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# FLYNN DRIVE BASIC FAUNA SURVEY 2020

City of Wanneroo

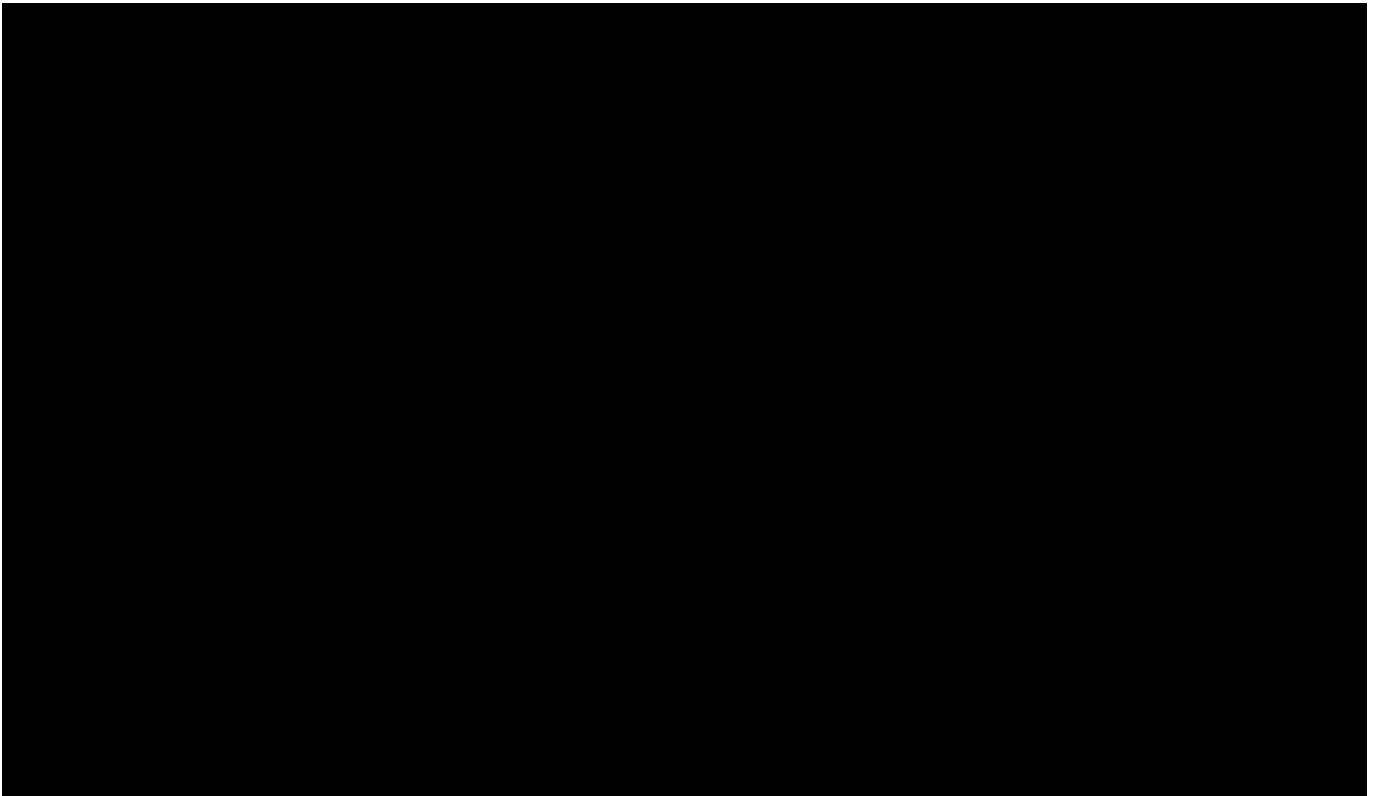
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Image 1: Marri nuts chewed by Carnaby's Cockatoo

## EXECUTIVE SUMMARY

The City of Wanneroo (the City) engaged Ecoscape to undertake a biological survey of a portion of Flynn Drive in Neerabup (between Travertine Vista and Pinjar Road), 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 2020.

The desktop assessment identified the following relevant aspects:

- database searches for significant fauna species identified 34 terrestrial vertebrate fauna species. Five of these species were considered to have a high likelihood of occurrence within the survey area.
- one species of Black Cockatoo (Carnaby's Cockatoo – *Calyptorhynchus latirostris*) had previously been recorded from the survey area.

The field survey undertaken during 6-7 October 2020 identified the following:

- 21 vertebrate fauna species were recorded from the survey area during the field survey (one mammal, 19 birds, one reptile) including one species of significance (Carnaby's Cockatoo)
- 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 and the Forest Red-tailed Black Cockatoo)
- 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	
<b>BC Act</b>	Western Australian <i>Biodiversity Conservation Act 2016</i>
<b>BoM</b>	Bureau of Meteorology
<b>CD</b>	Conservation Dependent (fauna; specially protected species under the Western Australian BC Act)
<b>CR</b>	Critically Endangered (listed under Commonwealth EPBC Act and/or Western Australian BC Act)
<b>DAWE</b>	Commonwealth Department of Agriculture, Water and Environment (2020-)
<b>DBCA</b>	Western Australian Department of Biodiversity, Conservation and Attractions
<b>DBH</b>	Diameter at Breast Height (1.3 m)
<b>DEC</b>	Western Australian Department of Environment and Conservation (2006-2013, now DBCA)
<b>DEWHA</b>	Commonwealth Department of the Environment, Water, Heritage and the Arts (2007-2010, now DAWE)
<b>DMIRS</b>	Western Australian Department of Mines, Industry Regulation and Safety
<b>DPaW</b>	Western Australian Department of Parks and Wildlife (2013-2017, now DBCA)
<b>DoE</b>	Commonwealth Department of the Environment (2013-2016, now DAWE)
<b>DotEE</b>	Commonwealth Department of the Environment and Energy (2016-2020)
<b>DPIRD</b>	Western Australian Department of Primary Industries and Rural Development
<b>DSEWPaC</b>	Commonwealth Department of Sustainability, Environment, Water, Population and Communities (2010-2013, now DAWE)
<b>EN</b>	Endangered (listed under Commonwealth EPBC Act and/or Western Australian BC Act)
<b>Ecoscape</b>	Ecoscape (Australia) Pty Ltd
<b>EP Act</b>	Western Australian <i>Environmental Protection Act 1986</i>
<b>EPA</b>	Western Australian Environmental Protection Authority
<b>EPBC Act</b>	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
<b>GDA 94</b>	Geographic Datum of Australia 1994
<b>GIS</b>	Geographic Information System
<b>GPS</b>	Global Positioning System
<b>ha</b>	hectare/hectares
<b>IA</b>	Species protected by international agreement (under the Western Australian BC Act)
<b>IBRA</b>	Interim Biogeographic Regionalisation for Australia
<b>IUCN</b>	International Union for Conservation of Nature
<b>km</b>	kilometre/kilometres
<b>m</b>	metre/metres
<b>MGA</b>	Map Grid of Australia
<b>MA</b>	Marine species (fauna; specially protected species under the Commonwealth EPBC Act)
<b>MI</b>	Migratory species (fauna; specially protected species under the Western Australian BC Act and/or Commonwealth EPBC Act)
<b>MNES</b>	Matters of National Environmental Significance
<b>OS</b>	Other specially protected species (fauna; specially protected species under the Western Australian BC Act)
<b>PMST</b>	Protected Matters Search Tool (hosted by DAWE, used to search for MNES)
<b>sp.</b>	Species (singular)
<b>spp.</b>	Species (plural)
<b>subsp.</b>	Subspecies (infrataxon)
<b>T</b>	Threatened Fauna species listing by DBCA
<b>var.</b>	Variety (infrataxon)

<b>Acronyms and abbreviations</b>	
<b>VU</b>	Vulnerable (listed under Commonwealth EPBC Act and/or Western Australian BC Act)
<b>WAM</b>	Western Australian Museum
<b>*</b>	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 to undertake a biological survey of a portion of Flynn Drive in Neerabup (between Travertine Vista and Pinjar Road), 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 survey is required to support clearing permits for proposed road upgrade works; inform any permit amendments due to design changes; and inform an environmental impact assessment of the proposed clearing between Mather Drive and Pinjar Road.

## 1.2 SURVEY AREA

The project area, known as the 'survey area' in this report, is located in Neerabup, within the City of Wanneroo on the Swan Coastal Plain, approximately 30 km north of Perth (**Figure 1**). The survey area approximates 20.55 ha in size and forms a linear corridor of vegetation adjacent to a busy roadway. A portion of the survey area abuts the Mather Reserve conservation area.



**Figure 1: Survey area location**

### 1.3 SURVEY REQUIREMENTS

The biological survey was to be undertaken in spring of 2020, and in compliance with the *Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment* (EPA 2020a). 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*
- Department of Environment, Water, Heritage and the Arts (DEWHA 2009) *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 (2020a) *Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment*, known herein as the Fauna Technical Guidance
- EPA (2020b) *Statement of Environmental Principles, Factors and Objectives.*

#### 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) including important flora, fauna, ecological communities and heritage areas listed under the Act. Threatened taxa (flora and fauna) are protected under the EPBC Act, which lists species and ecological communities that have been assessed as meeting the criteria to be listed as Critically Endangered, Endangered, Vulnerable, Conservation Dependant, Extinct, or Extinct in the Wild, as detailed in **Table 13** in **Appendix One**. Threatened Ecological Communities (TECs) are categorised as Critically Endangered, Endangered or Vulnerable, and are detailed in **Table 13**.

### 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 14** 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 13** 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 14** 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 14** 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

#### 2.1.1 CLIMATE

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). The survey area borders on the arid zone.

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; the average coldest month maximum is between 18°C 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 2020). 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 2020 was drier than typical, recording approximately 68% 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 33.3°C and minimum of 17.6°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.

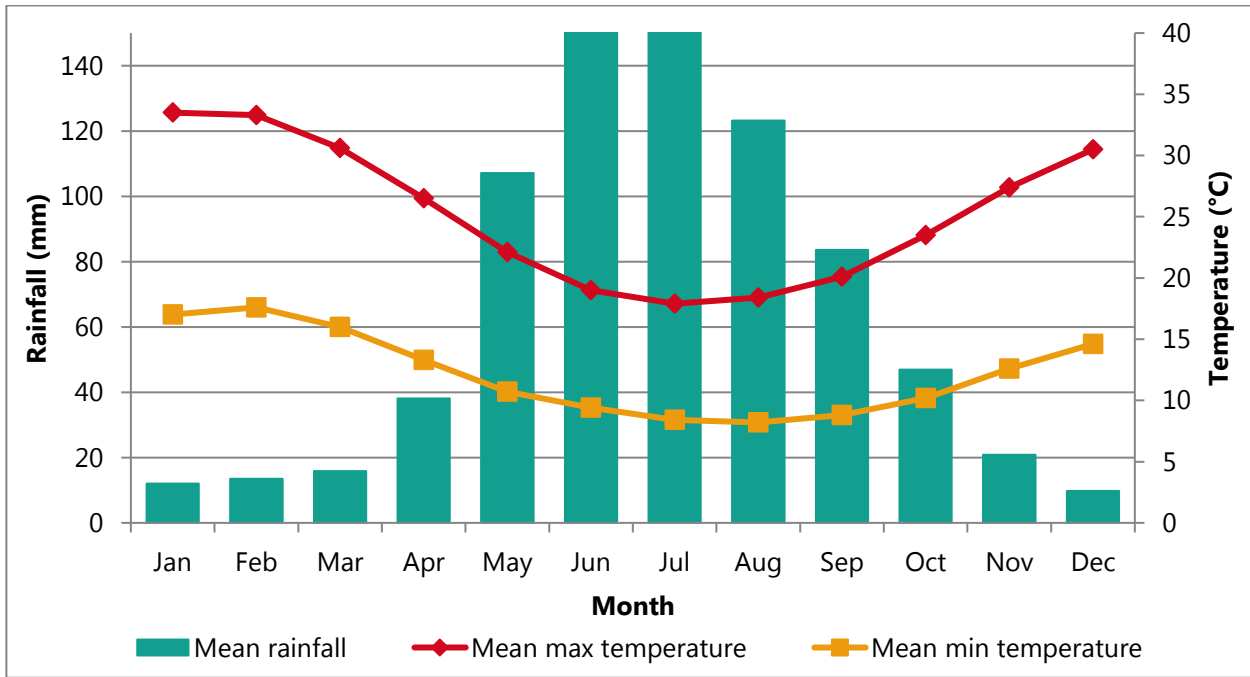


Figure 2: Rainfall and temperature data for the survey area

### 2.1.2 LAND SYSTEMS

According to the Department of Primary Industries and Rural Development (DPIRD 2020) soil landscape mapping, the following two land systems intersect the survey area (Table 2 and Map 1).

Table 2: Land systems (DPIRD 2020)

Mapping unit	Land system	Description	Extent (ha)	%
211Sp	Karrakatta shallow soils Phase	Low hills and ridges. Bare limestone or shallow siliceous or calcareous sand over limestone. Dense low shrub dominated by <i>Banksia sessilis</i> , <i>Melaleuca huegelii</i> and species of <i>Grevillea</i> .	3.33	16.22
211Sp	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.	17.20	83.78

### 2.1.3 GEOLOGY

Geological mapping covering the survey area is associated with the Muchea map sheet (20341) of the Department of Mines Industry Regulation and Safety (DMIRS) map series 1:50,000 Geological Series of Western Australia (2018). According to this mapping, three geological units intersect the survey area, as shown in Table 3 and Map 1.

Table 3: Geology of the survey area (DMIRS 2018)

Code	Description	Extent (ha)	%
LS1	LIMESTONE - pale yellow-brown fine-grained angular and medium-grained rounded quartz and calcite cross-bedding, minor heavy minerals.	7.93	38.43
LS2	LIMESTONE - as LS1 abundant karstic phenomena including caves, swallows, dolines.	4.72	38.59
S7	SAND - pale and olive-yellow medium to coarse-grained sub-angular quartz, moderately sorted, of residual origin, modified by marine inundation.	7.90	22.99

#### 2.1.4 WETLANDS AND DRAINAGE

The survey area is in the Wanneroo Coastal Lakes catchment, in the river region of Swan Coast – Avon River (Landgate 2020). The survey area does not intersect with any wetlands or drainage lines. The nearest wetland is Neerabup Lake located approximately 0.3 km to the north west. The nearest significant river is the Swan River located approximately 23 km south east of the survey area.

#### 2.1.5 ENVIRONMENTALLY SENSITIVE AREAS

The survey area partially intersects a Bush Forever site in the west and two TECs in the east, *Banksia Woodlands of the Swan Coastal Plain* ecological community and *Banksia attenuata* woodland over species rich dense shrublands (Department of Water and Environmental Regulation 2020).

#### 2.1.6 CONSERVATION LANDS

The survey area does not intersect any conservation lands (i.e. National Parks, Nature Reserves or other areas vested for conservation). The nearest conservation land is Neerabup National Park located approximately 0.5 km west of the survey area.

### 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) (Department of Agriculture Water and the Environment 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 Rottneest, 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'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 three pre-European vegetation units, as shown in **Table 4**.

**Table 4: Pre-European vegetation corresponding with the survey area**

Association	Code	Description	% of survey area
Spearwood System	6	Low woodland or open low woodland	78.20
Spearwood System	949	Woodland southwest	14.89
Spearwood System	998	Woodland southwest	6.91

The pre-European vegetation associations identified from the survey area (DPIRD 2019) and their pre-European and current extents 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
	949	218,193.94	123,104.02	23.72
	998	51,015.33	18,492.63	36.25
IBRA biographic region (Swan Coastal Plain)	6	56,343.01	13,362.25	23.72
	949	209,983.26	120,287.93	57.28
	998	50,867.50	18,492.32	36.35
IBRA biographic subregion (Perth)	6	56,343.01	13,362.25	23.72
	949	184,475.82	104,128.96	56.45
	998	50,867.50	18,492.32	36.35
LGA (City of Wanneroo)	6	12,662.10	2,777.67	21.94
	949	37,138.40	17,196.34	46.30
	998	4,635.30	2,787.40	60.13

### 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 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-Jarra-Marri open forest; closed heath on the Limestone outcrops.	78.20
Herdsmen Complex	53	Swan Coastal Plain – Aeolian deposits	Sedgeland and fringing woodland of <i>Eucalyptus rudis</i> - <i>Melaleuca</i> species.	6.91
Karrakatta Complex – Central and South	49	Swan Coastal Plain – Aeolian deposits	Predominantly open forest of Tuart-Jarra-Marri and woodland of Jarrah- <i>Banksia</i> species. <i>Agonis flexuosa</i> is co-dominant south of the Capel River.	14.89



**Table 7: Vegetation complex extents in the Swan Coastal Plain**

Vegetation Complex	Pre-European extent (ha)	Current extent (ha)	% Remaining	Proportion within the LGA <sup>1</sup>
Cottesloe Complex – Central and South	45,299.61	14,567.87	32.16	29.39
Herdsmen Complex	9,665.15	3,103.70	32.11	18.20
Karrakatta Complex – Central and South	53,080.99	12,467.20	23.49	19.85

## 2.2.4 THREATENED AND PRIORITY FAUNA

Exclusively marine species (e.g. whales, sea turtles etc.) are not included in the Threatened and Priority Fauna lists as their habitat does not occur within with the survey area.

### 2.2.4.1 Protected Matters Search

The PMST search (search reference QIIVSQ) using a 5 km buffer was used to identify conservation significant fauna and/or fauna habitat suitable for such species within the search area buffer. The PMST search identified:

- one mammal: one 'species or species habitat likely to occur within area'
- 24 birds: ten 'species or species habitat known to occur within area', six 'species or species habitat likely to occur within area', eight 'species or species habitat may occur within area'.

The PMST results are incorporated in **Table 17 in Appendix Two**. Not all species identified by the PMST search have DBCA/Western Australian Museum (WAM) records (*NatureMap*, (DBCA 2007-2020) see below). The following were identified by the PMST search but not by the *NatureMap* search:

- Great Egret (*Ardea alba*)
- Cattle Egret (*Ardea ibis*)
- Sharp-tailed Sandpiper (*Calidris acuminata*) - MI
- Red Knot, Knot (*Calidris canutus*) – EN
- Curlew Sandpiper (*Calidris ferruginea*) – CR
- Pectoral Sandpiper (*Calidris melanotos*) - MI
- Red-necked Stint (*Calidris ruficollis*) - MI
- Chuditch (*Dasyurus geoffroii*) – VU
- White-bellied Sea-Eagle (*Haliaeetus leucogaster*)
- Pied Stilt (*Himantopus Himantopus*)
- Malleefowl (*Leipoa ocellata*) – VU
- Rainbow Bee-eater (*Merops ornatus*)
- Grey Wagtail (*Motacilla cinerea*) - MI
- Eastern Curlew (*Numenius madagascariensis*) – CR
- Osprey (*Pandion haliaetus*)
- Australian Painted Snipe (*Rostratula australis*) – EN
- Painted Snipe (*Rostratula benghalensis (sensu lato)*)
- Australian Fairy Tern (*Sternula nereis nereis*) – VU
- Osprey (*Pandion haliaetus*) – MI
- Hooded Plover (*Thinornis rubricollis*) – P4
- Common Greenshank (*Tringa nebularia*) – MI.

#### 2.2.4.2 NatureMap

*NatureMap* (DBCA 2007-2020) 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 is maintained by the DBCA.

The *NatureMap* search identified 204 vertebrate fauna species previously recorded within the applied 5 km buffer area:

- 14 mammals (nine native; five introduced)
- 142 birds (137 native; five introduced)
- 42 reptiles (42 native; none introduced)
- six amphibians (six native; none introduced).

Eleven conservation significant vertebrate fauna were identified:

- Common Sandpiper (*Actitis hypoleucos*) - MI
- Fork-tailed Swift (*Apus pacificus*) – MI
- Baudin's Cockatoo (*Calyptorhynchus baudinii*) – EN
- Carnaby's Cockatoo (*Calyptorhynchus latirostris*) – EN
- Peregrine Falcon (*Falco peregrinus*) – OS
- Water Rat (*Hydromys chrysogaster*) – P4
- Caspian Tern (*Hydroprogne caspia*) – MI
- Quenda (*Isoodon fusciventer*) – P4
- Western Brush Wallaby (*Notamacropus irma*) – P4
- Blue-billed Duck (*Oxyura australis*) – P4
- Glossy Ibis (*Plegadis falcinellus*) - MI.

The conservation significant species identified by the NatureMap search are incorporated into **Table 17** in **Appendix Two**.

#### 2.2.4.3 DBCA Database Search

The DBCA database search (search reference QIIVSQ using a 5 km buffer) returned the following results for vertebrate fauna:

- three mammals
- six birds
- one reptile.

DBCA database search results are incorporated into **Table 17** in **Appendix Two** and shown on **Map 3**.

#### 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.

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 (<5 km) within the past 25 years; and suitable habitat occurs within the survey area
Medium	Species historically recorded in close proximity (<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 10 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 20 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 species occurring within the survey area are indicated in **Table 17** in **Appendix Two**. One species has been previously identified from within the survey area, *Calyptorhynchus latirostris*. Four species were assessed as having a High likelihood of occurring within the survey area:

- *Calyptorhynchus banksii naso*
- *Isoodon fusciventer*
- *Neelaps calonotos*
- *Notamacropus irma*.

The likelihood of occurrence was re-evaluated following the field survey, when actual survey area characteristics were better understood, and the level of survey effort was considered. The post-survey likelihood is also incorporated into **Table 17** and discussed further in **Section 5.1.2.1**.

## 2.3 LITERATURE REVIEW

The following documents were reviewed for relevance to the survey area:

- ERM (2009) *NewGen Neerabup Gas Pipeline Fauna Clearance Summary*, relevant to the Swan Coastal Plain subregion
- Valentine *et al.* (2009) *Patterns of ground-dwelling vertebrate biodiversity in the Gnangara Sustainability Strategy study area*, broadly corresponds with the survey area
- Wilson *et al.* (2009) *Habitat Loss and Fragmentation*, broadly corresponds with the survey area
- Wilson *et al.* (2012) *Terrestrial Mammals of the Gnangara Groundwater System, Western Australia: history, status, and the possible impacts of a drying climate*, corresponds with the survey area
- EcoLogical (2012) *Vertebrate Fauna Survey Lot 701 Flynn Drive Neerabup*, partially corresponds with the western portion of the survey area
- EcoLogical (2013) *Targeted Flora and Fauna Assessment Lot 4 Flynn Drive Neerabup*, partially corresponds with the eastern portion of the survey area
- GHD (2014) *Main Road Western Australia - Neerabup Road Extension, Level 2 Fauna Survey*, relevant to the Swan Coastal Plain subregion

- How & Dell (2000) *Ground Vertebrate Fauna of Perth's Vegetation Remnants: Impacts of 170 years of Urbanization*, relevant to the Swan Coastal Plain subregion.

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 ERM and GHD surveys include (showing status under the BC Act; EPBC Act):

- Carnaby's Cockatoo – *Calyptorhynchus latirostris* – (EN; EN) (ERM 2009; GHD 2014)
- Rainbow Bee-eater – *Merops ornatus* – (IA; MA) (GHD 2014)
- Quenda – *Isoodon 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 2020a). 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

### 3.2.1 FIELD SURVEY METHODS

The methods utilised during the field survey followed those outlined in the Fauna Technical Guidance (EPA 2020a), conducted as a Basic phase survey.

Conservation criteria used in this assessment are included in **Table 13** and **Table 14** in **Appendix One**.

#### 3.2.1.1 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 2020a), 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.

Based on the desktop assessment, the following were considered to have a High likelihood of occurring in the survey area and they, and habitat suitable to support them, were targeted during the field survey:

- *Calyptorhynchus banksii naso* (Forest Red-tailed Black Cockatoo)
- *Calyptorhynchus latirostris* (Carnaby's Cockatoo)
- *Isoodon fusciventer* (Quenda)
- *Notamacropus irma* (Western Brush Wallaby)
- *Neelaps calonotos* (Black-striped Snake).

### 3.2.1.2 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 land form, 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.

### Black Cockatoo Assessment

Black Cockatoo Species (Carnaby's Cockatoo; Baudin's Cockatoo EN, Forest Red-tailed Black-cockatoo VU (EPBC Act, BC Act))

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 are 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 [or Differential GPS with an accuracy of <1 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 15** 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 16** in **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*).

### 3.2.1.3 Field Survey Timing

The survey was conducted over two days on 6 and 7 October 2020.

## 3.2.2 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 Hugh Osborn (Zoologist) during 6-7 October 2020. The survey was conducted in accordance with the requirements outlined in the Fauna Technical Guidance (EPA 2020a).

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.

### 4.1.1 FAUNA ASSEMBLAGE

A total of 21 vertebrate fauna species were recorded during the survey (**Table 18** in **Appendix Three**).

One species is conservation-listed:

- *Calyptorhynchus latirostris* (Carnaby's Cockatoo); EN; EN, a pair were sighted flying over the survey area.

Four are introduced species (three mammals and one bird):

- *Canis familiaris familiaris* (Dog)
- *Oryctolagus cuniculus* (Rabbit)
- *Rattus rattus* (Black Rat)
- *Spilopelia chinensis* (Spotted Turtle Dove).

Survey sites are listed in **Table 19** in **Appendix Three**.

### 4.1.2 FAUNA HABITAT

Two fauna habitat types and two fauna habitat sub-units were recorded within the survey area (**Table 9**):

- Woodland
  - Sub-unit *Eucalyptus gomphocephala* (Tuart) woodland
  - Sub-unit *Banksia attenuata* woodland
- Shrubland.





The Woodlands occur across the entire survey area and comprise of two sub-units: *Eucalyptus gomphocephala* (Tuart) woodland; and *Banksia attenuata* woodland. Both are suitable to support the identified assemblage of species from the desktop investigation and provide foraging and roosting resources to black cockatoo species. The Tuart woodland was assessed as good quality and the *Banksia attenuata* woodland was assessed as very good quality.

Shrublands are present in revegetated areas found in isolated patches throughout the survey area. They are comprised of areas of revegetated or landscape plantings and may support some of the identified assemblage of fauna species. The Shrubland habitat unit was assessed as low quality.

The quality of each habitat type was based on the field surveyor's experience (8 years) 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
<p><b>Woodland</b>  <b>Sub-unit:</b>  <i>Eucalyptus gomphocephala</i>  <b>(Tuart)</b>  <b>woodland</b></p>	<p><b><i>Eucalyptus gomphocephala</i> woodland over mixed shrubs</b></p> <p>This habitat provides food and shelter resources for both the bird and ground-dwelling vertebrate species present.</p> <p><b>Extent:</b> 5.05 ha; 24.60%</p>	
<p><b>Woodland</b>  <b>Sub-unit:</b>  <i>Banksia attenuata</i>  <b>woodland</b></p>	<p><b><i>Banksia attenuata</i> woodland over mixed proteaceous shrubs</b></p> <p>This habitat provides food and shelter resources for both the bird and ground-dwelling vertebrate species present.</p> <p><b>Extent:</b> 3.41 ha; 16.6%</p>	
<p><b>Shrubland</b></p>	<p><b>Shrubland of revegetation or landscape plantings</b></p> <p>This habitat contains plantings of shrubs and ground covers some of which may provide food and shelter resources for both the bird and ground-dwelling vertebrate species present. <b>Extent:</b> 2.22 ha; 10.83%</p>	
<p><b>Not Habitat/Cleared</b></p>	<p><b>Not habitat (cleared, non-native vegetation)</b></p> <p>This area provides little or no suitable habitat for fauna species. No species are expected.</p> <p><b>Extent:</b> 9.85 ha; 47.96%</p>	

### 4.1.3 SIGNIFICANT FAUNA AND ASSOCIATED HABITAT

The significant fauna species and habitat 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.

#### 4.1.3.1 Carnaby's Cockatoo

Carnaby's Cockatoo is a large species of cockatoo endemic to south-western Western Australia which has predominantly black plumage with white cheek patches and tail feather panels. The known distribution for the species runs roughly south-west of a line between Kalbarri and Esperance, extending along the south coast to Cape Arid National Park (Commonwealth of Australia 2017), with birds foraging in Proteaceous woodlands and shrublands in coastal areas from January to July, then moving inland to woodlands with suitable nesting hollows during the breeding season of late July to December (Saunders 1980). There has been an estimated 50% decline in Carnaby's Cockatoo numbers over the last 70 years, primarily due to loss of foraging habitat and nesting hollows of suitable size in breeding areas (DPaW 2013). The taxon is classified as Endangered under both the BC Act and EPBC Act.

The species occurs in uncleared or remnant native eucalypt woodlands and shrubland or kwongan heathland dominated by *Hakea*, *Banksia* and *Grevillea* species (DPaW 2013). It is a seasonal visitor to plantations of exotic Pines (*Pinus* spp.), and sometimes occurs in forests.

The species was opportunistically observed flying over the survey area on one occasion. Evidence of foraging activity, in the form of chewed Marri fruits, was also observed at one location. There are suitable resources within the survey area to provide foraging habitat for this species.

#### 4.1.4 BLACK COCKATOO BREEDING HABITAT

A total of 46 potential Black Cockatoo breeding trees were recorded, being either Jarrah (*Eucalyptus marginata*) or Tuart (*Eucalyptus gomphocephala*). Each tree was assessed for the potential to provide breeding habitat for the Black Cockatoo species (Forest Red-tailed Black Cockatoo and Carnaby's Cockatoo) as per Commonwealth guidelines (DSEWPac 2012). Of the 46 trees recorded 10 were Jarrah and 36 were Tuart. Tree locations are shown in the **Map 4** series.

Breeding trees were scored using the scale developed by Dr Mike Bamford (Bamford 2016) to further refine nesting value to the species. Definitions of tree classes are detailed in **Table 15** in **Appendix One**. Results recorded were as follows:

- no trees were recorded as either Class 1 (hollow with bird seen entering/emerging) or Class 2 (suitable hollow with visible chew marks)
- three trees scored as Class 3 (suitable hollow present, no chew marks)
- 11 trees scored as Class 4 (hollows not suitable)
- 32 trees scored as Class 5 (no hollows).

Class 3 trees possess the necessary characteristics preferred by the Black Cockatoos, but no evidence of use was recorded. Class 4 trees have hollows large enough for nesting but do not exhibit the characteristics preferred by the birds. Class 5 trees do not currently exhibit the characteristics necessary for Black Cockatoo to use for nesting. None of the trees showed signs of nesting activity (e.g. hollows with chew marks at entrance) at the time of the survey, however, the trunks were of suitable size (DBH >500 mm) and have a high potential to form suitable hollows in the future.

Beehives were found to be present in three of the recorded breeding trees. Presence of bees is a deterrent to hollow use by Black Cockatoos, however, hollows may be utilised in future should the bees vacate the tree.

The location and species of each recorded potential breeding tree is presented in **Table 20** in **Appendix Three**. Class 3 trees recorded during the survey are listed in **Table 10**. Class 3 trees are more likely to support Black Cockatoo breeding as they possess suitably sized hollows of the preferred orientation by Black Cockatoo.

**Table 10: Class 3 trees**

Tree number	species	DBH (mm)	No. of Hollows	Bees present
2	Jarrah	590	3	no
26	Tuart	1500	3	yes
43	Tuart	790	1	no

The low proportion of suitable breeding trees (6%; three Class 3 trees out of the 46 trees that satisfied the Commonwealth guidelines) indicates that the survey area, when viewed in isolation, may constitute very low value as breeding habitat.

#### 4.1.5 BLACK COCKATOO FORAGING HABITAT

The survey area was assessed for quality of existing suitable foraging habitat using the government scoring tool recommended in the *Revised Draft Referral Guidelines for the three Black Cockatoo species* (Commonwealth of Australia 2017), which is presented in **Table 16** in **Appendix One**. The total extent of foraging habitat within the survey area is 10.68 ha. Foraging habitat quality was not assessed for Baudin's Cockatoo as the desktop investigation assessed this species as being unlikely to occur within the survey area. Foraging habitat quality for Carnaby's Cockatoo and Forest Red-Tailed Cockatoo was assessed and scored, as detailed in **Table 11** and **Table 12** respectively.

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

Final Score	Habitat Summary for Carnaby's Cockatoo foraging habitat
15	<p>Starting score:</p> <ul style="list-style-type: none"> <li>Impact area has a section of Banksia woodland ie. Woodland dominated by proteaceous plant species and also includes native eucalypt woodland that contains foraging species such as <i>Banksia</i> spp. including along roadsides. (<b>score of 7</b>).</li> </ul> <p>Attributes improving functionality of foraging habitat:</p> <ul style="list-style-type: none"> <li>Impact area is within the Swan Coastal Plain (important foraging area) (<b>add 3</b>);</li> <li>Impact area contains trees with suitable nest hollows (<b>add 3</b>);</li> <li>Impact area contains trees with potential to be used for breeding (DBH <math>\geq</math>500mm) (<b>add 2</b>).</li> </ul> <p>Attributes reducing functionality of foraging habitat.</p> <ul style="list-style-type: none"> <li>No attributes detected that reduce the functionality of foraging habitat.</li> </ul>

The final score is **15** (of a maximum score of 21). According to the guidelines this indicates very high quality habitat for Carnaby's Cockatoo (Commonwealth of Australia 2017).

Foraging habitat quality for Forest Red-tailed Black Cockatoo was assessed and scored as listed in **Table 12**.

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

Final Score	Habitat Summary for Forest Red-tailed Black Cockatoo foraging habitat (*note this is also habitat for Carnaby's Cockatoo; a separate score has been generated for this species)
8	<p>Starting score:</p> <ul style="list-style-type: none"> <li>Impact area has native eucalypt woodland and forest that contains foraging species, including jarrah (<i>Eucalyptus marginata</i>), she-oak (<i>Allocasuarina fraseriana</i>) (<b>score of 7</b>).</li> </ul> <p>Attributes improving functionality of foraging habitat:</p> <ul style="list-style-type: none"> <li>Impact area contains trees with suitable nest hollows (<b>add 3</b>);</li> <li>Impact area contains trees with potential to be used for breeding (DBH <math>\geq</math>500mm) (<b>add 2</b>).</li> </ul> <p>Attributes reducing functionality of foraging habitat:</p> <ul style="list-style-type: none"> <li>No clear evidence of feeding debris (<b>subtract 2</b>)</li> <li>Is &gt; 12km from a known breeding location (<b>subtract 1</b>)</li> <li>Is &gt; 12 km from a known roosting site (<b>subtract 1</b>)</li> </ul>

The final score is **8** (of a maximum score of 21). According to the guidelines (Commonwealth of Australia 2017) this indicates high to very high quality habitat for Forest Red-tailed Black Cockatoo.

### Roosting Habitat

Suitable roosting habitat for Black Cockatoos exists within the Banksia and Tuart Woodlands habitats as the mature Jarrah and Tuart trees provide this value and cover 8.46 ha (41.20%) of the survey area.

Roosting behaviour was not observed during the survey period.

## 4.2 FIELD OBSERVATIONS

Carnaby's Cockatoo were observed flying over the survey area on one occasion in the mid-morning.

Feeding evidence was recorded in the form of Marri nuts showing chew markings distinctive to Carnaby's Cockatoo (**Image 3**). Feeding evidence was not recorded for Forest Red-tailed Black Cockatoo.



**Image 1: Marri nuts chewed by Carnaby's Cockatoo**

## 4.2.1 FAUNA SURVEY LIMITATIONS

Possible limitations	Constraints (yes/no): Significant, moderate, or negligible	Comment
Competency/experience of the consultant conducting the survey	No	The fauna field surveyor was experienced with the fauna survey methods used and with the identification of fauna taxa.
Scope (what faunal groups were sampled and were some sampling methods not able to be employed because of constraints such as weather conditions).	No	The survey was conducted as a Level 1 fauna assessment. Sufficient time was allocated to the fauna survey, which included active diurnal searches, to adequately describe the fauna assemblage present in the survey area.
Proportion of fauna identified, recorded and/or collected.	No	All fauna species opportunistically observed were identified in the field.
Sources of information (previously available information as distinct from new data).	No	Many sources referencing field surveys in the vicinity were available.
The proportion of the task achieved and further work which might be needed.	No	The survey area was adequately searched.
Timing/weather/season/cycle.	Negligible	The timing of the field survey was within a period suitable to identify most components of the expected fauna assemblage if they were present on site except for reptiles. The seasonal conditions were suitable for fauna survey with warm daytime temperatures and fine weather during the survey period.
Disturbances which affected results of the survey (e.g. fire, flood, accidental human intervention).	No	No disturbance to the survey was detected.
Intensity (in retrospect was the intensity adequate).	No	The survey was considered suitable to determine the presence or potential presence of conservation significant fauna.
Completeness (e.g. was relevant area fully surveyed), remoteness and/or access problems	No	The entire survey area was adequately searched and was entirely accessible.
Resources (e.g. degree of expertise available in animal identification to taxon level).	No	Field staff has over 8 years' experience identifying fauna. All terrestrial vertebrate fauna was identified to species level.
Availability of contextual (e.g. biogeographic) information on the region).	Negligible	The survey region is well-documented and there is sufficient availability of contextual information.

# 5 DISCUSSION

## 5.1 FAUNA SIGNIFICANCE

### 5.1.1 FAUNA HABITAT TYPES AND FAUNA ASSEMBLAGE

Two fauna habitat types and two fauna habitat sub-units were recorded within the survey area (**Table 9**), consisting of:

- Woodland
  - Sub-unit *Eucalyptus gomphocephala* (Tuart) woodland
  - Sub-unit *Banksia attenuata* woodland
- Shrubland.

Overall, 21 terrestrial vertebrate fauna species (16 native and five introduced species) were recorded from the survey area during field survey (**Table 18**), comprised predominantly of birds, with one native mammal (Western Grey Kangaroo) and one reptile (Bobtail) observed. Of these, one species is of significance (Carnaby's Cockatoo - EN).

The majority of fauna species identified from the desktop assessment as having been previously recorded within the vicinity of the survey area (**Table 17**) are shorebirds and other waterbirds reliant on waterbodies for foraging and/or nesting activities. The habitat present within the survey area is not considered suitable for these species, and they are unlikely to use the survey area itself other than to overfly the area to access preferred habitat. Previous fauna surveys conducted in the Neerabup area (ERM 2009; GHD 2014) recorded a higher number of reptile species. However, records from the ERM and GHD surveys included capture records from trapping and/or trench capture methodologies, which are not employed as part of the current level of survey.

The Woodland habitat within the survey area will likely support bird and ground-dwelling vertebrate species. This includes the conservation significant Black Cockatoo species known to occur within the vicinity (Carnaby's and the Forest Red-tailed Black Cockatoo), and Quenda (*Isodon fusciventer* – P4), which was assessed as having a high likelihood of occurrence. Additionally, the *Banksia attenuata* Woodland habitat sub-unit is suitable for a number of small reptiles found on sandy soils, including the Black-striped Snake (*Neelaps calanotos* – P3), which is considered likely to occur based on desktop assessment.

### 5.1.2 CONSERVATION-LISTED SPECIES

A single fauna species recorded during survey constitutes a conservation-listed taxon:

- Carnaby's Cockatoo – *Calyptorhynchus latirostris* (EN; EN).

No other terrestrial vertebrate species of conservation significance were observed within the survey area during field survey. Three species that were not observed are still considered likely to occur (**Section 5.1.2.1**) due to the availability of suitable habitat and low, or irregular, chance of detection.

#### Carnaby's Cockatoo

Carnaby's Cockatoo (**Section 4.1.3.1**) is a seasonal visitor to plantations of exotic pine and native forests, and was recorded during the field survey. The species was opportunistically observed flying over the survey area on one occasion and foraging evidence observed.

There are suitable resources within the survey area to provide habitat for this species. No potential Black Cockatoo breeding trees in the survey area showed evidence of use, and no roosting behaviour was observed. Assessment for foraging habitat indicates the survey area constitutes very high quality habitat for this species, although it is not considered to be dependent on habitat within the survey area.

#### 5.1.2.1 Post-survey Likelihood Assessment

The remaining (i.e. those not recorded) conservation-listed fauna species identified during the desktop assessment as having a High likelihood of occurring are discussed below with respect to each species' habitat requirements, taking into consideration the findings of the field survey and survey effort. The post-survey likelihood assessment is incorporated into **Table 17** in **Appendix Two**.

#### Quenda (*Isodon fusciventer*) – P4

Quenda are widely distributed from near the coast from Guilderton (north of Perth) to the east of Esperance. They also have a patchy distribution through the Jarrah and Karri forest, the Swan Coastal Plain, and inland as far as Hyden. Quenda have been recorded in swampy vegetation with dense cover up to 1 m high, often feeding 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. On the Swan Coastal Plain, Quenda are often associated with wetlands (DEC 2012).

There is only moderate suitable habitat for Quenda in the survey area, habitat quality is reduced due to fragmentation, predator presence and proximity to traffic.

#### Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) – VU; VU

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 (DSEWPaC 2012). This taxon usually occurs in pairs or small flocks, seldom large flocks (up to 200) and has declined due to destruction of forests and woodlands and competition for nest hollows with native and exotic species, and the impact of fire.

Its Commonwealth mapped distribution includes the survey area and it has been recorded in previous nearby surveys (Bamford Consulting Ecologists 2017).

The Woodland habitat within the survey area contains three suitable potential nesting trees and suitable foraging habitat provided by the extents of Jarrah and Tuart trees for this species within the survey area. The Tuart Woodland survey area is suitable night roosting habitat within the Woodland habitat. Although this species is expected to occur as an irregular visitor to the survey area, it was not observed during the field survey.

#### Black-striped Snake (*Neelaps calonotos*) – P3

This species is now restricted to the sandy coastal strip near Perth between Mandurah and Cataby and is found in dune and sand-plains, vegetated with heaths and eucalypt/Banksia woodlands (Wilson & Swan 2017). It feeds largely on *Lerista praepedita*, the smallest of the burrowing skinks, within its range.

There is suitable habitat for this species within the *Banksia attenuata* Woodland within the survey area, however, due to its cryptic behaviour, it is difficult to observe. Its prey species *Lerista praepedita* is common within the region but was not observed during the survey.



## 6 CONCLUSION

The Basic fauna survey and Black Cockatoo habitat assessments were conducted during 6-7 October 2020 by an experienced zoologist, 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*)
- three further conservation significant species (Forest Red-tailed Black Cockatoo, Quenda and Black-striped Snake) are considered likely to utilise the survey area
- very high quality foraging habitat is available for Carnaby's Cockatoo
- high to very high foraging habitat is available for Forest Red-tailed Black Cockatoo
- there is a low proportion of suitable breeding trees for Black Cockatoo species in the survey area, indicating very low value as breeding habitat
- two fauna habitat types (Woodland and Shrubland) occur within the survey area, supportive of bird and ground-dwelling vertebrate species
- no fauna species inhabiting, or likely to inhabit, the survey area, are considered to be dependent on the habitat within the survey area.

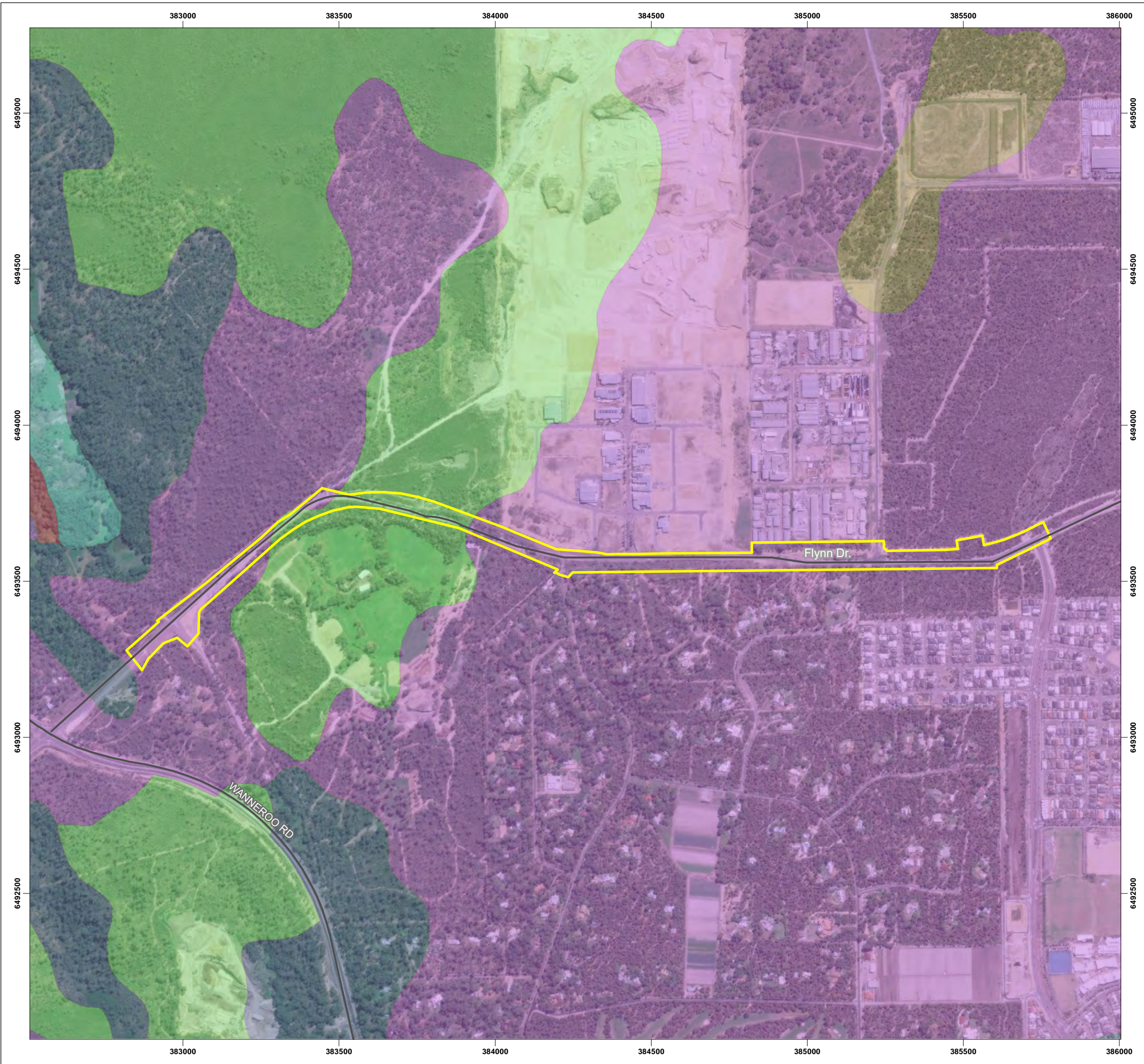
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# MAPS



**LEGEND**

- Survey Area
- Roads

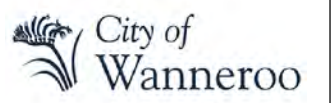
**Land System**

- Karrakatta Sand Grey Phase: Low hilly to gently undulating terrain. Iron podzols. *Banksia* spp woodland with *E. todtiana* and *depauperata*, *E. marginata*; dense shrub layer.
- 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.
- 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*.
- Spearwood Sand Phase: Irregular banks of karst depressions. Some limestone outcrop. Shallow brown sands. *Banksia* spp. woodland with emergent *E. gomphocephala* and *E. marginata*; dense shrub layer.
- Spearwood wet, lake Phase: Lake
- Spearwood, Beonaddy Sand Phase: Flat terrain fringing water in base of karst depressions; light grey sand with water table within 2m; *E. rudis*, *B. littoralis* and *Melaleuca* spp; *Typha* spp. near waters edge.

**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, AERGRID, IGN, AND THE GIS USER COMMUNITY



**SOIL LANDSCAPE MAPPING**  
**FLYNN DRIVE SPRING**  
**BIOLOGICAL SURVEY 2020**



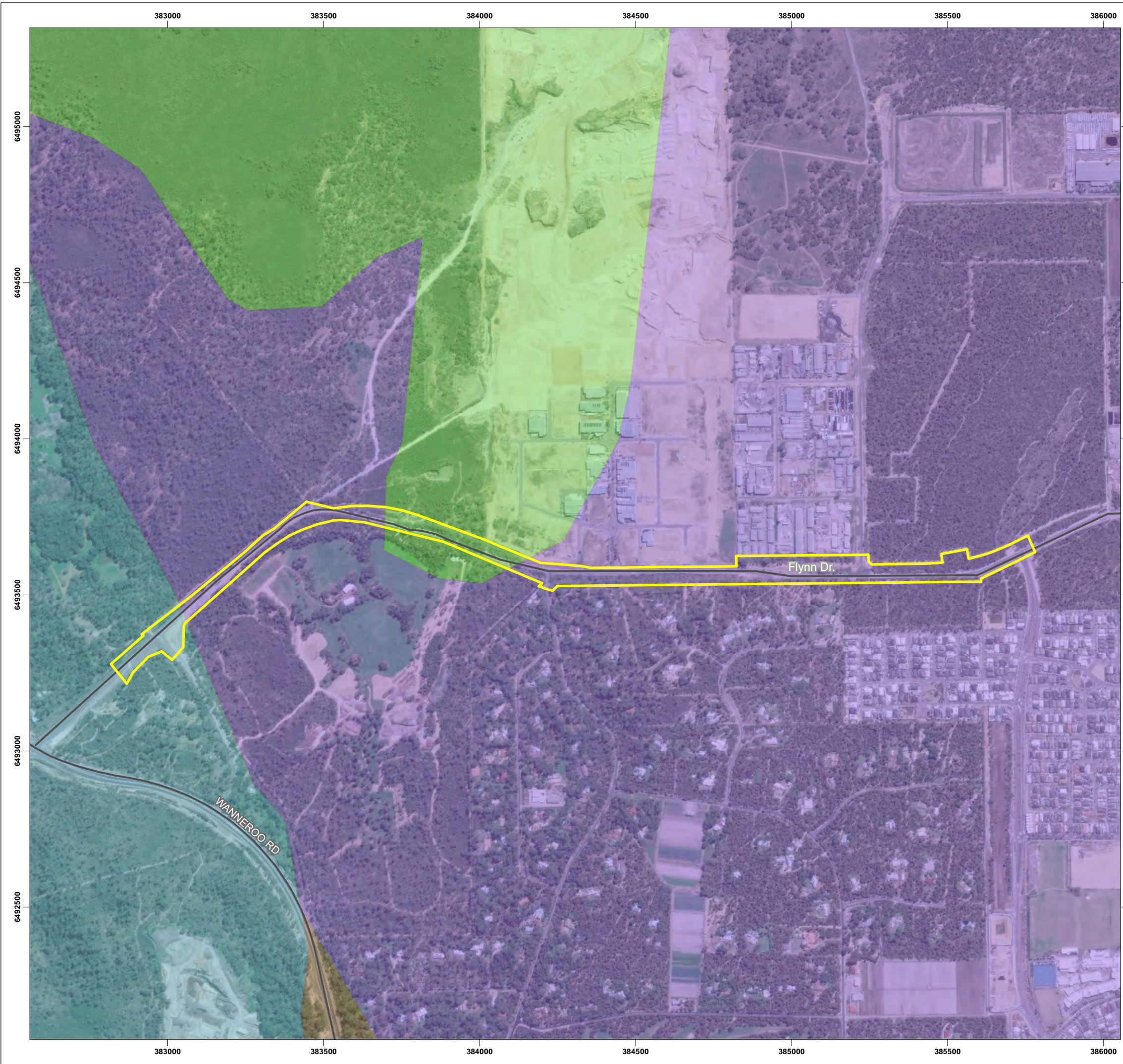
COORDINATE SYSTEM: GDA 1994 MGA ZONE 50  
 PROJECTION: TRANSVERSE MERCATOR  
 DATUM: GDA 1994  
 UNITS: METER

SCALE: 1:12,000 @ A3

PROJECT NO: 4544-20

REV	AUTHOR	APPROVED	DATE
00	KP	SB	27/11/2020

**MAP**  
**01**



**LEGEND**

- Survey Area
- Roads

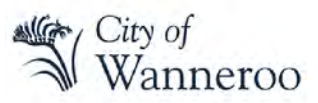
**System Association**

- Spearwood 6: Woodland southwest
- Spearwood 37: Thicket
- Spearwood 949: Low woodland or open low woodland
- Spearwood 998: Woodland southwest

**DATASOURCES:**  
 SOURCE DATA: PRE-EUROPEAN VEGETATION (DPIRD-006)  
 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 ASSOCIATIONS**  
**FLYNN DRIVE SPRING**  
**BIOLOGICAL SURVEY 2020**

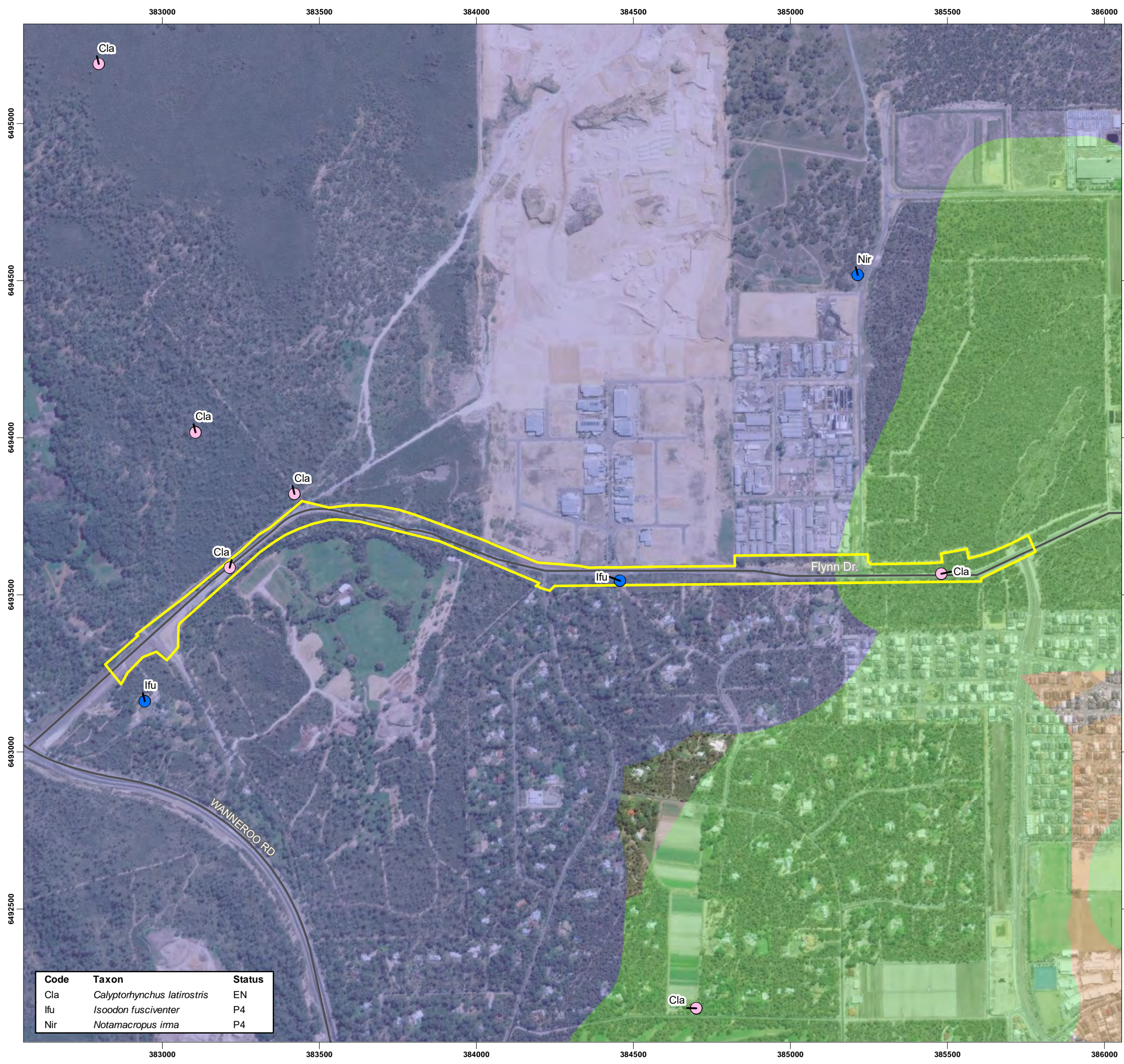


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 DATUM: GDA 1994  
 UNITS: METER



REV	AUTHOR	APPROVED	DATE
00	KP	SB	27/11/2020

**MAP**  
**02**



**LEGEND**

- Survey Area
- Roads

**Conservation Significant Fauna (DBCAs 2020)**

- Critically Endangered
- Endangered
- Vulnerable
- Migratory
- Conservation Dependent
- Other Specially Protected
- Priority 2
- Priority 3
- Priority 4

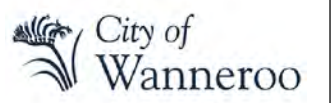
**TEC/PEC**

- 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))
- Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain

**DATASOURCES:**  
 SOURCE DATA: CS FAUNA (DBCAs 2020)  
 AERIAL: ESRI BASEMAP (2019)  
 BASEMAP: GEOSCIENCE AUSTRALIA  
 SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



**FAUNA  
 DATABASE SEARCH RESULTS  
 FLYNN DRIVE SPRING  
 BIOLOGICAL SURVEY 2020**



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

SCALE: 1:12,000 @ A3

**MAP  
03**

PROJECT NO: 4544-20			
REV	AUTHOR	APPROVED	DATE
00	KP	SB	27/11/2020

Code	Taxon	Status
Cla	<i>Calyptorhynchus latirostris</i>	EN
Ifu	<i>Isoodon fusciventer</i>	P4
Nir	<i>Notamacropus ima</i>	P4



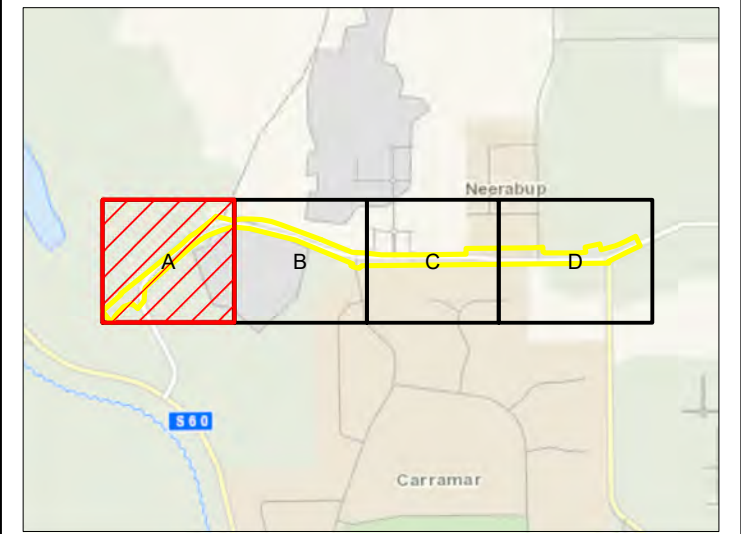


**LEGEND**

- Survey Area
- Roads
- Habitat Assessment Points
- Habitat Trees**
- Eucalyptus gomphocephala***
- Class 3
- Class 4
- Class 5
- Eucalyptus marginata***
- ▲ Class 3
- ▲ Class 4
- ▲ Class 5
- Conservation Significant Fauna Locations**
- Calyptorhynchus latirostris* (Endangered)

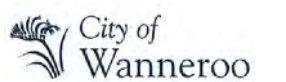
- Fauna Habitat**
- Banksia attenuata* Woodland
- Eucalyptus gomphocephala* Woodland
- Shrubland
- Not habitat

**DATASOURCES:**  
 SOURCE DATA: TRANSPORT ROAD CENTRELINES (MRWA 2012)  
 AERIAL: ESRI BASEMAP (2019)  
 BASEMAP: GEOSCIENCE AUSTRALIA  
 SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AERGRID, IGN, AND THE GIS USER COMMUNITY

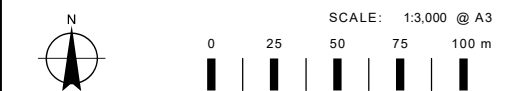


**ecoscape**

**FAUNA HABITAT, ASSESSMENT POINTS, CS FAUNA & BC TREE LOCATIONS**  
**FLYNN DRIVE SPRING**  
**BIOLOGICAL SURVEY 2020**



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



PROJECT NO: 4544-20

REV	AUTHOR	APPROVED	DATE
00	KP	SB	27/11/2020

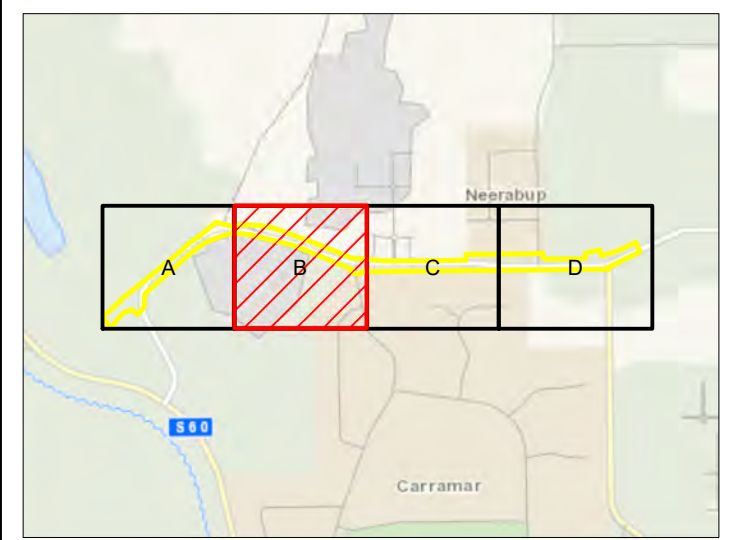
**MAP**  
**4A**



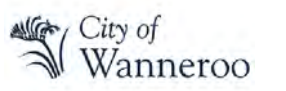
**LEGEND**

- Survey Area
- Roads
- Habitat Assessment Points
- Habitat Trees**
- Eucalyptus gomphocephala*
  - Class 3
  - Class 4
  - Class 5
- Eucalyptus marginata*
  - Class 3
  - Class 4
  - Class 5
- Conservation Significant Fauna Locations**
  - Calyptorhynchus latirostris* (Endangered)
- Fauna Habitat**
  - Banksia attenuata* Woodland
  - Eucalyptus gomphocephala* Woodland
  - Shrubland
  - Not habitat

**DATASOURCES:**  
 SOURCE DATA: TRANSPORT ROAD CENTRELINES (MRWA 2012)  
 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



**FAUNA HABITAT, ASSESSMENT POINTS, CS FAUNA & BC TREE LOCATIONS**  
**FLYNN DRIVE SPRING BIOLOGICAL SURVEY 2020**



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

SCALE: 1:3,000 @ A3

PROJECT NO: 4544-20

REV	AUTHOR	APPROVED	DATE
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**MAP 4B**



**LEGEND**

Survey Area (Yellow outline)  
 Roads (Black line)  
 Habitat Assessment Points (Yellow square)

**Habitat Trees**

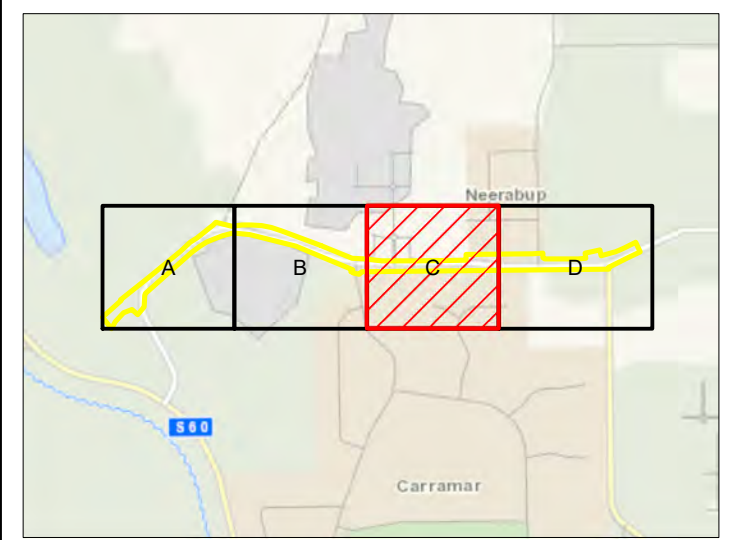
*Eucalyptus gomphocephala*  
 Class 3 (Red square)  
 Class 4 (Blue square)  
 Class 5 (Orange square)

*Eucalyptus marginata*  
 Class 3 (Green triangle)  
 Class 4 (Blue triangle)  
 Class 5 (Yellow triangle)

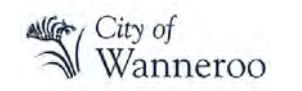
**Conservation Significant Fauna Locations**  
 Calyptrorhynchus latirostris (Endangered) (Pink circle)

**Fauna Habitat**  
 Banksia attenuata Woodland (Orange)  
 Eucalyptus gomphocephala Woodland (Green)  
 Shrubland (Pink)  
 Not habitat (Hatched)

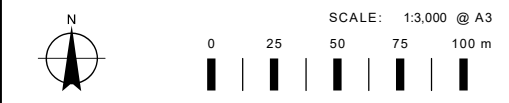
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 BASEMAP: GEOSCIENCE AUSTRALIA  
 SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRIID, IGN, AND THE GIS USER COMMUNITY



**FAUNA HABITAT, ASSESSMENT POINTS, CS FAUNA & BC TREE LOCATIONS**  
**FLYNN DRIVE SPRING BIOLOGICAL SURVEY 2020**



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



PROJECT NO: 4544-20

REV	AUTHOR	APPROVED	DATE
00	KP	SB	27/11/2020

**MAP 4C**

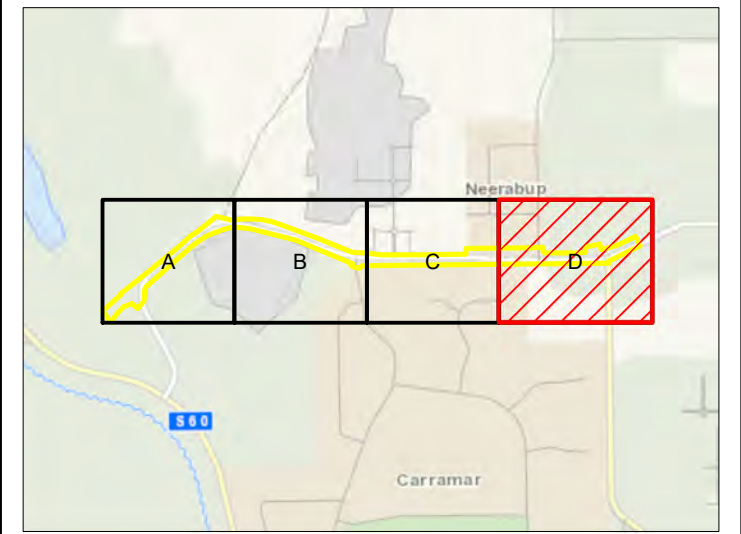


**LEGEND**

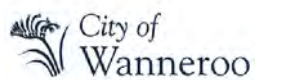
- Survey Area
- Roads
- Habitat Assessment Points
- Habitat Trees**
- Eucalyptus gomphocephala***
- Class 3
- Class 4
- Class 5
- Eucalyptus marginata***
- ▲ Class 3
- ▲ Class 4
- ▲ Class 5
- Conservation Significant Fauna Locations**
- Calyptorhynchus latirostris* (Endangered)

- Fauna Habitat**
- Banksia attenuata* Woodland
- Eucalyptus gomphocephala* Woodland
- Shrubland
- Not habitat

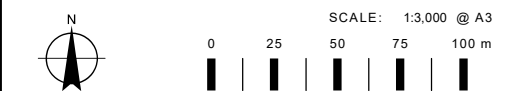
**DATASOURCES:**  
 SOURCE DATA: TRANSPORT ROAD CENTRELINES (MRWA 2012)  
 AERIAL: ESRI BASEMAP (2019)  
 BASEMAP: GEOSCIENCE AUSTRALIA  
 SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AERGRID, IGN, AND THE GIS USER COMMUNITY



**FAUNA HABITAT, ASSESSMENT  
 POINTS, CS FAUNA & BC TREE  
 LOCATIONS**  
**FLYNN DRIVE SPRING  
 BIOLOGICAL SURVEY 2020**



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



REV	AUTHOR	APPROVED	DATE
00	KP	SB	27/11/2020

**MAP  
 4D**

PROJECT NO: 4544-20

# APPENDIX ONE

# DEFINITIONS AND CRITERIA

**Table 13: EPBC Act categories for flora, fauna and ecological communities**

Category	Threatened species	Threatened Ecological Communities
<b>Extinct</b>	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
<b>Extinct in the wild</b>	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
<b>Critically Endangered (CE)</b>	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
<b>Endangered (EN)</b>	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.
<b>Vulnerable (VU)</b>	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.
<b>Conservation Dependent</b>	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 14: Conservation codes for Western Australian flora and fauna (DBCA 2019b)

<b>Conservation Codes for Western Australian Flora and Fauna</b>	
Threatened, Extinct and Specially Protected fauna or flora <sup>1</sup> are species <sup>2</sup> 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.	
<b>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.</b>	
<b>Categories of Threatened, Extinct and Specially Protected fauna and flora are:</b>	
<b>T</b>	<p><b>Threatened species</b></p> <p>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).</p> <p>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.</p> <p>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.</p> <p>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.</p>
<b>CR</b>	<p><b>Critically endangered species</b></p> <p>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>".</p> <p>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.</p>
<b>EN</b>	<p><b>Endangered species</b></p> <p>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>".</p> <p>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.</p>
<b>VU</b>	<p><b>Vulnerable species</b></p> <p>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>".</p> <p>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.</p>
<b>Extinct species</b>	
<b>Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.</b>	
<b>EX</b>	<p><b>Extinct species</b></p> <p>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).</p> <p>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.</p>
<b>EW</b>	<p>Extinct in the wild species</p> <p>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).</p> <p>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.</p>
<b>Specially protected species</b>	
<b>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.</b>	
<b>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.</b>	

<b>Conservation Codes for Western Australian Flora and Fauna</b>	
<b>MI</b>	<p><b>Migratory species</b></p> <p>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).</p> <p>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.</p> <p>Published as migratory birds protected under an international agreement under schedule 5 of the <i>Wildlife Conservation (Specially Protected Fauna) Notice 2018</i>.</p>
<b>CD</b>	<p><b>Species of special conservation interest (conservation dependent fauna)</b></p> <p>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).</p> <p>Published as conservation dependent fauna under schedule 6 of the <i>Wildlife Conservation (Specially Protected Fauna) Notice 2018</i>.</p>
<b>OS</b>	<p><b>Other specially protected species</b></p> <p>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).</p> <p>Published as other specially protected fauna under schedule 7 of the <i>Wildlife Conservation (Specially Protected Fauna) Notice 2018</i>.</p>
<b>P</b>	<p><b>Priority species</b></p> <p>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.</p> <p>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.</p> <p>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.</p>
<b>1</b>	<p><b>Priority 1: Poorly-known species</b></p> <p>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.</p>
<b>2</b>	<p><b>Priority 2: Poorly-known species</b></p> <p>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.</p>
<b>3</b>	<p><b>Priority 3: Poorly-known species</b></p> <p>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.</p>

<b>Conservation Codes for Western Australian Flora and Fauna</b>	
<b>4</b>	<p><b>Priority 4: Rare, Near Threatened and other species in need of monitoring</b></p> <p>(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.</p> <p>(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.</p> <p>(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.</p>
<p><sup>1</sup> The definition of flora includes algae, fungi and lichens.</p> <p><sup>2</sup> 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).</p>	

**Table 15: Grading system for the assessment of potential nest trees for Black Cockatoos (Bamford 2016)**

<b>Class</b>	<b>Description of tree and hollows/activity</b>
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 16: Commonwealth Black Cockatoo foraging quality scoring tool (Commonwealth of Australia 2017)**

<b>Starting Score</b>	<b>Foraging habitat for Carnaby's Cockatoo</b>	<b>Foraging habitat for Baudin's Cockatoo</b>	<b>Foraging habitat for Forest Red-tailed Black cockatoo</b>
<b>10 (Very high quality)</b>	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 $\geq 10$	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 $\geq 10$	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 $\geq 10$
<b>7 (High quality)</b>	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



<b>Starting Score</b>	<b>Foraging habitat for Carnaby's Cockatoo</b>	<b>Foraging habitat for Baudin's Cockatoo</b>	<b>Foraging habitat for Forest Red-tailed Black cockatoo</b>
<b>5 (Quality)</b>	Pine plantation or introduced eucalypts	Pine plantation or introduced eucalypts	Pine plantation or introduced eucalypts
<b>1 (Low quality)</b>	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
<b>Additions</b>	<b>Context adjustor - attributes improving functionality of foraging habitat</b>	<b>Context adjustor - attributes improving functionality of foraging habitat</b>	<b>Context adjustor - attributes improving functionality of foraging habitat</b>
<b>+3</b>	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).
<b>+3</b>	Contains trees with suitable nest hollows	Contains trees with suitable nest hollows	Contains trees with suitable nest hollows
<b>+2</b>	Primarily contains marri	Primarily contains marri	Primarily contains marri and/or jarrah
<b>+2</b>	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)
<b>+1</b>	Is known to be a roosting site	Is known to be a roosting site	Is known to be a roosting site
<b>Subtractions</b>	<b>Context adjustor - attributes reducing functionality of foraging habitat</b>	<b>Context adjustor - attributes reducing functionality of foraging habitat</b>	<b>Context adjustor - attributes reducing functionality of foraging habitat</b>
<b>-2</b>	No clear evidence of feeding debris	No clear evidence of feeding debris	No clear evidence of feeding debris
<b>-2</b>	No other foraging habitat within 6 km	No other foraging habitat within 6 km	No other foraging habitat within 6 km
<b>-1</b>	Is > 12 km from a known breeding location	Is > 12 km from a known breeding location	Is > 12 km from a known breeding location
<b>-1</b>	Is > 12 km from a known roosting site	Is > 12 km from a known roosting site	Is > 12 km from a known roosting site
<b>-1</b>	Is > 2 km from a watering point	Is > 2 km from a watering point	Is > 2 km from a watering point
<b>-1</b>	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 17: Fauna database results and likelihood assessments**

Blue shading indicates high likelihood; darker blue indicates species is known (recorded) from the survey area

Species (*)	Common name	Conservation status		Database			Likelihood of occurrence	
		EPBC Act	Western Australian	PMST**	DBCA	NatureMap	Desktop	Post-survey
<b>Mammals</b>								
<i>Dasyurus geoffroii</i>	Chuditch	VU	VU	Likely	-	-	Low	Low
<i>Isoodon fusciventer</i>	Quenda	-	P4	-	X	X	High	High
<i>Notamacropus irma</i>	Western Brush Wallaby	-	P4	-	X	X	Medium	Low
<i>Hydromys chrysogaster</i>	Water-rat	-	P4	-	X	X	Medium	Medium
<b>Birds</b>								
<i>Actitis hypoleucos</i>	Common Sandpiper	MI	MI	Known	X	X	Very Low	Very Low
<i>Apus pacificus</i>	Fork-tailed Swift	MI	MI	Likely	X	X	Medium	Medium
<i>Ardea alba</i>	Great Egret	-	-	Known	-	-	Very Low	Very Low
<i>Ardea ibis</i>	Cattle Egret	-	-	May	-	-	Very Low	Very Low
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	MI	MI	Known	-	-	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>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black Cuckoo	VU	VU	Likely	X	X	High	High
<i>Calyptorhynchus baudinii</i>	Baudin's Cuckoo	EN	EN	-	-	X	Medium	Low
<i>Calyptorhynchus latirostris</i>	Carnaby's Cuckoo	EN	EN	Known	X	X	Recorded	Recorded
<i>Falco peregrinus</i>	Peregrine Falcon	-	OS	-	X	X	Medium	Medium
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	-	-	Likely	-	-	Very Low	Very Low
<i>Himantopus himantopus</i>	Pied Stilt	-	-	Known	-	-	Very Low	Very Low
<i>Hydroprogne caspia</i>	Caspian Tern	MI	MI	-	-	X	Very Low	Very Low
<i>Leipoa ocellata</i>	Malleefowl	VU	VU	Likely	-	-	Very Low	Very Low
<i>Merops ornatus</i>	Rainbow Bee-eater	-	-	May	-	-	Low	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>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>Oxyura australis</i>	Blue-billed Duck	-	P4	-	X	X	Medium	Very Low
<i>Pandion haliaetus</i>	Osprey	-	-	Known	-	-	Very Low	Very Low
<i>Plegadis falcinellus</i>	Glossy Ibis	MI	MI	-	-	X	Medium	Low
<i>Recurvirostra novaehollandiae</i>	Red-necked Avocet	-	-	Known	-	X	Very Low	Very Low
<i>Rostratula australis</i>	Australian Painted Snipe	EN	EN	Likely	-	-	Very Low	Very Low
<i>Rostratula benghalensis (sensu lato)</i>	Painted Snipe	-	-	Likely	-	-	Very Low	Very Low
<i>Sternula nereis nereis</i>	Fairy Tern	VU	VU	May	-	-	Very Low	Very Low
<i>Thinornis rubricollis</i>	Hooded Plover	-	P4	May	-	-	Very Low	Very Low
<i>Tringa nebularia</i>	Common Greenshank	MI	MI	Known	-	-	Very Low	Very Low
<b>Reptiles</b>								
<i>Neelaps calonotos</i>	Black-striped Snake	-	P3	-	X	-	High	High

\* introduced

\*\* PMST likelihood of occurrence or likelihood of habitat occurring

## APPENDIX THREE FIELD SURVEY RESULTS

Table 18: Recorded fauna species

Species	Common name	EPBC Act status	Western Australian status
<b>Mammals</b>			
<i>Canis familiaris familiaris</i> *	Dog	-	-
<i>Macropus fuliginosus melanops</i>	Western Grey Kangaroo	-	-
<i>Oryctolagus cuniculus</i> *	Rabbit	-	-
<i>Rattus rattus</i> *	Black Rat	-	-
<b>Birds</b>			
<i>Anthochaera carunculata</i>	Red Wattlebird	-	-
<i>Cacatua roseicapilla</i>	Galah	-	-
<i>Cacatua sanguinea</i>	Little Corella	-	-
<i>Calyptorhynchus latirostris</i>	Carnaby's Cockatoo	EN	EN
<i>Corvus coronoides</i>	Australian Raven	-	-
<i>Cracticus tibicen</i>	Australian Magpie	-	-
<i>Gavicalis virescens</i>	Singing Honeyeater	-	-
<i>Lichmera indistincta</i>	Brown Honeyeater	-	-
<i>Pachycephala occidentalis</i>	Western Golden Whistler (Western Whistler)	-	-
<i>Petrochelidon nigricans</i>	Tree Martin	-	-
<i>Phylidonyris novaehollandiae</i>	New Holland Honeyeater	-	-
<i>Platycercus zonarius</i>	Australian Ringneck	-	-
<i>Rhipidura leucophrys</i>	Willie Wagtail	-	-
<i>Spilopelia chinensis</i> *	Spotted Turtle Dove	-	-
<i>Threskiornis moluccus</i>	Australian White Ibis	-	-
<i>Zosterops lateralis</i>	Grey-breasted White-eye (Silvereye)	-	-
<b>Reptiles</b>			
<i>Tiliqua rugosa rugosa</i>	Bobtail	-	-

\* Introduced species

Table 19: Fauna sites (GDA94, Zone 50)

Site Name	Site Type	Easting	Northing
HA01	Fauna: Habitat Assessment	385308.573	6493587.625
HA02	Fauna: Habitat Assessment	385603.522	6493601.204
HA03	Fauna: Habitat Assessment	385689.816	6493641.404
HA04	Fauna: Habitat Assessment	385134.923	6493611.861
HA05	Fauna: Habitat Assessment	384842.801	6493616.814
HA06	Fauna: Habitat Assessment	384761.497	6493545.954
HA07	Fauna: Habitat Assessment	384289.054	6493544.334
HA08	Fauna: Habitat Assessment	383398.031	6493715.471
HA09	Fauna: Habitat Assessment	382856.784	6493292.95
CBC01	Fauna: Evidence	382971.479	6493318.528
CBC02	Fauna: Sighting	383144.464	6493512.722

**Table 20: Details of Black Cockatoo habitat trees (GDA94, Zone 50)**

Tree number	Species	DBH (mm)	Number of hollows	Tree Class	Bees Present	Easting	Northing
1	jarrah	920	0	5_no_hollows	no	385318	6493595
2	jarrah	590	3	3_hollow_no_chew_marks	no	385561	6493609
3	jarrah	915	0	5_no_hollows	no	385673	6493643
4	jarrah	540	0	5_no_hollows	no	385448	6493546
5	jarrah	660	0	5_no_hollows	no	385288	6493547
6	jarrah		1	4_hollows_not_suitable	no	385224	6493533
7	tuart	730	0	5_no_hollows	no	385135	6493618
8	jarrah	630	0	5_no_hollows	no	385113	6493625
9	tuart	1360	1	4_hollows_not_suitable	no	384928	6493621
10	tuart	1230	0	5_no_hollows	no	384853	6493613
11	tuart	700	0	5_no_hollows	no	384931	6493615
12	tuart	600	1	4_hollows_not_suitable	no	384850	6493624
13	jarrah	850	2	4_hollows_not_suitable	no	384874	6493549
14	jarrah	940	1	4_hollows_not_suitable	yes	385045	6493551
15	jarrah	590	0	5_no_hollows	no	385108	6493546
16	tuart	590	0	5_no_hollows	no	384792	6493548
17	tuart	570	0	5_no_hollows	no	384783	6493548
18	tuart	1550	0	5_no_hollows	no	384755	6493546
19	tuart	2110	0	5_no_hollows	no	384688	6493541
20	tuart	980	0	5_no_hollows	no	384653	6493541
21	tuart	960	0	5_no_hollows	no	384454	6493545
22	tuart	610	0	5_no_hollows	no	384418	6493542
23	tuart	135	1	4_hollows_not_suitable	no	384403	6493532
24	tuart	780	0	5_no_hollows	no	384344	6493537
25	tuart	1040	0	5_no_hollows	no	384344	6493549
26	tuart	1500	3	3_hollow_no_chew_marks	yes	384141	6493581
27	tuart	1620	2	4_hollows_not_suitable	no	384133	6493612
28	tuart	550	0	5_no_hollows	no	384012	6493645
29	tuart	1040	0	5_no_hollows	no	383998	6493659
30	tuart	980	1	4_hollows_not_suitable	no	383977	6493653
31	tuart	7500	0	5_no_hollows	no	383954	6493662
32	tuart	650	0	5_no_hollows	no	383942	6493669
33	tuart	540	0	5_no_hollows	no	383935	6493680
34	tuart	770	0	5_no_hollows	no	383921	6493687
35	tuart	610	0	5_no_hollows	no	383914	6493690
36	tuart	650	0	5_no_hollows	no	383901	6493692
37	tuart	790	1	4_hollows_not_suitable	no	383854	6493715
38	tuart	640	0	5_no_hollows	no	383786	6493717
39	tuart	620	0	5_no_hollows	no	383172	6493519
40	tuart	560	0	5_no_hollows	no	383175	6493524
41	tuart	740	0	5_no_hollows	no	383268	6493608
42	tuart	650	0	5_no_hollows	no	383302	6493638
43	tuart	790	1	3_hollow_no_chew_marks	no	383426	6493711
44	tuart	680	0	5_no_hollows	no	383596	6493770
45	tuart	1000	1	4_hollows_not_suitable	yes	382864	6493217
46	tuart	840	1	4_hollows_not_suitable	no	382874	6493228