
WALLANGARRA RESERVE FAUNA SURVEY 2021

City of Wanneroo

ecoscape



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Wallangarra Reserve Fauna Survey 2021
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EXECUTIVE SUMMARY

The City of Wanneroo (the City) engaged Ecoscape to undertake a biological survey of Wallangarra Reserve to gain a detailed understanding of the environmental values of the site. The survey consisted of a Basic fauna survey and Black Cockatoo habitat survey. The combined surveys were undertaken during spring of 2021.

The desktop assessment identified the following relevant aspects:

- database searches for conservation listed species fauna species identified 34 terrestrial vertebrate fauna species
- four of these species identified by database search were considered to have a high likelihood of occurrence within the survey area.

The field survey undertaken during 20-21 October 2021 identified the following:

- 24 vertebrate fauna species were recorded from the survey area during the field survey (one mammal and 23 birds) including three species of significance under the *Biodiversity Conservation Act 2016* (BC Act) and *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act):
 - Carnaby's Cockatoo (Endangered under the BC and EPBC Acts)
 - Rainbow Bee-eater (Marine under the EPBC Act)
 - Quenda (Priority 4 under the BC Act)
- one fauna habitat type occurs: Banksia Woodland, which occurs across the entire survey area
- woodland habitat within the survey area will likely support bird and ground-dwelling vertebrate species present, including the conservation significant Black Cockatoo species (Carnaby's Cockatoo and the Forest Red-tailed Black Cockatoo), Quenda (Priority 4) and Rainbow Bee-eater (Marine)
- no fauna species inhabiting, or likely to inhabit, the survey area, are considered to be dependent on the habitat within the survey area.

ACRONYMS AND ABBREVIATIONS

Table 1: Acronyms and abbreviations

Acronyms and abbreviations	
BC Act	Western Australian <i>Biodiversity Conservation Act 2016</i>
BoM	Bureau of Meteorology
CR	Critically Endangered (listed under Commonwealth EPBC Act and/or Western Australian BC Act)
CS	Conservation Significant. Species which are either conservation-listed under State or Commonwealth agencies, or have other significance to conservation.
DAWE	Commonwealth Department of Agriculture, Water and Environment (2020-)
DBCA	Western Australian Department of Biodiversity, Conservation and Attractions
DBH	Diameter at Breast Height (1.3 m)
DEWHA	Commonwealth Department of the Environment, Water, Heritage and the Arts (2007-2010, now DAWE)
DMIRS	Western Australian Department of Mines, Industry Regulation and Safety
DPaW	Western Australian Department of Parks and Wildlife (2013-2017, now DBCA)
DoE	Commonwealth Department of the Environment (2013-2016, now DAWE)
DotEE	Commonwealth Department of the Environment and Energy (2016-2020)
DPIRD	Western Australian Department of Primary Industries and Rural Development
DSEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities (2010-2013, now DAWE)
EN	Endangered (listed under Commonwealth EPBC Act and/or Western Australian BC Act)
Ecoscape	Ecoscape (Australia) Pty Ltd
EP Act	Western Australian <i>Environmental Protection Act 1986</i>
EPA	Western Australian Environmental Protection Authority
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
GDA 94	Geographic Datum of Australia 1994
GIS	Geographic Information System
GPS	Global Positioning System
ha	hectare/hectares
IA	Species protected by international agreement (under the Western Australian BC Act)
IBRA	Interim Biogeographic Regionalisation for Australia
IUCN	International Union for Conservation of Nature
km	kilometre/kilometres
m	metre/metres
MGA	Map Grid of Australia
MA	Marine species (fauna; specially protected species under the Commonwealth EPBC Act)
MI	Migratory species (fauna; specially protected species under the Western Australian BC Act and/or Commonwealth EPBC Act)
MNES	Matters of National Environmental Significance
OS	Other specially protected species (fauna; specially protected species under the Western Australian BC Act)
PMST	Protected Matters Search Tool (hosted by DAWE, used to search for MNES)
sp.	Species (singular)
spp.	Species (plural)
subsp.	Subspecies (infrataxon)
T	Threatened Fauna species listing by DBCA
var.	Variety (infrataxon)

Acronyms and abbreviations	
VU	Vulnerable (listed under Commonwealth EPBC Act and/or Western Australian BC Act)
WAM	Western Australian Museum
*	Introduced species not native to Western Australia

1 INTRODUCTION

1.1 BACKGROUND

The City of Wanneroo (the City) is a local government authority located within the Perth metropolitan area, approximately 25 km north of the CBD. The City includes a number of natural areas for which it has management responsibility.

The City engaged Ecoscape in 2021 to undertake a biological survey of Wallangarra Reserve in Carramar, to gain a detailed understanding of the environmental values of the site. The terrestrial vertebrate fauna survey component consisted of a Basic fauna survey and Black Cockatoo habitat survey. The survey is required to investigate Wallangarra Reserve's suitability as an offset area for the proposed Flynn Drive Road Upgrade by defining its ecological values.

1.2 SURVEY AREA

The survey area is located in Carramar, within the City of Wanneroo on the Swan Coastal Plain, approximately 30 km north of Perth (**Figure 1**). Approximating 9.06 ha in size, the survey area forms a roughly rectangular remnant north of Wallangarra Road, bounded by Flynn Drive to the north and Pinjar Road to the east.

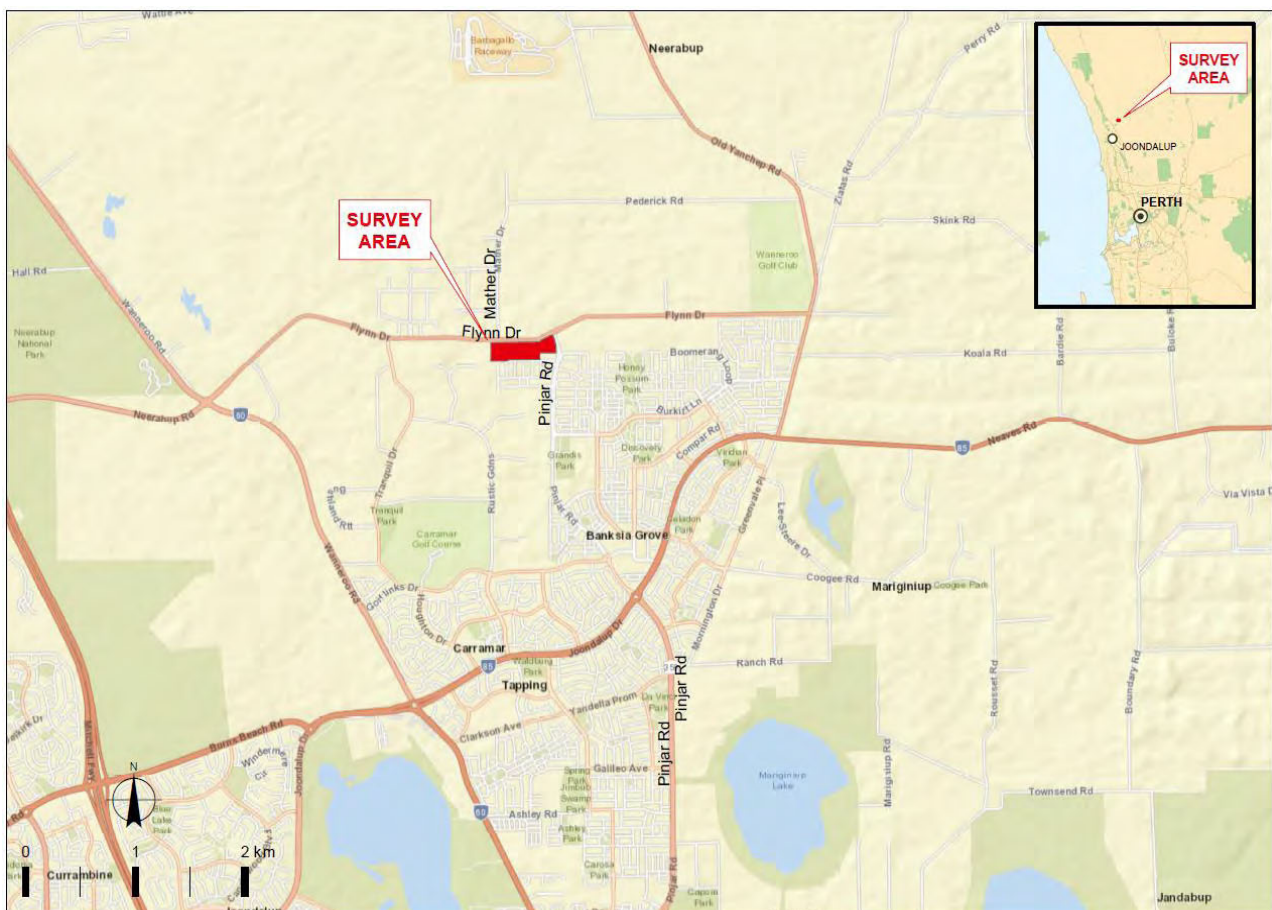


Figure 1: Survey area location

1.3 SURVEY REQUIREMENTS

The biological survey was to be undertaken during spring 2021, and in compliance with the *Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment* (EPA 2020). The requirements of the survey included the completion of a Basic (previously Level 1) fauna survey, incorporating a Black Cockatoo habitat assessment.

1.4 COMPLIANCE

This environmental assessment was conducted in accordance with Commonwealth and State legislation and guidelines:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- Western Australian *Environmental Protection Act 1986* (EP Act)
- Western Australian *Biodiversity Conservation Act 2016* (BC Act)
- Western Australian *Biodiversity Conservation Regulations 2018*
- Western Australian *Animal Welfare Act 2002*
- Commonwealth of Australia (2013) *Matters of National Environmental Significance. Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999*
- Department of Sustainability Environment Water Population and Communities (DSEWPac 2011) *Survey guidelines for Australia's threatened mammals*
- DEWHA (2010) *Survey guidelines for Australia's threatened birds*
- DSEWPac (2012) *EPBC Act referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo (endangered) *Calyptorhynchus latirostris*, Baudin's cockatoo (vulnerable) *Calyptorhynchus baudinii*, Forest red-tailed black cockatoo (vulnerable) *Calyptorhynchus banksii naso**, known in this document as the Black Cockatoo Referral Guidelines
- Commonwealth of Australia (2017) *Revised draft referral guideline for three threatened black cockatoo species: Carnaby's Cockatoo, Baudin's Cockatoo and the Forest Red-tailed Black Cockatoo*, known in this document as the Revised Draft Referral Guideline.

As well as those listed above, the assessment complied with EPA requirements for environmental survey and reporting in Western Australia, as outlined in:

- EPA (2020) *Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment*, known herein as the Fauna Technical Guidance
- EPA (2021) *Statement of Environmental Principles, Factors, Aims and Objectives for EIA*.

1.4.1 COMMONWEALTH ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

The EPBC Act is a legal framework to protect and manage matters of national environmental significance (MNES) listed under the Act.

1.4.2 WESTERN AUSTRALIAN ENVIRONMENTAL PROTECTION ACT 1986

The Western Australian EP Act was created to provide for an Environmental Protection Authority (the EPA) that has the responsibility for:

- prevention, control and abatement of pollution and environmental harm
- conservation, preservation, protection, enhancement and management of the environment
- matters incidental to or connected with the above.

The EPA is responsible for providing the guidance and policy under which environmental assessments are conducted. It conducts environmental impact assessments (based on the information provided by the proponent); initiates measures to protect the environment; and provides advice to the Minister for Environment.

1.4.3 WESTERN AUSTRALIAN BIODIVERSITY CONSERVATION ACT 2016

The Western Australian BC Act provides for the conservation, protection and ecologically sustainable use of biodiversity and biodiversity components in Western Australia.

Threatened species (both flora and fauna) and ecological communities that meet the categories listed within the BC Act are protected under this legislation and require authorisation by the Minister to take or disturb. These are known as Threatened Flora, Threatened Fauna and Threatened Ecological Communities. The conservation categories of Critically Endangered, Endangered and Vulnerable are detailed in **Table 15** in **Appendix One**. These categories align with those within the EPBC Act.

Flora and fauna species may be listed as being of special conservation interest if they satisfy at least one of the following criteria, and the Minister considers that taking of individuals may result in depletion of the species:

- have a naturally low population
- have a restricted natural range
- are subject to, or recovering from, a significant population decline or reduction of range
- are of special interest.

Migratory species and those subject to international agreement are also listed under the Act. These are known as specially protected species under the BC Act.

The most recent flora and fauna listings were published in the *Government Gazette* on 11 September 2018 (Government of Western Australia 2018a).

1.5 FAUNA

1.5.1 EPBC-LISTED THREATENED FAUNA

At the Commonwealth level, Threatened Fauna are protected under the EPBC Act, which lists species and ecological communities that are considered Critically Endangered, Endangered, Vulnerable, Conservation Dependant, Extinct, or Extinct in the Wild (detailed in **Table 14** in **Appendix One**).

Migratory species subject to international agreements are also protected under the EPBC Act. The definition of a migratory species under the Act follows that prescribed by the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) (DotEE 2020):

Migratory species are the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries.

Species listed by the following international agreements are currently protected under the EPBC Act:

- *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn Convention)
- *China-Australia Migratory Bird Agreement* (CAMBA)
- *Japan-Australia Migratory Bird Agreement* (JAMBA)
- *Republic of Korea-Australia Migratory Bird Agreement* (ROKAMBA).

1.5.2 WESTERN AUSTRALIAN BC ACT-LISTED FAUNA

Threatened fauna that meet the categories listed within the BC Act are protected and require authorisation by the Minister to take or disturb. The conservation categories of Critically Endangered, Endangered and Vulnerable have been aligned with those detailed in the EPBC Act.

Fauna species may be listed as being of special conservation interest if they satisfy at least one of the following criteria, and the Minister considers that taking of individuals may result in depletion of the species:

- have a naturally low population
- have a restricted natural range
- are subject to, or recovering from, a significant population decline or reduction of range
- are of special interest.

These are known as Specially Protected Species under the BC Act.

The categories covering State-listed threatened fauna species are outlined in **Table 15** in **Appendix One**.

1.5.3 WESTERN AUSTRALIAN PRIORITY FAUNA

Conservation significant fauna species are listed by the DBCA as Priority Fauna where populations are geographically restricted or threatened by local processes, or where there is insufficient information to formally assign them to threatened fauna categories. Whilst Priority Fauna are not specifically listed in the BC Act, these have a greater level of significance than other native species. The categories covering Priority Fauna species are outlined in **Table 15** in **Appendix One**.

1.6 ENVIRONMENTALLY SENSITIVE AREAS

There are a number of areas within Western Australia identified as being of environmental significance, within which the exemptions of the Native Vegetation Clearing Regulations do not apply. These are referred to as Environmentally Sensitive Areas (ESAs) and are declared under section 51B of the EP Act and described in the *Environmental Protection (Environmentally Sensitive Areas) Notice*.

1.7 CONSERVATION ESTATE

The National Reserve System is a network of protected areas managed for conservation under international guidelines. The objective of placing areas of bushland into the Conservation Estate is to achieve and maintain a comprehensive, adequate, and representative reserve system for Western Australia. The Conservation and Parks Commission is the vesting body for conservation lands, forest and marine reserves that are managed by DBCA (Government of Western Australia 2018b).

2 EXISTING ENVIRONMENT (DESKTOP ASSESSMENT)

2.1 PHYSICAL ENVIRONMENT

The southwest of Western Australia is generally described as having a Mediterranean-type climate of mild, wet winters and warm to hot, dry summers. The climate of the region is strongly influenced by the position of a band of high pressure known as the sub-tropical ridge. For much of the year the ridge is located to the south allowing the east or south easterly winds to prevail. During the cooler months the ridge periodically moves to the north, allowing cold fronts to pass over the west coast and deliver much of the annual rainfall (Beard 1990).

According to the Köppen-Geiger climate classification, the survey area has a temperate climate with hot, dry summers (Class Csa) (Peel, Finlayson & McMahon 2007). This classification is considered to represent a Mediterranean climate where average summer maximum temperatures exceed 22°C and the average coldest month maximum is between 18° and -3°C, and summer rainfall is less than one third of winter rainfall.

The closest Bureau of Meteorology (BoM) station with long term records for rainfall is Wanneroo (station no: 9105), which is located approximately 5 km from the survey area (BoM 2021a). The mean annual rainfall is 794.9 mm with the highest rainfall occurring in the winter months from June to August. The rainfall in the 6-month period preceding the survey in October 2021 was typical, recording approximately 99.2% of the long-term mean for the April to September period.

The closest BoM station with long term records for temperature is Pearce RAAF (station no: 9053), located approximately 22 km from the survey area. January is the hottest month with a mean maximum temperature of 33.5°C and minimum of 17°C. July is the coldest month with a mean maximum of 17.9°C and minimum of 8.4°C.

Figure 2 shows the average rainfall and temperatures of the survey area, with rainfall for the year preceding the field survey.

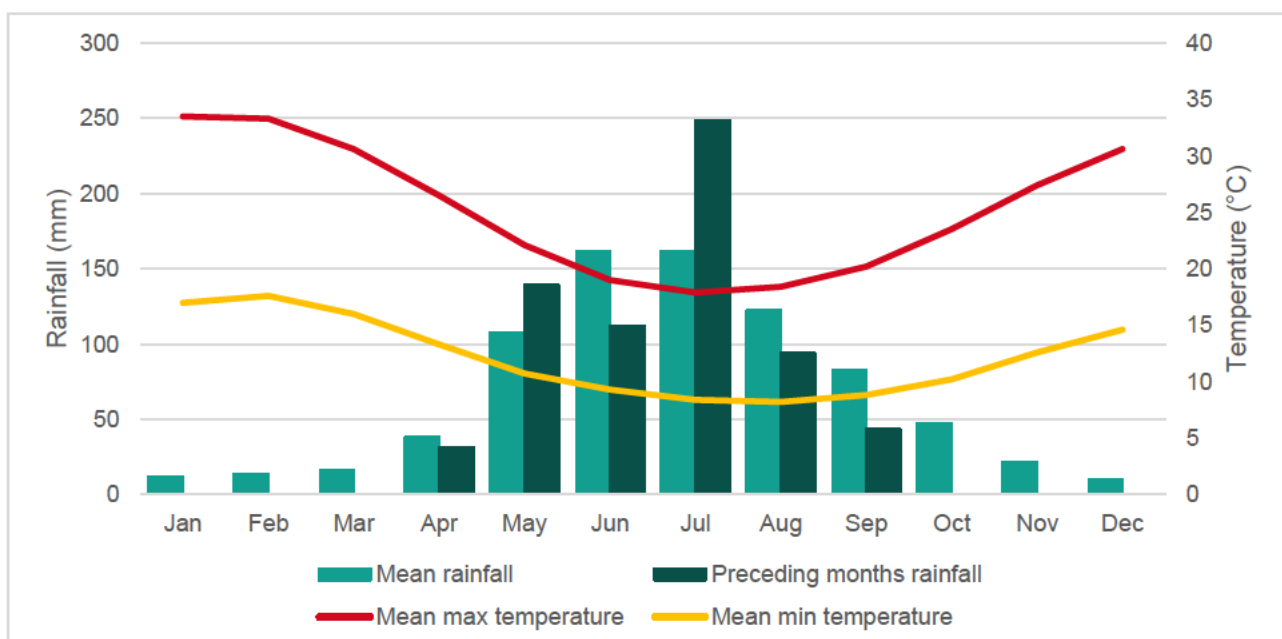


Figure 2: Rainfall and temperature data for the survey area (BoM 2021a)

2.1.1 LAND SYSTEMS

According to the Department of Primary Industries and Rural Development (DPIRD 2020) soil landscape mapping, the following land system intersects the survey area (**Table 2**).

Table 2: Land systems (DPIRD 2020)

Mapping unit	Land system	Description	Extent (ha)	%
211Sp_Ky	Karrakatta Sand Yellow Phase	Low hilly to gently undulating terrain. Yellow sand over limestone at 1-2 m. <i>Banksia</i> spp. woodland with scattered emergent <i>E. gomphocephala</i> and <i>E. marginata</i> and a dense shrub layer.	9.06	100

2.1.2 GEOLOGY

Regional geological mapping covering the survey area is associated with the Muchea (2034 I) map sheet of the 1:50,000 Geological Series of Western Australia (DMIRS 2020). According to this, one geological unit intersects the survey area, as shown in **Table 3**.

Table 3: Geology (DMIRS 2020)

Code	Description	Extent (ha)	%
S7	SAND – pale and olive yellow, medium to coarse-grained sub-angular quartz, moderately sorted, of residual origin, modified by marine inundation	9.06	100

2.1.3 WETLANDS AND DRAINAGE

The survey area is located in the Wanneroo Coastal Lakes catchment, in the river region of Swan Coast – Avon River (Landgate 2021). The survey area does not intersect with any wetlands or drainage lines. The nearest wetlands is Lake Adams located approximately 2.5 km to the south-east of the survey area. The nearest significant river is the Swan River located approximately 22 km to the south-east of the survey area.

2.1.4 GROUNDWATER DEPENDENT ECOSYSTEMS

The Groundwater Dependent Ecosystems Atlas (BoM 2021b) indicates that the survey area is considered as having low potential for terrestrial GDEs to occur, with an Inflow Dependent Ecosystem (IDE) likelihood of 3.

2.1.5 ENVIRONMENTALLY SENSITIVE AREAS

The survey area partially intersects Bush Forever site No. 295 in the eastern-most portion of the survey area, as well as Bush Forever site No. 494 across the remaining portion of the survey area (west of Viminea Street). Additionally, the survey area overlaps an area of vegetation mapped as being representative of several State and Commonwealth protected ecological communities which constitute ESAs.

2.1.6 CONSERVATION LANDS

The survey area does not directly intersect any formal conservation lands (i.e. DBCA managed lands including National Parks, Nature Reserves and other areas vested for conservation). The nearest conservation estate includes the Gngangara-Moore River State Forest 2.5 km to the east and north, and Neerabup National Park 3 km to the west.

2.1.7 LAND USE HISTORY

The survey area has been subject to minimal clearing associated with tracks, the majority represents native vegetation. The vicinity of the survey area has a history of horticultural and viticultural land use (DPIRD 2018). Prior activities in the area included market garden industry and sand quarrying. Areas to the west of the assessment area near Lake Neerabup were additionally used for lime kiln operation between 1930 and 1980.

2.2 BIOLOGICAL ENVIRONMENT

2.2.1 BIOGEOGRAPHIC REGION

Biogeographic regions are delineated on the basis of similar climate, geology, landforms, vegetation and fauna and are defined in the Interim Biogeographical Regionalisation for Australia (IBRA) (DAWE 2020).

The survey area is located in the Swan Coastal Plain IBRA region in the Perth subregion (SWA2), described as (Mitchell, Williams & Desmond 2002):

...a low lying coastal plain, mainly covered with woodlands. It is dominated by Banksia or Tuart on sandy soils, Casuarina obesa on outwash plains, and paperbark in swampy areas. In the east, the plain rises to duricrusted Mesozoic sediments dominated by Jarrah woodland. The climate is Warm Mediterranean. Three phases of marine sand dune development provide relief. The outwash plains, once dominated by C. obesa-marri woodlands and Melaleuca shrublands, are extensive only in the south. The Perth subregion is composed of colluvial and aeolian sands, alluvial river flats, coastal limestone. Heath and/or Tuart woodlands on limestone, Banksia and Jarrah-Banksia woodlands on Quaternary marine dunes of various ages, Marri on colluvial and alluvials. Includes a complex series of seasonal wetlands and also includes Rottnest, Carnac and Garden Islands etc. Rainfall ranges between 600 and 1000 mm annually and the climate is Mediterranean. The subregional area is 1,333,901 ha.

2.2.2 PRE-EUROPEAN VEGETATION

During the 1970s, John Beard and associates conducted a systematic survey of native vegetation, describing the vegetation systems in Western Australia at a scale of 1:250,000 in the south-west and at a scale of 1:1 000 000 in less developed areas (Beard 1990).

Beard's vegetation maps attempted to depict the native vegetation as it was presumed to be at the time of settlement and is known as the pre-European vegetation type and extent. Beard's vegetation maps have since been developed in digital form by Shepherd, Beeston & Hopkins (2002) and updated by DPIRD (2019). Extents are updated every two years by DBCA (2019a). This mapping indicates that the survey areas intersects one pre-European vegetation unit, as shown in **Table 4**.

Table 4: Pre-European vegetation corresponding with the survey area (DPIRD 2019)

Association	Code	Description	% of survey area
Spearwood System	6	Low woodland or open low woodland	100

The pre-European vegetation association identified from the survey area (DPIRD 2019) and its pre-European and current extent are listed in **Table 5** (DBCA 2019a) and shown on **Map 2**.

Table 5: Pre-European vegetation association representation (DBCA 2019a)

Region	Vegetation association	Original extent (ha)	Current extent (ha)	% remaining
Western Australia	6	56,343.01	13,362.25	23.72
IBRA biographic region (Swan Coastal Plain)	6	56,343.01	13,362.25	23.72
IBRA biographic subregion (Perth)	6	56,343.01	13,362.25	23.72
LGA (City of Wanneroo)	6	12,662.10	2,777.67	21.94

2.2.3 VEGETATION COMPLEXES

The relationship between vegetation and the various combinations of landforms, soils and rainfall (known as vegetation complexes) has been mapped for the Swan Coastal Plain at a scale of 1:250,000 (DBCA 2018). The mapping shows the pre-1750 distribution of vegetation complexes and is available in digital form. According to the mapping available, the survey area corresponds with three vegetation complexes (**Table 6**). Their original and current extents in the Swan Coastal Plain (DBCA 2019a) are shown in **Table 7**.

Table 6: Vegetation complexes corresponding with the survey area

Vegetation Complex	System 6 Code	Landform	Description	% of Survey Area
Cottesloe Complex – Central and South	52	Swan Coastal Plain – Aeolian deposits	Mosaic of Tuart woodland and Tuart-Jarrah-Marri open forest; closed heath on the Limestone outcrops.	23.62
Karrakatta Complex – Central and South	49	Swan Coastal Plain – Aeolian deposits	Predominantly open forest of Tuart-Jarrah-Marri and woodland of Jarrah- <i>Banksia</i> species. <i>Agonis flexuosa</i> is co-dominant south of the Capel River.	76.38

Table 7: Vegetation complex extents in the Swan Coastal Plain

Vegetation Complex	Pre-European extent (ha)	Current extent (ha)	% Remaining	Proportion within the LGA
Cottesloe Complex – Central and South	45,299.61	14,567.87	32.16	29.39
Karrakatta Complex – Central and South	53,080.99	12,467.20	23.49	19.85

2.2.4 THREATENED AND PRIORITY FAUNA

2.2.4.1 EPBC-listed Threatened Fauna

The Protected Matters Search Tool (PMST) search (DAWE 2021, search reference PMST_KOSC25, using a 10 km buffer), identified 40 Threatened fauna species, 49 Migratory species and 73 Marine species listed under the EPBC Act for which the species or species habitat have potential to occur. These included:

- 17 mammals: two 'breeding known to occur within area', two 'species or species habitat known to occur within area', three 'species or species habitat likely to occur within area', and ten 'species or species habitat may occur within area'
- 50 birds: one 'breeding known to occur within area', four 'foraging, feeding or related behaviour known to occur within area', nine 'species or species habitat known to occur within area', seven 'foraging, feeding or related behaviour likely to occur within area', nine 'species or species habitat likely to occur within area', and 20 'species or species habitat may occur within area'
- seven reptiles: four 'species or species habitat known to occur within area' and three 'species or species habitat may occur within area'

- 29 fish: two 'species or species habitat known to occur within area' and 27 'species or species habitat may occur within area'
- one invertebrate for which 'species or species habitat may occur within area'.

2.2.4.2 NatureMap

NatureMap (DBCA 2007-2022) is maintained collaboratively by the DBCA and the WAM. These records represent a combination of vouchered museum specimens and records obtained via the Fauna Survey Returns Database which are maintained by the DBCA.

A *NatureMap* search within a 10 km buffer covering the location of the survey area identified 38 State-listed vertebrate fauna species that have been recorded from the search buffer. This included nine Threatened species, one P2 species, four P3 species, six P4 species, and 16 IA species (protected under international agreement) consisting primarily of migratory birds. The conservation-listed species that were identified by *NatureMap* are indicated in **Table 18** in **Appendix Two**.

2.2.4.3 DBCA Database Search

A search of the DBCA databases was conducted (search reference: Fauna#6827) for a buffer area of 6 km radius (centred around a section of Flynn Drive) which incorporates the survey area. Eighteen conservation-listed species were identified as having previously been recorded from within the search area buffer, consisting of three mammals, nine birds, one reptile, and five invertebrates. All of these conservation-listed species were identified in either the EPBC PMST or *NatureMap* searches.

2.2.4.4 Threatened and Priority Fauna Likelihood Assessment

The likelihood of occurrence of significant fauna species identified by the database and literature searches was assessed using the following criteria:

- suitability of habitat types present within the survey area
- distance between previous record of conservation-listed species and the survey area
- frequency and number of records in the region
- date of record of conservation-listed species (recent or historical).

The following were also taken into consideration during the assessment:

- sufficiency of information
- behavioural and ecological characteristics such as cryptic behaviours
- record certainty.

Terrestrial vertebrate species identified by database searches for which there is no suitable habitat within the survey area (e.g. migratory wading birds) were excluded from the species likelihood assessment. Invertebrates and non-terrestrial species (e.g. aquatic species or marine mammals) are not within the scope of this survey and have thus also been excluded from further consideration of the database search results. Such excluded species are not referred to further in this document.

The categories of likelihood of occurrence, assessed using the above criteria, are shown in **Table 8**.

Table 8: Categories for likelihood of occurrence of conservation-listed fauna

Likelihood	Category
Recorded	Species recorded within the survey area within a reasonable timeframe (0-25 years)
High	Species recorded in close proximity to the survey area (<2.5 km) within the past 25 years; and suitable habitat occurs within the survey area
Medium	Species historically recorded in close proximity (<2.5 km) to the survey area, more than 25 years ago; and suitable habitat may exist within the survey area
Low	Species not recorded in the proximity of the survey area or rarely recorded within 5 km of the survey area; and suitable habitat unlikely to occur within the survey area
Very Low	Species not recorded by multiple surveys/databases within 10 km of the survey area and suitable habitat does not occur within the survey area, however, species or suitable habitat is listed as potentially occurring in the wider region

The likelihood of each of the assessed species occurring within the survey area is indicated in **Table 18** in **Appendix Two**. None of the species have previously been recorded from within the survey area. Four species were assessed as having a High likelihood of occurring within the survey area. These were (showing conservation status under State and Commonwealth listings):

- Carnaby's Cockatoo (*Calyptorhynchus latirostris*) – (EN; EN)
- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) – (VU; VU)
- Quenda (*Isoodon fusciventer*) – (P4; -)
- Western Brush Wallaby (*Notamacropus irma*) – (P4; -).

Likelihood of occurrence does not take into consideration factors such as frequency that a species occurs (or may occur), the duration that such species occupies (or may occupy) the survey area or dependence on habitat or resources within the survey area. Highly mobile species potentially only occur within (or for birds, overflying) the survey area for very brief periods and/or on very infrequent intervals. If a previous observation included in the database search records corresponds with this event it is listed as 'recorded'; if such a transient visitation is possible in the future the likelihood of such species occurring is likely listed as 'high'.

Following the field survey, when actual survey area characteristics are better understood and the level of survey effort was considered, the likelihood of occurrence was re-evaluated. The post-survey likelihood is also incorporated into **Table 18** in **Appendix Two**, and discussed further in **Section 5.1.3.1** to provide an indication of dependence of species on the habitat and resources available within the survey area.

2.3 LITERATURE REVIEW

The following reports from previous biological assessments were identified as having relevance to the current survey area and reviewed prior to the field survey:

- Ecoscape (2021a) *Flynn Drive Basic Fauna Survey 2020*. Survey area is adjacent to this survey area with similar habitat types. One conservation-listed species, Carnaby's Cockatoo (EN), was recorded during survey, with the survey area assessed as providing very high quality foraging habitat, and low quality breeding habitat, for this species. Three further conservation-listed species were not recorded but considered likely to utilise the survey area: Quenda (P4), Forest Red-tailed Black Cockatoo (VU) and Black-striped Snake (P3).
- Ecoscape (2021b) *Flynn Drive Flora and Vegetation Survey 2020*. Survey area is adjacent to this survey with similar habitat types. Two fauna habitat types occur: Woodland, which occurs across the majority of the

survey area; and Shrubland, which is present in revegetated areas found as isolated patches throughout the survey area. Woodland habitat within the survey area will likely support bird and ground-dwelling vertebrate species present, including the conservation significant Black Cockatoo species (Carnaby's Cockatoo and the Forest Red-tailed Black Cockatoo)

- Eco Logical (2013) *Targeted Flora and Fauna Assessment Lot 4 Flynn Drive Neerabup*. Survey area is adjacent to this survey with similar habitat types.
- Eco Logical (2012) *Vertebrate Fauna Survey Lot 701 Flynn Drive Neerabup*. Survey area is adjacent to this survey with similar habitat types and fauna assemblage
- Ecoscape (2019) *Black Cockatoo Habitat Survey (Neerabup Industrial Area) Offset Sites*. Survey area is adjacent to this survey with similar habitat types. Foraging habitat for the Black Cockatoo species was assessed as being in moderate quality.
- GHD (2014) *Neerabup Road Extension Level 2 Fauna Survey*. Survey area is adjacent to this survey with similar habitat types.

Review of the relevant literature indicates that some of the largest intact areas of vegetated habitat within the Swan Coastal Plain IBRA region overlay the Gngangara Groundwater System (GGS) (Wilson *et al.* 2009), over which the current survey area is situated. Remnant patches of native vegetation which are of sufficient quality and connectivity can allow for persistence of native fauna species in the local area (How & Dell 2000; Wilson *et al.* 2009). Vegetation within the GGS, particularly Banksia dominated woodlands, provides critical habitat for the endangered Carnaby's Cockatoo (Wilson *et al.* 2009).

Habitat overlying the GGS is dominated by *Banksia* woodlands with stands of *Eucalyptus* and *Allocasuarina*, over mixed understorey shrubs of Myrtaceae, Proteaceae and Fabaceae (Wilson *et al.* 2012). Scattered wetlands and damplands with *Melaleuca* are also present. This habitat is known to support a rich assemblage of ground-dwelling fauna, with a high diversity of species recorded from *Banksia* woodland, whilst Tuart woodland of the area is characterised by high abundance of reptiles but only a relatively low diversity of species (Valentine *et al.* 2009). Richness of mammal species on the Swan Coastal Plain is reported to have declined significantly since historic records, with approximately 37% of native mammal species extant in the northern Swan Coastal Plain in 1970 compared with historic records (Valentine *et al.* 2009). Surveys associated with recent major infrastructure works in the Neerabup area, undertaken by ERM (2009) and GHD (2014), also reported that bird and reptile species were the most commonly observed, with mammalian species (excluding bats) comprising just 12.5% and 8% of survey capture records respectively.

Conservation significant fauna species recorded from the Ecoscape, ERM and GHD surveys include (showing status under the BC Act; EPBC Act):

- Carnaby's Cockatoo – *Calyptorhynchus latirostris* – (EN; EN) (Ecoscape 2021a; ERM 2009; GHD 2014)
- Rainbow Bee-eater – *Merops ornatus* – (IA; MA) (GHD 2014)
- Quenda – *Isodon fusciventer* – (P4; -) (GHD 2014)
- Western Brush Wallaby – *Macropus irma* – (P4; -) (GHD 2014)
- Carpet Python – *Morelia spilota imbricata* – (OS; -) (GHD 2014).

3 METHODS

3.1 GUIDING PRINCIPLES

The fauna and fauna habitat survey was conducted as a Basic survey according to the Fauna Technical Guidance (EPA 2020). The EPA recommends a basic survey should:

- be conducted as a low intensity survey to gather broad fauna and habitat information
- verify the adequacy of the desktop assessment
- map, describe and photograph habitats
- record opportunistic fauna observations
- identify possible future survey site locations, access and logistics
- determine if a detailed survey is required.

Targeted surveys were also conducted to gather information on significant fauna and/or habitats.

3.2 FAUNA FIELD SURVEY

The methods utilised during the field survey followed those outlined in the Fauna Technical Guidance (EPA 2020), conducted as a Basic fauna survey. Conservation criteria used in this assessment are included in **Table 14** and **Table 15** in **Appendix One**. Survey method details are outlined below.

3.2.1 FAUNA HABITAT ASSESSMENT

The fauna habitats present within the survey areas were identified and mapped. Fauna habitats were described as an area which is distinguishable from its surrounding area by its landform, vegetation and fauna assemblage occupying the area. In addition, its likelihood to harbour specialised fauna species which are not found in adjacent areas was taken into consideration.

The following information was used to identify and map all fauna habitats within the survey area:

- previous fauna habitat mapping
- land systems
- vegetation type and condition mapping
- aerial imagery
- landforms
- soil characteristic
- fauna assemblage information.

The composition and characteristics of each fauna habitat type was recorded, including noting suitability for various fauna suites or conservation-listed species. Habitat types were delineated in the field and digitised upon return from the field survey.

3.2.2 FAUNA SURVEY

The fauna survey incorporated a number of survey techniques as per recommendations for Basic fauna survey in the Terrestrial Fauna Technical Guidance (EPA 2020), including habitat assessment, active diurnal searches, raking of spoil heaps and leaf litter, searches for secondary evidence such as scats and tracks, and opportunistic searches.

The use of motion-activated cameras for the detection of fauna was not applied for this survey. This was due to the low potential for image capture of target conservation-listed species (based on known behaviour and preferred habitat of species considered likely to occur), as well as the high risk of equipment theft or vandalism given public accessibility and proximity to a busy road. Recording devices for detection of bat calls were not installed for similar reasons.

Terrestrial vertebrate fauna were the main targets of the field survey. Survey techniques included:

- opportunistic bird observations while moving through the survey area
- turning of surface debris (rocks, logs, vegetation spoil heaps) that reptiles and mammals may shelter beneath
- raking of litter beds using to locate fossorial reptile species
- tree hollow inspection to detect arboreal fauna.

Fauna species were identified opportunistically based on sightings, calls, remains, diggings, and other signs. Potential habitats for conservation significant species were identified and evaluated, and the likelihood of species occurrence subsequently assessed. Species identified during desktop assessment as having a High likelihood of occurrence in the survey area was targeted during the field survey.

3.2.3 TARGETED SURVEY METHODS

3.2.3.1 Black Cockatoo Assessment Methods

Potential and active (actual) Black Cockatoo breeding trees were assessed as per Commonwealth guidance (DSEWPaC 2012). Relevant aspects of the recent draft referral guidelines (Commonwealth of Australia 2017) were also incorporated into the survey as this allows data to be gathered that could potentially be used when the updated referral guidelines are finalised.

Potential and actual Black Cockatoo habitat trees are:

- listed tree species as provided in the Commonwealth guidance (DSEWPaC 2012)
- minimum size of 500 mm diameter at breast height (DBH) for most species, or 300 mm DBH for Salmon Gum and Wandoo, neither of which occur within the survey area.

The following were recorded for each potential and actual habitat tree:

- location, recorded using a handheld GPS device with an accuracy of approximately 5 m
- species and DBH
- identifying if tree hollows of suitable size and orientation are present, and recording evidence of use by cockatoos such as chewing at the hollow entrance
- habitat value according to the scoring system developed by Dr Mike Bamford (2016); this score reflects the existing value of the tree characteristics with respect to its potential to be used as a nesting tree (as per **Table 16 in Appendix One**)
- photograph of each tree, showing hollows if possible
- known nesting trees as per DBCA data.

The suitability of the survey area for breeding (additional to the specific tree survey) and as foraging habitat (as per the Commonwealth (2017) scoring tool; **Table 17, Appendix One**) was also assessed and mapped, taking into consideration:

- the presence of species favoured for foraging (as listed in the Commonwealth guidance, including Proteaceous species, Eucalypt species, *Pinus* species etc.)

- evidence of foraging e.g. chewed Eucalypt nuts
- location of known nesting or night roosting trees
- surrounding vegetation, up to at least 12 km from the survey area and taking into consideration the proximity to any known breeding habitat and watering points
- presence of disease, such as *Phytophthora cinnamomi* or Marri Canker (*Quambalaria coyrecup*).

3.2.3.2 Other Species of Conservation Significance

Other conservation-listed species, including migratory birds, with the potential to occur, such as the listed migratory (MI) waterbirds, were targeted using active searches (incorporating avian surveys) during the field survey.

3.2.4 FIELD SURVEY TIMING

The survey was conducted in spring of 2021, over two days on 20 and 21 October.

3.3 DATA MANAGEMENT

Data gathered through the desktop review, field survey habitat assessments and observations were collated to provide locations of significant fauna species records and maps of fauna habitat types. Fauna habitat quality was assessed at each sampling point to provide an overall habitat quality of the survey area, as this may vary across habitats of different type.

4 FIELD SURVEY RESULTS

The fauna survey was conducted by [REDACTED] (Senior Ecologist) and [REDACTED] (Environmental Scientist) during 20-21 October 2021.

The survey was conducted in accordance with the requirements for a Basic fauna survey as outlined in the Fauna Technical Guidance (EPA 2020). The entire site was traversed on foot and all habitats were assessed for quality and capability of supporting both locally common and significant fauna species.

4.1 FAUNA HABITAT

One fauna habitat type was recorded within the survey area (**Table 9**):

- Banksia Woodland.

Degraded areas of prior disturbance or historical tracks or which had modified structure or floristic assemblage but were small in size and showing evidence of regeneration, are not considered to be a separate habitat unit. It is expected that similar resources are available in these areas to support the fauna assemblage of the survey area.

Some areas of cleared track within the survey area were not considered habitat for terrestrial vertebrates due to a lack of adequate structure or vegetation to provide shelter or foraging resources. These areas may provide some limited habitat for invertebrates which could be preyed upon opportunistically by vertebrate species, however, as these tracks within the survey area are well maintained and regularly accessed by vehicle, they are not expected to support the local fauna assemblage and have thus been mapped as not constituting habitat.

The quality of each habitat type was based on the field surveyor's experience and takes into consideration the level of disturbance to habitats from weeds, the amount of native vegetation, vegetation cover (density) and the context of the habitat with the surrounding landscape.

Table 9: Fauna habitat types

Habitat type	Description	Photograph
Banksia Woodland	<i>Banksia attenuata</i> low woodland over shrubs and sedges on grey sandy soils The habitat is significant foraging habitat for Black Cockatoo species and provides forage resources and shelter for small mammals, reptiles and woodland bird species. Extent: 8.39 ha; 92.69%	
Cleared Track	Not Habitat Well utilised sandy tracks and firebreak with no structural cover other than seasonal presence of weeds. Extent: 0.66 ha; 7.39%	

Banksia Woodland (8.39 ha)

Woodland habitat dominated by Candlestick Banksia, Jarrah and She-Oak over grasstrees and low shrubs and sedges. Habitat provides shelter, foraging and breeding resources for a common suite of small mammals, reptiles, and small woodland bird species e.g. Quenda, Skinks, and Fairy Wrens. Soils are dominated by loose grey Bassendean sands. The habitat provides foraging resources for the conservation listed Black Cockatoo species.

Cleared Track (0.66 ha)

Areas effectively devoid of vegetation, associated with road infrastructure or property utilised for business and/or industry. Also incorporates access tracks and firebreaks which are maintained or recently cleared. Positioned on undulating Bassendean sands, in part bituminised, these areas exhibit limited cover of weedy annual grasses and are subject to weed control activities. No natural habitat for vertebrate fauna species is provided, although fauna may pass through the area on occasion or opportunistically predate invertebrates.

4.2 FAUNA ASSEMBLAGE

Twenty-four vertebrate fauna species, including three that are conservation-listed and one introduced species, were recorded by bird survey or opportunistically during the survey (**Table 19, Appendix Three**). Survey sites are listed in **Table 20, Appendix Three**.

- one mammal
- 23 birds (one introduced).

Of these, three are conservation-listed:

- *Calyptorhynchus latirostris* (Carnaby's Cockatoo); EN (EPBC and BC status)
- *Isoodon fusciventer* (Quenda); P4 (DBCA status)
- *Merops ornatus* (Rainbow Bee-eater); MA (EPBC Status).

4.3 BLACK COCKATOO HABITAT ASSESSMENT

The survey area is within the mapped distribution of Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo (DSEWPac 2012). Carnaby's Cockatoo was recorded during the field survey. Baudin's Cockatoo was identified by the desktop assessment as potentially occurring within the survey area, however, the Commonwealth mapped distribution for this species does not cover the survey area.

4.3.1 BREEDING HABITAT

Black Cockatoo habitat trees were assessed according to the criteria outlined in Commonwealth guidelines (DSEWPac 2012), with additional information recorded using the Bamford (2016) grading classifications to identify the potential suitability of trees to be used for nesting based on the presence of, size and orientation of hollows (**Table 16, Appendix One**).

A total of 38 trees were recorded that satisfied the parameters of the guidelines to be considered as Black Cockatoo habitat trees (DSEWPac 2012). The trees are all Jarrah (*Eucalyptus marginata*), with the exception of one other Eucalypt (*Eucalyptus ?camaldulensis*) for which identification could not be confirmed to species level. The results of the habitat assessment for classes are summarised in **Table 10**. There were no Class 1 or Class 2 trees (i.e. those having hollows suitable for nesting) recorded.

Table 10: Black Cockatoo habitat tree summary

Tree Class	No. of trees
3 (suitable hollow, no chew marks)	2
4 (hollows not suitable)	15
5 (no hollows)	21

The potential for Black Cockatoo habitat trees to be used for breeding was assessed using the Bamford (2016) grading classification scale. Twenty-one Class 5 (no hollows), 15 Class 4 (no hollows of suitable size or orientation) and two Class 3 (suitable hollows without evidence of use) trees were recorded by the survey.

4.3.2 FORAGING AND ROOSTING HABITAT

There is roosting habitat within the survey area. A total of 38 large Eucalypt trees were identified within the survey area that are available as potential roosting habitat. The survey area is approximately 9.06 ha in extent and therefore the density of roosting habitat is approximately 4.19 roosting trees per hectare.

The suitability of the survey area as foraging habitat was assessed and mapped as per the Commonwealth (2017) scoring tool (**Table 17, Appendix One**).

The survey area recorded high quality foraging habitat where the Banksia Woodland habitat type was mapped. Carnaby's Cockatoo were observed flying overhead on several occasions during the survey.

The total extent of suitable foraging habitat within the survey area is 9.06 ha, with the habitat quality scores as below tabulated using the Commonwealth (2017) guidelines' example. Foraging habitat quality for the Black Cockatoo species likely to occur (and were recorded) was assessed and scored as detailed in **Table 11-12**.

Table 11: Foraging habitat scoring tool – Carnaby's Cockatoo

Habitat Summary for Carnaby's Cockatoo Foraging Habitat		Score
Starting Score:		
	Native shrubland, kwongan heathland and woodland dominated by proteaceous plant species such as <i>Banksia</i> spp.	7
Attributes improving functionality of foraging habitat:		
	Is within the Swan Coastal Plain	+3
	Contains trees with suitable nest hollows	+3
	Contains trees with potential to be used for breeding (DBH $\geq$ 500 mm).	+2
Attributes reducing functionality of foraging habitat:		
	None applicable	-
FINAL SCORE		15

The final score is 15 (out of a maximum score of 21). According to the guidelines this indicates 'very high quality' foraging habitat for Carnaby's Cockatoo.

Table 12: Foraging habitat scoring tool – Forest Red-tailed Black Cockatoo

Habitat Summary for Forest Red-tailed Black Cockatoo Foraging Habitat		Score
Starting Score:		
	Jarrah and marri woodlands	7
Attributes improving functionality of foraging habitat:		
	Contains trees with suitable nest hollows	+3
	Jarrah and/or marri show good recruitment	+3
	Contains trees with potential to be used for breeding (DBH ≥ 500 mm).	+2
Attributes reducing functionality of foraging habitat:		
	No clear evidence of feeding debris	-2
FINAL SCORE		13

The final score is 13 (out of a maximum score of 21). According to the guidelines this indicates 'very high quality' foraging habitat for Forest Red-tailed Black Cockatoo.

4.4 SIGNIFICANT FAUNA AND ASSOCIATED HABITAT

The conservation listed fauna species observed during the field survey are discussed below with respect to each species' habitat requirements, taking into consideration the findings of the field survey and survey effort.

Carnaby's Cockatoo (*Calyptorhynchus latirostris*) – EN EPBC and BC status

Carnaby's Cockatoo occurs in uncleared or remnant native eucalypt woodlands and shrubland or Kwongan heathland dominated by *Hakea*, *Banksia*, and *Grevillea* species. It is a seasonal visitor to plantations of exotic pines (*Pinus* spp.), and sometimes occurs in forests (Johnstone *et al.* 2011). The survey area falls within the species range with the woodlands of the survey area providing limited potential breeding and foraging habitat for the species.

This species was recorded flying over the survey area on several occasions during the survey. No individuals were observed alighting within the survey area, however, it is likely that the habitat is being utilised for foraging.

Quenda (*Isodon fusciventer*) – P4 DBCA status

Quenda are widely distributed in the southwest of Western Australia from Guilderton (north of Perth) to east of Esperance. They have a patchy distribution through the Jarrah and Karri forest, the Swan Coastal Plain, and inland as far as Hyden and have been recorded in swampy, vegetation with dense cover up to 1 m high. They often feed in adjacent forest and woodland that is burnt on a regular basis and in areas of pasture and cropland lying close to dense cover. Populations inhabiting Jarrah and Wandoo forests are usually associated with watercourses. Quenda will thrive in more open habitat subject to introduced predator control (Department of Environment and Conservation 2012).

The Banksia Woodland habitat within the survey area, and the immediate adjacent areas of native vegetation, provide shelter and foraging resources for the Quenda. Evidence of this species in the form of diggings (**Image 1, Image 2**) was recorded throughout the survey area during the field survey. Based on the recency and number of diggings observed, this species is managing to persist in the local area and is actively foraging within Wallangarra Reserve.



Image 1: Quenda diggings at base of sedges



Image 2: Quenda diggings in sand

Rainbow Bee-eater (*Merops ornatus*) – MA EPBC Status

The Rainbow Bee-eater is a colourful, medium-sized bird that is abundant and widespread across Australia. It is classified as 'Least Concern' under IUCN listings and is not considered globally threatened. Within Australia it is listed as a Marine species under the EPBC Act, but it does not hold any State listing under the BC Act nor as a Priority species. The Rainbow Bee-eater occurs in a wide range of habitats (including open woodland, shrubland and farmland), usually near permanent water, where it feeds on flying insects it catches in flight (DAWE 2021b). It is usually seen in pairs or small flocks, with breeding typically undertaken between August and January in loose colonies but occasionally as solitary pairs. Nests are comprised of an underground burrow chamber and entrance tunnel up to 1 m long, excavated in sandy soils of level or gently sloping ground (Boland 2004). Nests are not re-used in subsequent seasons.

Small numbers are likely to occur in the survey area seasonally as migratory visitors and potentially during the breeding period. There are suitable areas for potential nesting sites within the survey area, predominantly along sandy track edges and soil mounds formed from previous clearing of tracks.

The Rainbow Bee-eater was observed moving through Banksia woodland in the central and eastern parts of survey area and appeared to be frequenting a fenced sump area on Wallangarra Road, adjacent to the southeast corner of the reserve. Targeted observation of the individuals led to location of an active nesting burrow (**Image 3**) adjacent to a track within the survey area, to which individuals (likely a mating pair) were seen to descend on several occasions.



Image 3: Rainbow Bee-eater burrow in soil mound

4.5 FAUNA SURVEY LIMITATIONS

Table 13: Fauna survey limitations

Possible limitations	Constraints (yes/no): Significant, moderate or negligible	Comment
Availability of data and information	No	Many sources referencing field surveys in the vicinity were available and reviewed prior to field survey.
Competency/experience of the survey team, including bioregion experience	No	The fauna field surveyors were experienced with the fauna survey methods used and with the identification of fauna taxa.
Scope of survey e.g. excluded fauna groups	No	The survey was conducted as a Basic fauna assessment. Sufficient time was allocated to the fauna survey to assess the terrestrial vertebrate fauna assemblage and habitat present in the survey area. Targeted assessment of Black Cockatoo habitat included evaluation of forage vegetation and inspection of potential habitat trees.
Timing, weather, season	No	The timing of the field survey was within a period suitable to identify the expected fauna assemblage. The seasonal conditions were suitable.
Disturbances that may have affected results	No	No disturbance to the survey was detected.
Proportion of fauna identified, recorded, or collected	No	The survey was considered suitable to determine the presence or potential presence of conservation significant fauna.
Adequacy of survey intensity and proportion of survey achieved	No	The survey area was traversed on foot in its entirety and sufficient effort applied to habitat assessment, general and targeted survey techniques. The area is considered to be adequately surveyed.
Access	No	The entire survey area was accessible without restriction.

5 DISCUSSION

5.1 FAUNA SIGNIFICANCE

5.1.1 FAUNA HABITAT TYPES

One fauna habitat type was recorded during the field survey (**Section 4.1**):

- Banksia Woodland.

The habitat is significant as foraging habitat for the Black Cockatoo species and provides shelter and foraging resources for the suite of common vertebrate species. The survey area has value as a fauna refuge providing native vegetation cover and foraging resources in the local region.

5.1.2 FAUNA ASSEMBLAGE

A total of 24 vertebrate fauna species were recorded during the field survey (**Table 19 Appendix Three**). All were opportunistically recorded and the inventory is not exhaustive as many nocturnal and fossorial species were not detected due to the level of survey undertaken. It is likely that a common suite of Swan Coastal Plain reptiles and small mammals occur within and near to the survey area and are reliant on the bushland and Banksia Woodland habitat for their persistence. There are, however, major impacts and threats to the sustainability of these species, predominantly due to increased level of feral predators and domestic pets, mortality from vehicle impact on adjacent roads, and potentially future reductions in available habitat.

5.1.3 RECORDED CONSERVATION-LISTED SPECIES

Three conservation-listed species were recorded during the fauna survey:

- *Calyptorhynchus latirostris* (Carnaby's Cockatoo); EN (EPBC and BC status)
- *Isodon fusciventer* (Quenda); P4 (DBCA status)
- *Merops ornatus* (Rainbow Bee-eater); MA (EPBC status).

The presence of these species indicates a local level of significance as Carnaby's Cockatoo can utilise individual foraging or nesting trees, while Quenda can persist in bushland with a high density of low vegetation cover including native shrubs and sedges.

5.1.3.1 Post-survey Likelihood Assessment

Conservation-listed fauna species identified during the desktop assessment as having a High likelihood of occurring were reassessed post field survey, taking into consideration the survey effort and findings of the field survey, including habitat availability. The post-survey likelihood assessment is incorporated into **Table 18 in Appendix Two**.

The Western Brush Wallaby (*Notamacropus irma* – P4) was assessed post-field survey to have a Very low likelihood of utilising the survey area. This is due primarily to the survey area being bounded by diamond mesh fencing, preventing access by small to medium sized macropods.

Species initially assessed as having High potential to occur, that were not recorded during the field survey but are still considered to have a High likelihood of occurrence, are discussed below.

High Likelihood Species

Forest Red-tailed Black Cockatoo (*Calyptrorhynchus banksii naso*)– VU EPBC and BC status

The Forest Red-tailed Black Cockatoo was formerly common but is now rare to uncommon and patchily distributed over a range which has become markedly reduced. The species is usually observed in pairs or small flocks, seldom large flocks (up to 200). It has declined due to destruction of forests and woodlands, competition for nest hollows with native and exotic species, and the impact of fire (Department of Environment and Conservation 2008).

The Banksia Woodland habitat within the survey area contains potential nesting trees and suitable night roosting habitat, with areas of suitable foraging habitat. This species was recorded on multiple occasions in the nearby Mather Reserve and Neerabup Industrial Area development footprint (Ecoscape 2019).

6 CONCLUSION

The Basic fauna survey and Black Cockatoo habitat assessments were conducted during 20-21 October 2021 by experienced ecologists, with negligible limitations to the survey.

The following can be concluded from results of the field survey:

- the survey area is utilised by the endangered Carnaby's Cockatoo (*Calyptorhynchus latirostris*), Priority 4 Quenda (*Isoodon fusciventer*) and EPBC-listed Rainbow Bee-Eater (*Merops ornatus*)
- one further conservation-significant species (Forest Red-tailed Black Cockatoo) is considered likely to utilise the survey area
- very high quality foraging habitat is available for Carnaby's Cockatoo
- very high quality foraging habitat is available for Forest Red-tailed Black Cockatoo
- one fauna habitat type (Banksia Woodland) occurs within the survey area, supportive of bird and ground-dwelling vertebrate species
- no fauna species inhabiting, or likely to inhabit, the survey area, is considered to be dependent on the habitat within the survey area.

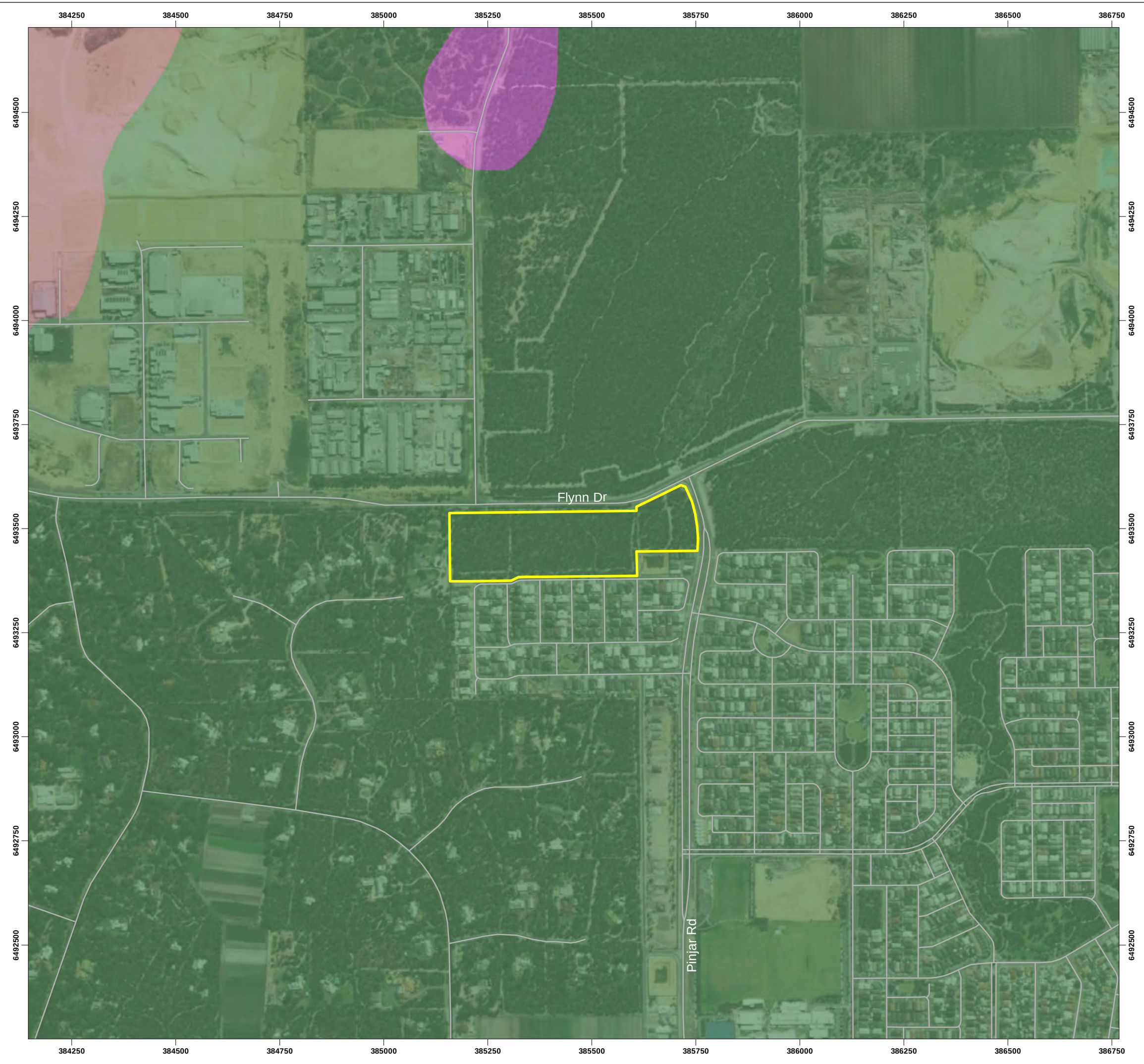
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MAPS



LEGEND

Survey Area

Roads

Land System

211Sp__Kg: Karrakatta Sand Grey Phase: Low hilly to gently undulating terrain. Iron podzols. Banksia spp woodland with E. tottiana and depauperate E. marginata; dense shrub layer.

211Sp__Kls: Karrakatta shallow soils Phase: Low hills and ridges. Bare limestone or shallow siliceous or calcareous sand over limestone. Dense low shrub dominated by Dryandra sessilis, Melaleuca huegellii and species of Grevillea.

211Sp__Ky: Karrakatta Sand Yellow Phase: Low hilly to gently undulating terrain. Yellow sand over limestone at 1-2 m. Banksia spp. woodland with scattered emergent E. gomphocephala and E. marginata and a dense shrub layer.

DATASOURCES :

SOURCE DATA: SOIL LANDSCAPE MAPPING - BEST AVAILABLE (DPIRD-027)

AERIAL: ESRI BASEMAP (2019)

BASEMAP: GEOSCIENCE AUSTRALIA

SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRIID, IGN, AND THE GIS USER COMMUNITY

SOIL LANDSCAPE MAPPING

WALLANGARRA RESERVE

SPRING BIOLOGICAL SURVEY 2021

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

PROJECTION: TRANSVERSE MERCATOR

DATUM: GDA 1994

UNITS: METER

N

0

100

200

300

400 m

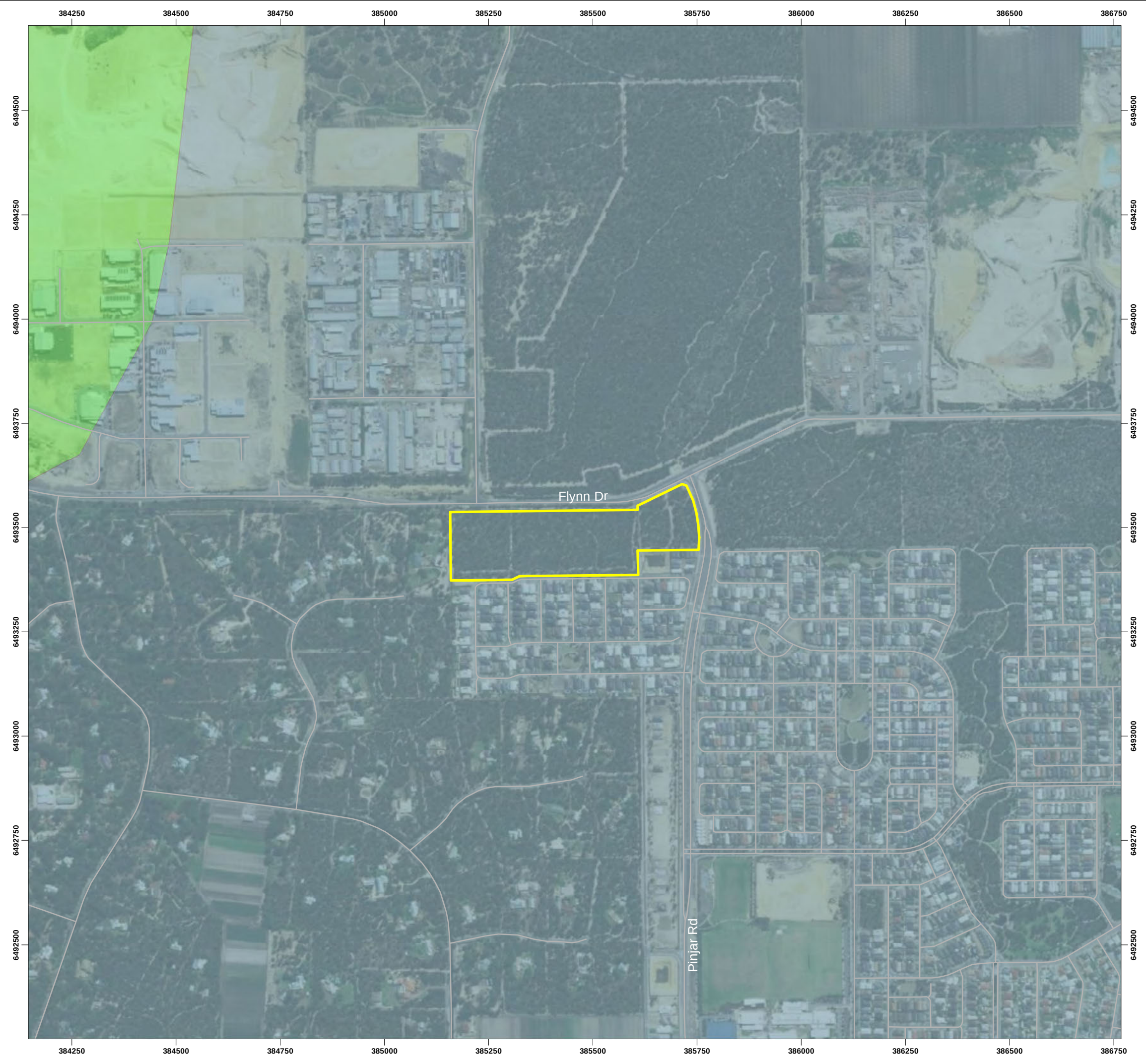
SCALE: 1:9,000 @ A3

PROJECT NO: 4693-21

REV	AUTHOR	APPROVED	DATE
00	TJ	NW	01/02/2022

MAP

1



LEGEND

Survey Area

Roads

System Association

SPEARWOOD_6: Woodland southwest: Jarrah, marri and wandoo
Eucalyptus marginata, *Corymbia calophylla*, *E. wandoo*.

SPEARWOOD_949: Low woodland or open low woodland: Other
acacia, banksia, peppermint, cypress pine, casuarina, York gum
Acacia spp., Banksia spp., Agonis flexuosa, Callitris spp.,
Allocasuarina spp., Eucalyptus loxophleba.

DATASOURCES :
SOURCE DATA: SOIL LANDSCAPE MAPPING - BEST AVAILABLE (DPIRD-027)
AERIAL: ESRI BASEMAP (2019)
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRIID, IGN, AND THE GIS USER COMMUNITY



PRE-EUROPEAN VEGETATION

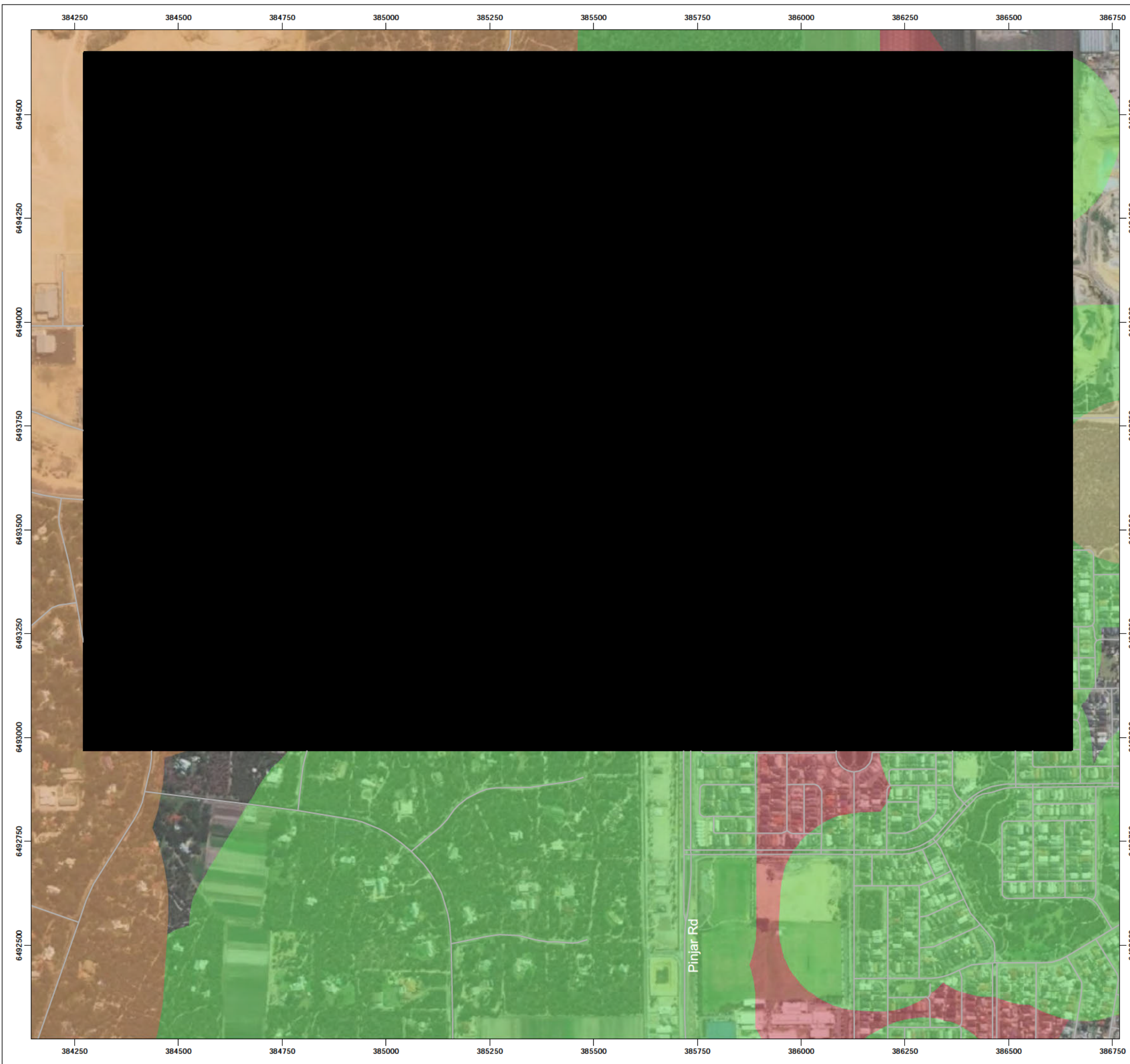
WALLANGARRA RESERVE
SPRING BIOLOGICAL SURVEY 2021



COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER



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LEGEND

- Survey Area
- Roads
- Endangered
- Priority 3
- Priority 4

TEC/PEC

- Banksia Dominated Woodlands of the Swan Coastal Plain IBRA Region
- Banksia attenuata* woodlands over species rich dense shrublands (floristic community type 20a as originally described in Gibson et al. (1994))
- Banksia ilicifolia* woodlands
- Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain

Code	Taxon	Status
Cla	<i>Calyptorhynchus latirostris</i>	EN
Hgl	<i>Hylaeus globuliferus</i>	P3
Ifu	<i>Isodon fusciventer</i>	P4
Nir	<i>Notamacropus irma</i>	P4
Sgr	<i>Synemon gratio</i>	P4

DATASOURCES :
SOURCE DATA: CONSERVATION-LISTED FLORA (DBCA 2021), TEC/PEC (DBCA 2021)
AERIAL: ESRI BASEMAP (2020)
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNESAIRBUS DS, USDA, USGS, AEROGRIID, IGN, AND THE GIS USER COMMUNITY



FLORA & COMMUNITIES DATABASE SEARCH RESULTS WALLANGARRA RESERVE SPRING BIOLOGICAL SURVEY 2021



COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER



REV	AUTHOR	APPROVED	DATE
00	TJ	NW	01/02/2022



LEGEND

Conservation Significant Fauna

- *Calyptrorhynchus latirostris* (Endangered)
- *Isodon fusciventer* (Priority 4)
- *Merops ornatus* (Marine)

Survey Area

Roads

Assessment Points

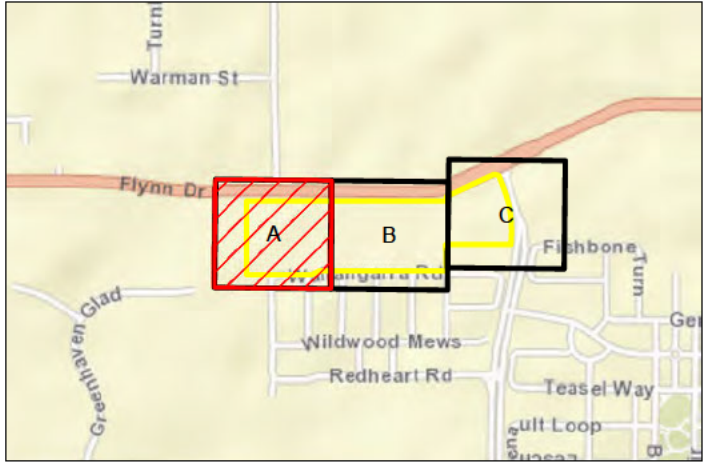
Black Cockatoo Habitat Trees

Tree Class

- ▲ 4 (hollows not suitable)
- ▲ 5 (no hollows)

Habitat Unit

- Banksia Woodland
- ▨ Cleared Track/Not Vegetated



DATASOURCES :
AERIAL: NEARMAP (2021)
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRIID, IGN, AND THE GIS USER COMMUNITY
SOURCES: ESRI, HERE, GARMIN, USGS, INTERMAP, INCREMENT P, NRCAN, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), ESRI KOREA, ESRI (THAILAND), NGCC, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

ecoscape

HABITAT, ASSESSMENT POINTS,
CS FAUNA & BC TREES
WALLANGARRA RESERVE
SPRING BIOLOGICAL SURVEY 2021



COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER



PROJECT NO: 4693-21			
REV	AUTHOR	APPROVED	DATE
00	TJ	NW	01/02/2022

MAP
4 A



LEGEND

Conservation Significant Fauna

- *Isodon fusciventer* (Priority 4)
- *Merops ornatus* (Marine)

Survey Area

— Roads

Assessment Points

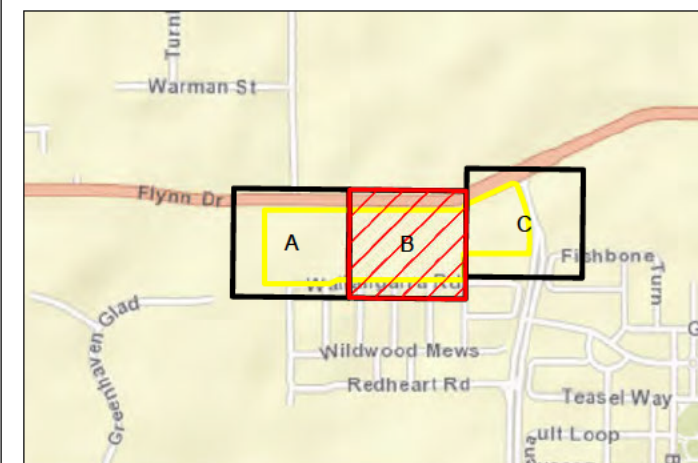
Black Cockatoo Habitat Trees

Tree Class

- ▲ 3 (hollow no chew marks)
- ▲ 4 (hollows not suitable)
- ▲ 5 (no hollows)

Habitat Unit

- Banksia Woodland
- Cleared Track/Not Vegetated



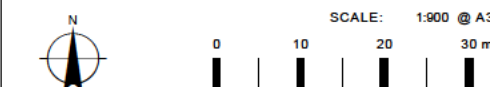
DATASOURCES :
AERIAL: NEARMAP (2021)
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRIID, IGN, AND THE GIS USER COMMUNITY
SOURCES: ESRI, HERE, GARMIN, USGS, INTERMAP, INCREMENT P, NRCAN, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), ESRI KOREA, ESRI (THAILAND), NGCC, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

ecoscape

HABITAT, ASSESSMENT POINTS, CS FAUNA & BC TREES WALLANGARRA RESERVE SPRING BIOLOGICAL SURVEY 2021



COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER



PROJECT NO: 4693-21

REV	AUTHOR	APPROVED	DATE
00	TJ	NW	01/02/2022

MAP
4B



LEGEND

Conservation Significant Fauna

- *Isodon fusciventer* (Priority 4)

- Survey Area

- Roads

- Assessment Points

Black Cockatoo Habitat Trees

Tree Class

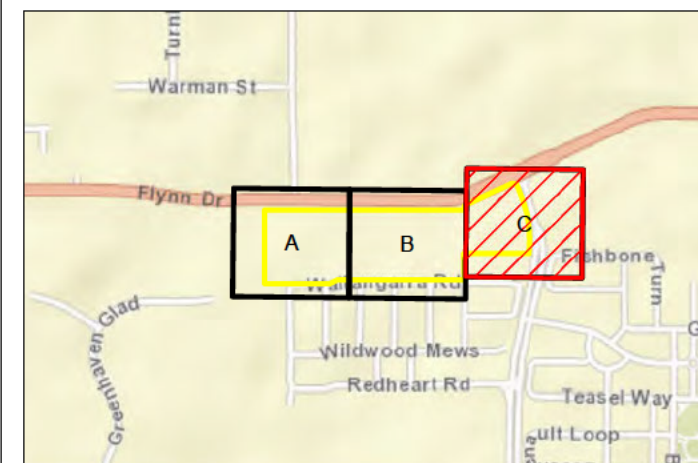
- ▲ 4 (hollows not suitable)

- ▲ 5 (no hollows)

Habitat Unit

- Banksia Woodland

- Cleared Track/Not Vegetated



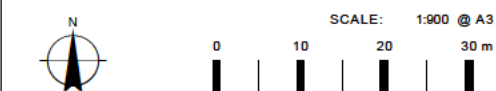
DATASOURCES :
AERIAL: NEARMAP (2021)
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRIID, IGN, AND THE GIS USER COMMUNITY
SOURCES: ESRI, HERE, GARMIN, USGS, INTERMAP, INCREMENT P, NRCAN, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), ESRI KOREA, ESRI (THAILAND), NGCC, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

ecoscape

HABITAT, ASSESSMENT POINTS, CS FAUNA & BC TREES WALLANGARRA RESERVE SPRING BIOLOGICAL SURVEY 2021



COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER



PROJECT NO: 4693-21

REV	AUTHOR	APPROVED	DATE
00	TJ	NW	01/02/2022

MAP
4C

APPENDIX ONE

DEFINITIONS AND CRITERIA

Table 14: EPBC Act categories for flora, fauna and ecological communities

Category	Threatened species	Threatened Ecological Communities
Extinct	A native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.	n/a
Extinct in the wild	A native species is eligible to be included in the extinct in the wild category at a particular time if, at that time: (a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or (b) it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.	n/a
Critically Endangered (CE)	A native species is eligible to be included in the <i>critically endangered</i> category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.	An ecological community is eligible to be included in the <i>critically endangered</i> category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria
Endangered (EN)	A native species is eligible to be included in the <i>endangered</i> category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.	An ecological community is eligible to be included in the <i>endangered</i> category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable (VU)	A native species is eligible to be included in the <i>vulnerable</i> category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium term future, as determined in accordance with the prescribed criteria.	An ecological community is eligible to be included in the <i>vulnerable</i> category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium term future, as determined in accordance with the prescribed criteria.
Conservation Dependent	A native species is eligible to be included in the conservation dependent category at a particular time if, at that time: (a) the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or (b) the following subparagraphs are satisfied: (i) the species is a species of fish; (ii) the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long-term survival in nature are maximised; (iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory; (iv) cessation of the plan of management would adversely affect the conservation status of the species.	n/a

Table 15: Conservation codes for Western Australian flora and fauna (DBCA 2019b)

Conservation Codes for Western Australian Flora and Fauna	
Threatened, Extinct and Specially Protected fauna or flora ¹ are species ² which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such.	
The Wildlife Conservation (Specially Protected Fauna) Notice 2018 and the Wildlife Conservation (Rare Flora) Notice 2018 have been transitioned under regulations 170, 171 and 172 of the Biodiversity Conservation Regulations 2018 to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the Biodiversity Conservation Act 2016.	
Categories of Threatened, Extinct and Specially Protected fauna and flora are:	
T	Threatened species Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the <i>Biodiversity Conservation Act 2016</i> (BC Act). Threatened fauna is that subset of 'Specially Protected Fauna' listed under schedules 1 to 3 of the <i>Wildlife Conservation (Specially Protected Fauna) Notice 2018</i> for Threatened Fauna. Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3 of the <i>Wildlife Conservation (Rare Flora) Notice 2018</i> for Threatened Flora. The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.
CR	Critically endangered species Threatened species considered to be "<i>facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines</i>". Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the <i>Wildlife Conservation (Specially Protected Fauna) Notice 2018</i> for critically endangered fauna or the <i>Wildlife Conservation (Rare Flora) Notice 2018</i> for critically endangered flora.
EN	Endangered species Threatened species considered to be "<i>facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines</i>". Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the <i>Wildlife Conservation (Specially Protected Fauna) Notice 2018</i> for endangered fauna or the <i>Wildlife Conservation (Rare Flora) Notice 2018</i> for endangered flora.
VU	Vulnerable species Threatened species considered to be "<i>facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines</i>". Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the <i>Wildlife Conservation (Specially Protected Fauna) Notice 2018</i> for vulnerable fauna or the <i>Wildlife Conservation (Rare Flora) Notice 2018</i> for vulnerable flora.
Extinct species	
Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.	
EX	Extinct species Species where "<i>there is no reasonable doubt that the last member of the species has died</i>", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act). Published as presumed extinct under schedule 4 of the <i>Wildlife Conservation (Specially Protected Fauna) Notice 2018</i> for extinct fauna or the <i>Wildlife Conservation (Rare Flora) Notice 2018</i> for extinct flora.
EW	Extinct in the wild species Species that "<i>is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form</i>", and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act). Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.
Specially protected species Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection. Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.	

Conservation Codes for Western Australian Flora and Fauna	
MI	Migratory species Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act). Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the <i>Convention on the Conservation of Migratory Species of Wild Animals</i> (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species. Published as migratory birds protected under an international agreement under schedule 5 of the <i>Wildlife Conservation (Specially Protected Fauna) Notice 2018</i>.
CD	Species of special conservation interest (conservation dependent fauna) Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act). Published as conservation dependent fauna under schedule 6 of the <i>Wildlife Conservation (Specially Protected Fauna) Notice 2018</i>.
OS	Other specially protected species Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act). Published as other specially protected fauna under schedule 7 of the <i>Wildlife Conservation (Specially Protected Fauna) Notice 2018</i>.
P	Priority species Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened fauna or flora. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring. Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.
1	Priority 1: Poorly-known species Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
2	Priority 2: Poorly-known species Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
3	Priority 3: Poorly-known species Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

Conservation Codes for Western Australian Flora and Fauna	
4	Priority 4: Rare, Near Threatened and other species in need of monitoring
	(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands.
	(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent.
	(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
¹ The definition of flora includes algae, fungi and lichens.	
² Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).	

Table 16: Grading system for the assessment of potential nest trees for Black Cockatoos (Bamford 2016)

Class	Description of tree and hollows/activity
1	Active nest observed; adult (or immature) bird seen entering or emerging from hollow.
2	Hollow of suitable size and angle (i.e. near-vertical) visible with chew marks around entrance.
3	Potentially suitable hollow visible but no chew marks present; or potentially suitable hollow present (as suggested by structure of tree, such as large, vertical trunk broken off at a height of >10m).
4	Tree with large hollows or broken branches that might contain large hollows but hollows or potential hollows are not vertical or near-vertical; thus a tree with or likely to have hollows of sufficient size but not to have hollows of the angle preferred by Black Cockatoos.
5	Tree lacking large hollows or broken branches that might have large hollows; a tree with more or less intact branches and a spreading crown.

Table 17: Black Cockatoo foraging quality scoring tool (Commonwealth of Australia 2017)

Starting Score	Foraging habitat for Carnaby's Cockatoo	Foraging habitat for Baudin's Cockatoo	Foraging habitat for Forest Red-tailed Black cockatoo
10 (Very high quality)	Foraging habitat that is being managed for black cockatoos such as habitat that is the focus of successful rehabilitation, and/or has some level of protection from clearing, and/or is quality habitat described below with attributes contributing to meet a score of ≥ 10	Foraging habitat that is being managed for black cockatoos such as habitat that is the focus of successful rehabilitation, and/or has some level of protection from clearing, and/or is quality habitat described below with attributes contributing to meet a score of ≥ 10	Foraging habitat that is being managed for black cockatoos such as habitat that is the focus of successful rehabilitation, and/or has some level of protection from clearing, and/or is quality habitat described below with attributes contributing to meet a score of ≥ 10
7 (High quality)	Native shrubland, kwongan heathland and woodland dominated by proteaceous plant species such as Banksia spp. (including Dryandra spp.), Hakea spp. and Grevillea spp., as well as native eucalypt woodland and forest that contains foraging species, including along roadsides. Does not include orchards, canola, or areas under a RFA	Native eucalypt woodlands and forest, and proteaceous woodland and heath, particularly marri, including along roadsides. Does not include orchards or areas under a RFA	Jarrah and marri woodlands and forest, and edges of karri forests, including wandoo and blackbutt, within the range of the subspecies, including along roadsides. Does not include areas under a RFA
5 (Quality)	Pine plantation or introduced eucalypts	Pine plantation or introduced eucalypts	Pine plantation or introduced eucalypts

Starting Score	Foraging habitat for Carnaby's Cockatoo	Foraging habitat for Baudin's Cockatoo	Foraging habitat for Forest Red-tailed Black cockatoo
1 (Low quality)	Individual foraging plants or small stand of foraging plants	Individual foraging plants or small stand of foraging plants	Individual foraging plants or small stand of foraging plants
Additions	Context adjustor - attributes improving functionality of foraging habitat	Context adjustor - attributes improving functionality of foraging habitat	Context adjustor - attributes improving functionality of foraging habitat
+3	Is within the Swan Coastal Plain (important foraging area).	Is within the known foraging area (see map).	Jarrah and/or marri show good recruitment (i.e. evidence of young trees).
+3	Contains trees with suitable nest hollows	Contains trees with suitable nest hollows	Contains trees with suitable nest hollows
+2	Primarily contains marri	Primarily contains marri	Primarily contains marri and/or jarrah
+2	Contains trees with potential to be used for breeding (dbh $\geq$ 500 mm or $\geq$ 300 mm dbh for salmon gum and wandoo)	Contains trees with potential to be used for breeding (dbh $\geq$ 500 mm or $\geq$ 300 mm dbh for salmon gum and wandoo)	Contains trees with potential to be used for breeding (dbh $\geq$ 500 mm or $\geq$ 300 mm dbh for salmon gum and wandoo)
+1	Is known to be a roosting site	Is known to be a roosting site	Is known to be a roosting site
Subtractions	Context adjustor - attributes reducing functionality of foraging habitat	Context adjustor - attributes reducing functionality of foraging habitat	Context adjustor - attributes reducing functionality of foraging habitat
-2	No clear evidence of feeding debris	No clear evidence of feeding debris	No clear evidence of feeding debris
-2	No other foraging habitat within 6 km	No other foraging habitat within 6 km	No other foraging habitat within 6 km
-1	Is > 12 km from a known breeding location	Is > 12 km from a known breeding location	Is > 12 km from a known breeding location
-1	Is > 12 km from a known roosting site	Is > 12 km from a known roosting site	Is > 12 km from a known roosting site
-1	Is > 2 km from a watering point	Is > 2 km from a watering point	Is > 2 km from a watering point
-1	Disease present (e.g. <i>Phytophthora cinnamomi</i> or marri canker)	Disease present (e.g. <i>Phytophthora cinnamomi</i> or marri canker)	Disease present (e.g. <i>Phytophthora cinnamomi</i> or marri canker)

APPENDIX TWO

DESKTOP ASSESSMENT RESULTS AND LIKELIHOOD ASSESSMENTS

Table 18: Fauna database results and likelihood assessments

Blue shading indicates post-survey high likelihood; darker blue indicates species was recorded from the survey area

Species	Common name	Conservation status		Database			Likelihood of occurrence	
		EPBC Act	Western Australian	PMST*	DBCA	NatureMap	Desktop	Post-survey
Mammals								
<i>Dasyurus geoffroii</i>	Chuditch	VU	VU	Likely	-	-	Very low	Very low
<i>Hydromys chrysogaster</i>	Water-rat	-	P4	-	X	X	Low	Very low
<i>Isoodon fusciventer</i>	Quenda	-	P4	-	X	X	High	Recorded
<i>Macroderma gigas</i>	Ghost Bat	VU	-	May	-	-	Very Low	Very Low
<i>Notamacropus irma</i>	Western Brush Wallaby	-	P4	-	X	X	High	Very low
<i>Perameles bougainville</i> subsp. <i>bougainville</i>	Western Barred Bandicoot	EN	VU	-	-	X	Very low	Very low
Birds								
<i>Apus pacificus</i>	Fork-tailed Swift	MI	MI	Likely	-	-	Very low	Very low
<i>Botaurus poiciloptilus</i>	Australasian Bittern	EN	EN	May	-	X	Very low	Very low
<i>Calidris canutus</i>	Red Knot	EN & MI	EN	May	-	-	Very low	Very low
<i>Calidris ferruginea</i>	Curlew Sandpiper	CR & MI	CR	Known	-	-	Very low	Very low
<i>Calidris melanotos</i>	Pectoral Sandpiper	MI	MI	May	-	-	Very low	Very low
<i>Calidris ruficollis</i>	Red-necked Stint	MI	MI	Known	-	-	Very low	Very low
<i>Calidris subminuta</i>	Long-toed Stint	MI	MI	Known	-	-	Very low	Very low
<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black Cockatoo	VU	VU	Likely	X	X	High	High
<i>Calyptorhynchus baudinii</i>	Baudin's Cockatoo	EN	EN	-	X	X	Low	Low
<i>Calyptorhynchus latirostris</i>	Carnaby's Cockatoo	EN	EN	Known	X	X	High	Recorded
<i>Falco peregrinus</i>	Peregrine Falcon	-	OS	-	X	X	Medium	Low
<i>Ixobrychus dubius</i>	Australian Little Bittern	-	P4	-	-	X	Very low	Very low
<i>Leipoa ocellata</i>	Malleefowl	VU	VU	Likely	-	-	Very low	Very low
<i>Limosa limosa</i>	Black-tailed Godwit	MI	MI	-	X	X	Very low	Very low
<i>Limosa lapponica</i>	Bar-tailed Godwit	MI (& VU or CR at subsp. level)	MI (& VU or CR at subsp. level)	May	-	-	Very low	Very low

DESKTOP ASSESSMENT RESULTS AND LIKELIHOOD ASSESSMENTS

Species	Common name	Conservation status		Database			Likelihood of occurrence	
		EPBC Act	Western Australian	PMST*	DBCA	NatureMap	Desktop	Post-survey
<i>Limosa lapponica menzbieri</i>	Bar-tailed Godwit (Northern Siberian)	CR (& MI at sp. level)	CR (& MI at sp. level)	May	-	-	Very low	Very low
<i>Merops ornatus</i>	Rainbow Bee-eater	MA	-	May	-	-	Low	Recorded
<i>Motacilla cinerea</i>	Grey Wagtail	MI	MI	May	-	-	Very low	Very low
<i>Numenius madagascariensis</i>	Eastern Curlew	CR & MI	CR	May	-	-	Very low	Very low
<i>Plegadis falcinellus</i>	Glossy Ibis	MI	MI	-	X	X	Low	Very low
<i>Rostratula australis</i>	Australian Painted Snipe	EN	EN	Likely	-	-	Very low	Very low
Reptiles								
<i>Neelaps calonotos</i>	Black-striped Snake	-	P3	-	X	X	Low	Low

* PMST likelihood of occurrence or likelihood of habitat occurring

APPENDIX THREE FIELD SURVEY RESULTS

Table 19: Recorded fauna species

Species	Common name	EPBC Act status	Western Australian status
Mammals			
<i>Isodon fusciventer</i>	Quenda	-	P4
Birds			
<i>Acanthorhynchus superciliosus</i>	Western Spinebill	-	-
<i>Anthochaera carunculata</i>	Red Wattlebird	-	-
<i>Banardius zonarius</i>	Australian Ringneck	-	-
<i>Cacatua roseicapilla</i>	Galah	-	-
<i>Cacatua sanguinea</i>	Little Corella	-	-
<i>Calyptorhynchus latirostris</i>	Carnaby's Cockatoo	EN	EN
<i>Colluricincla harmonica subsp. rufiventris</i>	Grey Shrike-thrush	-	-
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	-	-
<i>Corvus coronoides</i>	Australian Raven	-	-
<i>Cracticus tibicen</i>	Australian Magpie	-	-
<i>Cracticus torquatus</i>	Grey Butcherbird	-	-
<i>Gavicalis virescens</i>	Singing Honeyeater	-	-
<i>Gerygone fusca</i>	Western Gerygone	-	-
<i>Lichmera indistincta</i>	Brown Honeyeater	-	-
<i>Malurus splendens</i>	Splendid Fairy-wren	-	-
<i>Merops ornatus</i>	Rainbow Bee-eater	MA	-
<i>Lichmera indistincta</i>	Brown Honeyeater	-	-
<i>Pachycephala occidentalis</i>	Western Golden Whistler	-	-
<i>Pachycephala pectoralis</i>	Golden Whistler	-	-
<i>Pardalotus striatus</i>	Striated Pardalote	-	-
<i>Phaps chalcoptera</i>	Common Bronzewing	-	-
<i>Phylidonyris novaehollandiae</i>	New Holland Honeyeater	-	-
<i>*Trichoglossus haematodus</i>	Rainbow Lorikeet	-	-

*introduced species

Table 20: Fauna sites (GDA94, Zone 50)

Site Name	Site Type	Easting	Northing
B01	Ornithological Survey		
B02	Ornithological Survey		
F01	Sighting		
F02	Burrow/Mound		
F03	Sighting		
F04	Sighting		
F05	Tracks/Diggings/scratching		
F06	Burrow/Mound		
F07	Tracks/Diggings/Scratching		

Site Name	Site Type	Easting	Northing
F08	Burrow/Mound		
F09	Sighting		
F10	Sighting		
F11	Burrow/Mound		
H01	Habitat Assessment		
H02	Habitat Assessment		
H03	Habitat Assessment		

Table 21: Black Cockatoo habitat tree data

Tree No.	Species	DBH (mm)	No. of Hollows	Tree Class	Bees Present
1	Jarrah	620	0	5_no_hollows	no
2	Jarrah	1750	1	4_hollows_not_suitable	no
3	Jarrah	510	0	5_no_hollows	no
4	Jarrah	900	0	5_no_hollows	no
5	Jarrah	780	0	5_no_hollows	no
6	Jarrah	540	0	5_no_hollows	no
7	Jarrah	580	0	5_no_hollows	no
8	Jarrah	910	1	3_hollow_no_chew_marks	no
9	Jarrah	131	2	4_hollows_not_suitable	no
10	Jarrah	670	0	5_no_hollows	no
11	Jarrah	670	1	4_hollows_not_suitable	no
12	Jarrah	650	1	4_hollows_not_suitable	no
13	Jarrah	1160	0	5_no_hollows	no
14	Jarrah	870	0	5_no_hollows	no
15	Jarrah	990	3	4_hollows_not_suitable	no
16	Jarrah	630	0	5_no_hollows	no
17	Jarrah	530	1	4_hollows_not_suitable	no
18	Jarrah	1040	0	5_no_hollows	no
19	Jarrah	860	1	4_hollows_not_suitable	no
20	Jarrah	710	2	3_hollow_no_chew_marks	no
21	Jarrah	670	1	4_hollows_not_suitable	no
22	Jarrah	1000	0	5_no_hollows	no
23	Jarrah	830	0	5_no_hollows	no
24	Jarrah	1080	1	4_hollows_not_suitable	no
25	Jarrah	1090	1	4_hollows_not_suitable	no
26	Jarrah	710	3	4_hollows_not_suitable	no
27	Jarrah	520	1	4_hollows_not_suitable	no
28	Jarrah	510	0	5_no_hollows	no
29	Jarrah	550	0	5_no_hollows	no
30	Jarrah	1230	0	5_no_hollows	no
31	Jarrah	750	0	5_no_hollows	no
32	Jarrah	770	0	5_no_hollows	no
33	Jarrah	520	0	5_no_hollows	no
34	Jarrah	530	0	5_no_hollows	no
35	Jarrah	580	1	4_hollows_not_suitable	no
36	Jarrah	540	1	4_hollows_not_suitable	no

Tree No.	Species	DBH (mm)	No. of Hollows	Tree Class	Bees Present
37	Jarrah	860	1	4_hollows_not_suitable	yes
38	<i>Eucalyptus</i> <i>?camaldulensis</i>	600	0	5_no_hollows	no