					
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*						+		
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*								
Strigidae (hawk-owls)									
Southern Boobook Owl	*Ninox novaeseelandiae*			+					
Tytonidae (barn owls)									
Barn Owl	*Tyto alba*					+			
Podargidae (frogmouths)									
Tawny Frogmouth	*Podargus strigoides*								
Apodidae (swifts)									
Fork-tailed Swift	*Apus pacificus*	Mi							+
Halcyonidae (forest kingfishers)									
Laughing Kookaburra	*Dacelo novaeguineae*	Int.	+	+	+				
Sacred Kingfisher	*Todiramphus sanctus*			+	+				
Meropidae (bee-eaters)									
Rainbow Bee-eater	*Merops ornatus*			+	+	+	+		
Maluridae (fairy-wrens)									
Red-winged Fairy-wren	*Malurus elegans*	LS				+			
Splendid Fairy-wren	*Malurus splendens*	LS		+	+				
Pardalotidae (pardalotes)									
Spotted Pardalote	*Pardalotus punctatus*		+	+	+		+		
Striated Pardalote	*Pardalotus striatus*		+	+	+	+	+		
Acanthizidae (thornbills and allies)									
White-browed Scrubwren	*Sericornis frontalis*	LS		+	+				
Weebill	*Smicrornis brevirostris*	LS	+	+	+		+		
Western Gerygone	*Gerygone fusca*			+	+		+		
Inland Thornbill	*Acanthiza apicalis*	LS		+	+		+		
Western Thornbill	*Acanthiza inornata*	LS			+				
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	LS		+	+		+		

Appendix 4. (cont.)

Species		Status	Records						
			Site visit 2019	Birdata	BA	WAM	FSRD	DBCA	EBPC
Meliphagidae (honeyeaters)									
Red Wattlebird	*Anthochaera carunculata*		+	+	+		+		
Western Wattlebird	*Anthochaera lunulata*	LS			+				
White-naped Honeyeater	*Melithreptus chloropsis*	LS			+				
Singing Honeyeater	*Gavicallis virescens*		+	+	+				
Brown Honeyeater	*Lichmera indistincta*		+	+	+		+		
New Holland Honeyeater	*Phylidonyris novaehollandiae*	LS		+	+		+		
White-cheeked Honeyeater	*Phylidonyris nigra*	LS		+	+				
Tawny-crowned Honeyeater	*Phylidonyris melanops*	LS							
Yellow-plumed Honeyeater	*Ptilotula ornata*	LS		+	+				
Western Spinebill	*Acanthorhynchus superciliosus*			+	+				
Petroicidae (Australian robins)									
Red-capped Robin	*Petroica goodenovii*			+	+				
Scarlet Robin	*Petroica boodang*	LS		+	+				
Neosittidae (sittellas)									
Varied Sittella	*Daphoenositta chrysoptera*	LS		+	+				
Pachycephalidae (whistlers)									
Rufous Whistler	*Pachycephala rufiventris*		+	+	+		+		
Golden Whistler	*Pachycephala pectoralis*	LS		+	+		+		
Grey Shrike-thrush	*Colluricincla harmonica*	LS		+	+	+			
Dicruridae (flycatchers)									
Magpie-lark	*Grallina cyanoleuca*			+	+		+		
Grey Fantail	*Rhipidura fuliginosa*		+	+	+		+		
Willie Wagtail	*Rhipidura leucophrys*			+	+	+			
Campephagidae (cuckoo-shrikes)									
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*			+	+	+	+		
White-winged Triller	*Lalage tricolor*								
Artamidae (woodswallows)									
Black-faced Woodswallow	*Artamus cinereus*	LS		+	+		+		
Dusky Woodswallow	*Artamus cyanopterus*	LS		+	+				
Cracticidae (butcherbirds, currawongs & magpies)									
Grey Butcherbird	*Cracticus torquatus*			+	+		+		
Australian Magpie	*Cracticus tibicen*		+	+	+		+		
Grey Currawong	*Strepera versicolor*	LS							
Corvidae (ravens and crows)									
Australian Raven	*Corvus coronoides*			+	+		+		
Hirundinidae (swallows)									
White-backed Swallow	*Cheramoeca leucosternus*								
Welcome Swallow	*Hirundo neoxena*			+	+				
Tree Martin	*Hirundo nigricans*		+	+	+				
Zosteropidae (white-eyes)									
Silvereye	*Zosterops lateralis*		+	+	+		+		

Appendix 4. (cont.)

Species	Status	Records						
		Site visit 2019	Birdata	BA	WAM	FSRD	DBCA	EBPC
Dicaeidae (flower-peckers)								
Mistletoebird *Dicaeum hirundinaceum*		+	+	+				
Motacillidae (pipits and true wagtails)								
Australian Pipit *Anthus australis*								
# bird species potentially occurring in the study area:	**91**							

Appendix 5. Mammals that Potentially Occur in the Study Area.

Site visit 2019 = species records from this survey.
Quenda = species records from the Quenda Community Survey (see Table 1).
WAM = species records from the Western Australian Museum Database (see Table 1).
FSDB = species records from the Fauna Survey Database (see Table 1).
DBCA = species records from the DBCA Threatened and Priority Species Database (see Table 1).
EPBC = species & species habitat from the EPBC Protected Matters Search Tool (see Table 1).
Int = introduced species.

Species		Status	Records					
			Site visit 2019	Quenda	WAM	FSDB	DBCA	EBPC
Tachyglossidae (echidnas)								
Echidna	*Tachyglossus aculeatus*							
Dasyuridae (Dasyurid marsupials)								
Mardo (Yellow-footed Antechinus)	*Antechinus flavipes*				+			
Chuditch	*Dasyurus geoffroii*	T					+	+
Brush-tailed Phascogale	*Phascogale tapoatafa*	SP					+	
Peramelidae (bandicoots)								
Quenda or Southern Brown Bandicoot	*Isoodon fusciventer*	P	+	+	+	+	+	
Tarsipedidae (honey possum)								
Honey Possum	*Tarsipes rostratus*							
Phalangeridae (possums)								
Brush-tailed Possum	*Trichosurus vulpecula*					+		
Macropodidae (kangaroos and wallabies)								
Brush Wallaby	*Macropus irma*	P			+		+	
Western Grey Kangaroo	*Macropus fuliginosus*		+			+		
Mollosidae (mastiff bats)								
White-striped Bat	*Tadarida australis*							
Vespertilionidae (vesper bats)								
Gould's Wattled Bat	*Chalinolobus gouldii*							
Chocolate Wattled Bat	*Chalinolobus morio*							
Western False Pipistrelle	*Falsistrellus mackenziei*	P					+	
Southern Forest Bat	*Vespedalus regulus*							
Lesser Long-eared Bat	*Nyctophilus geoffroyi*							
Gould's Long-eared Bat	*Nyctophilus gouldii*							
Greater Long-eared Bat	*Nyctophilus major*							
Muridae (rats and mice)								
House Mouse	*Mus musculus*	Int.				+		
Black Rat	*Rattus rattus*	Int.			+	+		
Water-rat	*Hydromys chrysogaster*	P					+	
Leporidae (rabbits and hares)								
Rabbit	*Oryctolagus cuniculus*	Int.						
Canidae (foxes and dogs)								
European Red Fox	*Vulpes vulpes*	Int.				+		
Felidae (cats)								
Feral Cat	*Felis catus*	Int.				+		
	# mammal species:		**23**					

Appendix 6. EPBC Protected Matters Search Tool results.

Species listed for the 1km radius around 32° 14' 39" S, 116° 00' 56" E on the EPBC Protected Matters Search Tool.

Species	Status	Author's Comment
Botaurus poiciloptilus Australian Bittern	Endangered	Wetland species; no suitable habitat present in the study area.
Calidris ferruginea Curlew Sandpiper	Critically Endangered & Migratory (wetland)	Shorebird species; no suitable habitat present in the study area.
Numenious madagascariensis Eastern Curlew	Critically Endangered & Migratory (wetland)	Shorebird species; no suitable habitat present in the study area.
Calyptorhynchus banksii naso Forest Red-tailed Black Cockatoo	Vulnerable	Known to occur.
Calyptorhynchus latirostris Carnaby's Black-Cockatoo	Endangered	Likely to be present.
Calyptorhynchus baudinii Baudin's Black-Cockatoo	Endangered	Known to occur.
Leipoa ocellata Malleefowl	Vulnerable	Locally extinct on the Swan Coastal Plain.
Rostratula australis Australian Painted Snipe	Endangered & Migratory	Shorebird species; no suitable habitat present in the study area.
Dasyurus geoffroii Chuditch	Vulnerable	May be present on occasion.
Bettongia penicillata ogilbyi Woylie	Endangered	No nearby records on databases; likely to be locally extinct.
Pseudocheirus occidentalis Western Ringtail Possum	Vulnerable	No nearby records on databases; likely to be locally extinct.
Setonix brachyurus Quokka	Vulnerable	No nearby records on databases; likely to be locally extinct.
Apus pacificus Fork-tailed Swift	Migratory (terrestrial)	May possibly overfly area.
Motacilla cinerea Grey Wagtail	Migratory (terrestrial)	Shorebird species; no suitable habitat present in the study area.
Tringa hypoleucos Common Sandpiper	Migratory (wetland)	Shorebird species; no suitable habitat present in the study area.
Calidris acuminata Sharp-tailed Sandpiper	Migratory (wetland)	Shorebird species; no suitable habitat present in the study area.
Calidris canutus Red Knot	Migratory (wetland)	Shorebird species; no suitable habitat present in the study area.
Calidris melanotos Pectoral Sandpiper	Migratory (wetland)	Shorebird species; no suitable habitat present in the study area.
Pandion haliaetus Osprey	Migratory (wetland)	Wetland and coastal species; no suitable habitat present in the study area.