

APPENDIX C ATTACHMENTS LIST (Biota 2019b - Part 1 of 2)

Biota. (2019b). *Bunbury Outer Ring Road Southern Section Targeted Fauna Assessment*. Unpublished report prepared for Main Roads Western Australia.

BORR IPT. (2019a). *Bunbury Outer Ring Road Southern Section Vegetation and Flora Study*. Unpublished report prepared for Main Roads Western Australia.

Brad Goode & Associates. (2012). *Aboriginal Heritage Survey Report of the Proposed Bunbury Outer Ring Road Stage 2, Western Australia*. Unpublished report prepared for GHD Pty Ltd on behalf of Main Roads Western Australia.

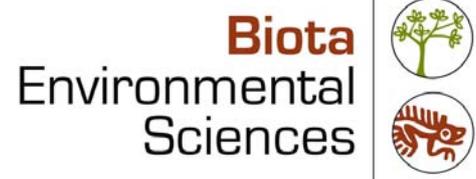
Main Roads WA. (2018). *Environmental Policy*.

WRM. (2019). *Bunbury Outer Ring Road Southern Investigation Area: Targeted Conservation Significant Aquatic Fauna Survey*. Unpublished report prepared for BORR IPT on behalf of Main Roads Western Australia.



Bunbury Outer Ring Road Southern Section Targeted Fauna Assessment





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BORR Southern Section Fauna Assessment

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1.0 Executive Summary

1.1 Introduction

Main Roads Western Australia is proposing to construct the Bunbury Outer Ring Road (BORR) Southern Section, a dual carriage highway linking from South Western Highway (near Bunbury Airport) to Bussell Highway (Figure 3.1). The project will include service roads, side road intersections, road overpass, service re-locations, fencing and noise walls. To inform the environmental impact assessment of the Proposal, Biota Environmental Sciences was commissioned to undertake a desktop review and targeted field survey in relation to the following conservation significant species:

- Carnaby's Black-cockatoo (Schedule 2, Endangered);
- Baudin's Black-cockatoo (Schedule 2, Endangered);
- Forest Red-tailed Black-cockatoo (Schedule 3, Vulnerable); and
- Western Ringtail Possum (Schedule 1, Critically Endangered).

Furthermore, likelihood of occurrence was to be assessed for the following conservation significant species:

- Wambenger Brush-tailed Phascogale (hereafter the Brush-tailed Phascogale) (Schedule 6); and
- Chuditch (Schedule 3, Vulnerable).

1.2 Methods

This report details surveys conducted at two scales:

- Proposal area: the 296.78 ha area being referred to the EPA; and
- Survey area: a 187.05 ha area within the Proposal area.

Habitat for black-cockatoos was assessed by foot-traversing the survey area (28.3 ha of remnant vegetation remains in unsurveyed gaps between the Proposal area and survey area). In larger vegetation fragments, a systematic approach was applied, whereby transects of 25 m spacing were overlain on the survey area in GIS. A zoologist then walked down the middle of two 25 m transects, effectively using them as the boundary of a strip-search, and recorded habitat trees. This was continued until the entire fragment had been searched. In small fragments or where there were singular trees, foot traverses were also undertaken and recorded via a track file. Foraging habitat descriptions were recorded while conducting foot traverses. For any tree supporting hollow/s, details of the hollows were taken, and a differential GPS was used to record an accurate location of the tree. These trees were also subject to a dedicated breeding hollow assessment, which included the use of a remotely piloted aircraft (RPA) to obtain images of the hollows.

Spotlighting for Western Ringtail Possums was completed over the large majority of the suitable habitat occurring in the Proposal area, using a strip-sampling technique (similar to that described for black-cockatoos) that aimed to record all individuals.

Night-spotting was also used as the search method for the Brush-tailed Phascogale and Chuditch, and was completed in conjunction with the Western Ringtail Possum surveys.

1.3 Results

1.3.1 Fauna Habitats

Of the 296.78 ha Proposal area, 192.81 ha represents land historically cleared for agriculture, road infrastructure and housing, leaving 103.97 ha of largely native vegetation. Within the Proposal area, a survey area of 187.05 ha was assessed and as far as practicable, all of the vegetation was ground-truthed. Based on the field observations, together with reference to the vegetation mapping of the survey area, the following broad habitats were described for the survey area (from most common to least):

- *Mari/Eucalyptus* woodland (42.55 ha);
- Dampland with *Melaleuca* shrubland and/or woodland (16.36 ha); and
- *Mari/Eucalyptus* in paddocks and road reserves (16.81 ha).

1.3.2 Target Species

Black-cockatoo breeding habitat trees were considered to be those of relevant species with a diameter at breast height (DBH) of 50 cm or greater as defined in the draft Commonwealth referral guidelines (DSEWPaC 2012a). A total of 1,017 trees of a suitable DBH were recorded within the survey area. A total of 115 trees were included in a dedicated tree hollow assessment, which incorporated the use of a Remotely Piloted Aircraft. Of the 115 trees, 18 contained hollows that were classified as 'Suitable' for black-cockatoo breeding with eight of these classified as 'Suitable with Evidence of Use', 24 trees had hollows of 'Limited Suitability', 64 trees had hollows that were 'Not Suitable' and nine trees received a 'Ground assessment only' rating as they contained hollows that could not be accessed with the aircraft. The survey area was comprised 59.4 ha of black-cockatoo foraging habitat, and feeding debris of all three black-cockatoo species was identified.

Strip-transect sampling in the Proposal area recorded 73 individual Western Ringtail Possums.

No Brush-tailed Phascogales were recorded within the Proposal area but six individuals were recorded from an adjacent reserve (Reserve 23000 Shire of Capel). Given the habitat availability, this species was considered likely to occur within the Proposal area.

No Chuditch were recorded within the Proposal area and they are considered a possible visitor only.

1.3.3 Non-target Conservation Significant Species

In addition to the target conservation significant species, the following seven species were either recorded during this study, or are considered to have some potential to occur within the Proposal area based on habitat availability and previous records in the area:

- Southern Brown Bandicoot, Quenda (Priority 4) – Occurs (recorded);
- Black-striped Dwarf Galaxias, Black-stripe Minnow (Schedule 2, Endangered) – Likely;
- Peregrine Falcon (Schedule 7) – Likely to occur (visitor);
- Coastal Plains Skink (Priority 3) – Possible;
- Western Brush Wallaby (Priority 4) – Possible;
- Western False Pipistrelle (Priority 4) – Possible; and
- Blue-billed Duck (Priority 4) – Possible (visitor).

2.0 Glossary and Acronyms

BC Act	Western Australian <i>Biodiversity Conservation Act 2016</i> .
Biota	Biota Environmental Sciences.
BORR	Bunbury Outer Ring Road.
Black-cockatoos	Refers to all three species of black-cockatoo endemic to the south-west of Western Australia: Carnaby's Black-cockatoo, Baudin's Black-cockatoo and Forest Red-tailed Black-cockatoo.
Breeding habitat (black-cockatoo)	Defined in the DSEWPaC (2012) referral guidelines as species of trees known to support breeding within the range of the species, which either have a suitable nest hollow OR are of a suitable diameter at breast height (DBH) to develop a nest hollow. For most species of trees, suitable DBH is 50 cm; for Salmon Gum and Wandoo, suitable DBH is 30 cm.
Conservation significant	Defined as those species listed under the Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i> , the WA <i>Biodiversity Conservation Act 2016</i> or Department of Biodiversity, Conservation and Attractions Priority species list.
DBCA	Western Australian Department of Biodiversity, Conservation and Attractions (formerly the Department of Environment and Conservation).
DBH	Diameter at breast height (approximately 1.3 m from base).
DoEE	Federal Department of Environment and Energy.
EPA	Environmental Protection Authority, Western Australia.
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i> .
Foraging habitat (black-cockatoo)	Defined in the DSEWPaC (2012) EPBC Act referral guidelines as plants of species known to support foraging within the range of each of the species.
Known nesting trees (black-cockatoo)	Any existing tree in which breeding has been recorded or suspected (e.g. showing evidence of use through scratches or feathers).
Proposal area	The BORR Southern Section Proposal area to be referred to the EPA.
Roosting habitat (black-cockatoo)	Defined as a suitable tree (generally the tallest) or group of tall trees, native or introduced, usually close to an important water source, and within an area of quality foraging habitat within the range of the species.
RPA	Remotely-piloted aircraft.
SCP	Swan Coastal Plain.
Survey area	The area of interest to which much of the field work was constrained; in this study, an area included within but not wholly encompassing the Proposal area.
Brush-tailed Phascogale	Wambenger Brush-tailed Phascogale, <i>Phascogale tapoatafa wambenger</i> .
WC Act	Western Australian <i>Wildlife Conservation Act 1950</i> (now repealed).

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3.0 Introduction

3.1 Proposal

Main Roads Western Australia (Main Roads) is proposing to construct the Bunbury Outer Ring Road (BORR), a dual carriage highway linking Forrest Highway and Bussell Highway, providing a bypass of Bunbury for inter-regional traffic. This report pertains to the Southern Section of the BORR, from South Western Highway (near Bunbury Airport) to Bussell Highway (Figure 3.1) (the Proposal). The Proposal includes service roads, side road intersections, road overpass, service re-locations, fencing and noise walls.

3.2 Study Objectives and Scope

Main Roads proposes to refer the BORR Southern Section to the Environmental Protection Authority (EPA) for assessment under Section 38 of the *Environmental Protection Act 1986* (EP Act). In order to inform the environmental impact assessment of the Proposal, Biota Environmental Sciences (Biota) was commissioned to undertake the following:

- conduct a desktop review of relevant previous fauna survey work;
- assess black-cockatoo foraging habitat, as well as roosting, potential breeding and actual breeding trees as per Commonwealth guidelines;
- estimate abundance of the Western Ringtail Possum within the Proposal area and place this estimate in the context of previous local and regional surveys;
- provide an assessment of the likelihood of occurrence of other conservation significant fauna (particularly Chuditch and Brush-tailed Phascogale); and
- delineate and map fauna habitats.

The fauna assessments relating to the project commenced in 2017 and are ongoing. The initial survey area for the fauna assessments is shown in Figure 3.1, together with its extent within the Proposal area. At the time of writing, the large majority of the Proposal area has been surveyed for the Western Ringtail Possum, while black-cockatoo assessments had been completed over the survey area portion of the Proposal area.

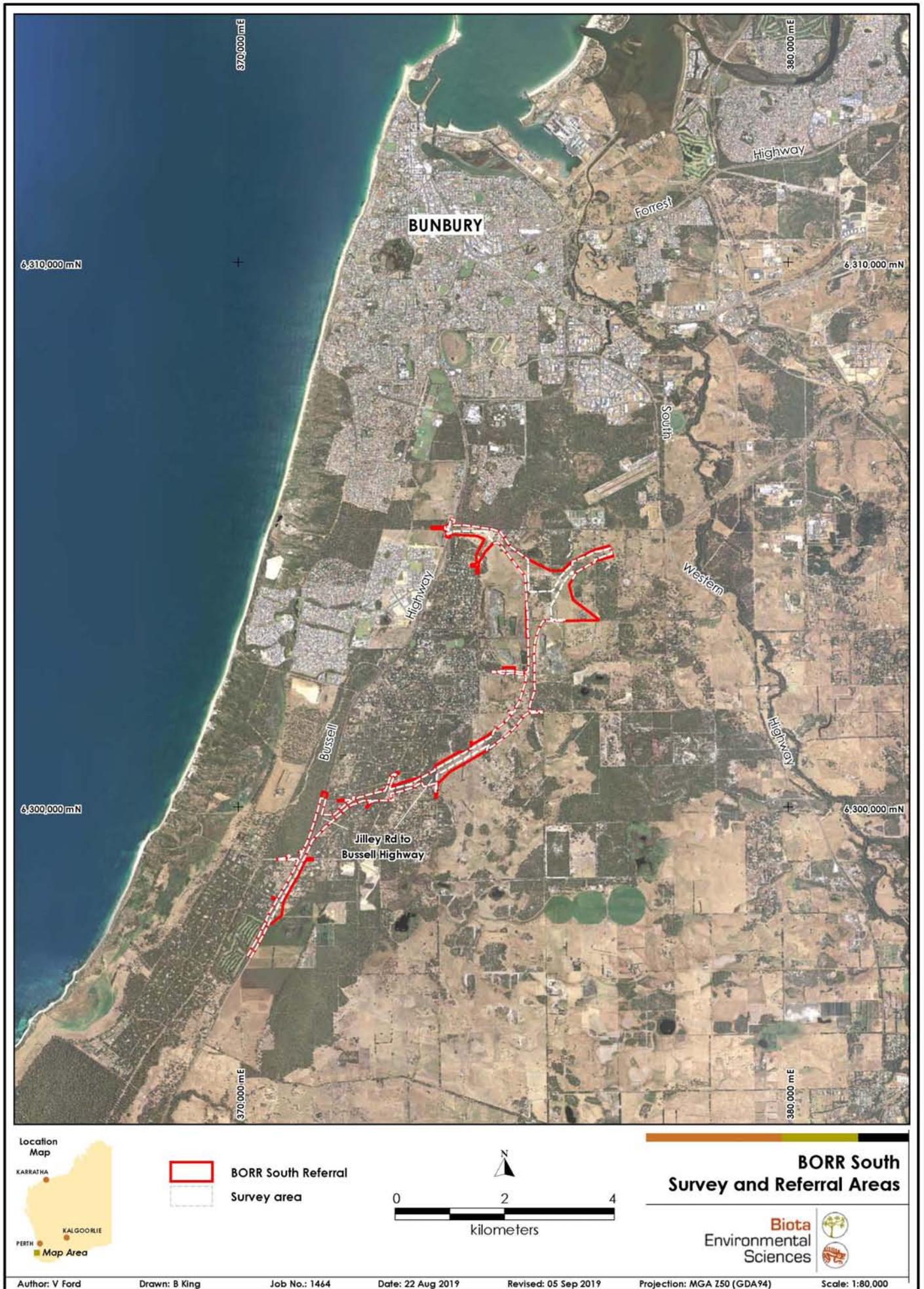


Figure 3.1: Location of the BORR Southern Section Proposal area and the survey area.

4.0 Methods

4.1 Desktop Review

A literature review was carried out to ascertain previous sampling effort in the local area (within 10 km); in particular, records of the target species (Western Ringtail Possum, black-cockatoos, Chuditch and Brush-tailed Phascogale), but also other conservation significant fauna.

The following sources of information were reviewed to compile a species inventory for the Proposal area:

1. NatureMap database (<http://NatureMap.dec.wa.gov.au>): a joint project of the Department of Biodiversity Conservation and Attractions (DBCA) and the Western Australian Museum (WAM). This database represents the most comprehensive source of information on the distribution of Western Australia's fauna, comprising records from the Fauna Survey Returns database and WA Threatened Fauna Database (both managed by the DBCA), the WAM Specimen database and the Birdlife Australia Birddata database. The database search was completed on 29 October 2018 using a 10 km buffer on a central line described by the coordinates:
 - 33°23'14"S 115°39'49"E;
 - 33°24'50"S 115°39'06"E;
 - 33°26'06"S 115°37'06"E;
 - 33°27'24"S 115°36'11"E.

The raw data returned are included as Appendix 4.

2. The Commonwealth EPBC Act Protected Matters Search Tool database. The database was searched using the same coordinates as the NatureMap search above, on the 29 October 2018. The raw data returned are included as Appendix 5.
3. Biota's internal database. Biota has conducted a number of recent studies associated with the BORR proposal; our database of records was utilised particularly in the context of Western Ringtail Possums and black-cockatoos. These studies are detailed in Table 4.2; and
4. Studies by other authors, as detailed in Table 4.2.

4.2 Conservation Significant Species Likelihood Assessment

The conservation significant species returned from the desktop review were assigned to one of four categories, ranging from 'Occurs' to 'Unlikely to occur' as defined in Table 4.1. The number of historical records, and their timing and distance from the Proposal area were considered in the likelihood assessment. Some species returned during the desktop review were confidently assessed as 'Unlikely to occur' due to an absence of specific habitat requirements within the Proposal area, or a well-defined distribution that does not include the Proposal area.

Table 4.1: Categories of likelihood assigned to conservation significant species in desktop search.

Status	Description
Occurs	Recorded in current survey through direct sighting or secondary evidence such as nut chews or diggings.
Likely to occur	Recent records (past 5 years) within Proposal area and nearest record <1 km from Proposal area boundary.
Possible	Nearest record <5 km from Proposal area boundary, and suitable habitat present. Lack of records may be due to low survey effort/cryptic behaviour of species or rarity. In some cases the study area lacks core habitat, however, it may occur as a visitor to forage or on route between areas of core habitat.
Unlikely to occur	Few records overall in past 10 years, or no records at all. Nearest record >5 km from Proposal area boundary. Habitat unsuitable or degraded/fragmented.

Table 4.2: Previous studies reviewed in relation to the Proposal area.

Report / Survey	Survey Dates (effort)	Survey Description	Records	Proximity to Proposal Area
Lot 1 Wallrod Road, Picton Environmental Values Assessment (GHD 2010a).	October 2010 (1 day)	Site inspection searching for evidence of Western Ringtail Possum and cockatoos (scats, dreys, nut chews, sightings).	Western Ringtail Possum and black-cockatoo species confirmed.	3 km.
Lot 15 Bunbury Outer Ring Road (Stage 2) Environmental Values Assessment (GHD 2010b).	October 2010 (1 day)	Site inspection searching for evidence of Western Ringtail Possum and cockatoos (scats, dreys, nut chews, sightings).	Western Ringtail Possum and black-cockatoo species confirmed.	2.5 km.
Western Ringtail Possum Survey & Black Cockatoo Habitat Assessment of Sabina Vale Loc 3819 (Harewood 2013).	(i) 26 March 2013 (ii) 2 April 2013 (1 day, 1 night)	Targeted daytime searches for cockatoo habitat trees and evidence of Western Ringtail Possum (scats, dreys, sightings). Nocturnal survey for Western Ringtail Possums.	1 Western Ringtail Possum, 195 black-cockatoo habitat trees (13 with hollows).	30 km.
Bunbury Outer Ring Road Southern Section, South Western to Bussell Highways (GHD 2012).	21 – 23 September 2011 (3 days)	Targeted daytime searches for cockatoo habitat trees and evidence of Western Ringtail Possum (scats, dreys, sightings).	565 black-cockatoo habitat trees, secondary evidence of Western Ringtail Possum (<3 sightings).	Overlapping Proposal area.
Main Roads Lot 1 Ducane Road Environmental Values Assessment (GHD 2014).	12 – 13 June 2013 (2 days, 1 night)	Level 1 and targeted daytime searches for cockatoo habitat trees and evidence of Western Ringtail Possums (scats, dreys, sightings). Nocturnal survey for Western Ringtail Possums.	38 black-cockatoo habitat trees, 1 Western Ringtail Possum recorded during night survey.	Overlapping Proposal area.
Shire of Dardanup Waterloo Urban and Industrial Expansion Flora and Fauna Survey (GHD 2015).	(i) 13 – 14 August 2014 (ii) 29 – 31 October 2014 (5 days)	Black cockatoo and Western Ringtail Possum habitat assessment. Evidence of Western Ringtail Possum and cockatoos (scats, dreys, nut chews, sightings).	Western Ringtail Possum and black-cockatoo species confirmed.	6 km.
Bunbury Port Access Road Project Stage 2 Rare Fauna Survey (GHD 2010c).	(i) 17 February – 5 March 2009 (ii) 4 – 7 August 2009 (8 days, 5 nights)	Level 1 fauna survey.	3 Western Ringtail Possums, black-cockatoo confirmed.	Partially overlapping.
Bunbury Outer Ring Road (Southern Section) Black Cockatoo Tree Survey (Biota 2018a).	13 – 15 November 2017 (3 days)	Cockatoo habitat tree assessment.	649 black-cockatoo breeding habitat trees (139 with hollows).	Largely within Proposal area.
Bunbury Outer Ring Road, Southern Section Western Ringtail Possum Assessment (Biota 2018b).	25 February – 5 March 2018 (8 nights)	Targeted survey for Western Ringtail Possum within the BORR Proposal area and contextual sites (Reserve 23,000, Lot 1 and Lot 2).	136 Western Ringtail Possums.	Largely within Proposal area.
Phase 1 Survey for the Western Ringtail Possum in the BORR, Lot 1 Bussell Highway, Maidment Parade Road Reserve, Gelorup and Davenport Localities (Biota 2018c).	10 – 13 July 2018 (3 nights)	Targeted survey for Western Ringtail Possums	73 Western Ringtail Possums.	Some sites overlapping and otherwise all within 5 km.

Report / Survey	Survey Dates (effort)	Survey Description	Records	Proximity to Proposal Area
Phase 2 Survey for the Western Ringtail Possum in the BORR, Lot 1 Bussell Highway, Maidment Parade Road Reserve, Gelorup and Davenport Localities, Centenary Road, Golf Drive, Picton East (Biota 2018d).	22 August 2018 – 4 September 2018 (12 nights)	Targeted survey for Western Ringtail Possums	114 Western Ringtail Possums.	Some sites overlapping and otherwise all within 5 km.
Phase 3 Survey for the Western Ringtail Possum in the BORR: Southern Lots and Manea Park (Biota in prep.).	30 October – 5 November 2018 (6 nights)	Targeted survey for Western Ringtail Possums	143 Western Ringtail Possums.	Southern Lots are located within 1–6 km of the Proposal area and Manea Park is adjacent to the northern edge of the Proposal area.

4.3 Legislation and Policy Conformance

All surveys were completed as far as practicable in accordance with relevant State and Commonwealth policy, and to a standard that would provide adequate information to assess the Proposal against principles and environmental aims relating to the environmental factor 'Terrestrial Fauna' (EPA 2016a). Table 4.3 provides a summary of the most important and relevant legislation, policy and guidelines relating to this study.

Table 4.3: State and Commonwealth legislation, policy and guidelines of most relevance to this study.

Legislation, Guideline or Policy	Application to this Study	Regulating Authority
Commonwealth		
<i>Environment Protection and Biodiversity Conservation Act 1999</i> (the EPBC Act).	The Australian Government's central piece of environmental legislation.	The Department of Environment and Energy
Significant Impact Guidelines 1.1 - Matters of National Environmental Significance (DoE 2013).	Details the species falling within the MNES category and what constitutes a significant impact.	The Department of Environment and Energy
Significant impact guidelines for the vulnerable western ringtail possum (<i>Pseudocheirus occidentalis</i>) in the southern Swan Coastal Plain, Western Australia (DEWHA 2009)	Details habitat classification.	The Department of Environment and Energy
EPBC Act referral guideline for three threatened black cockatoo species: Carnaby's Cockatoo (<i>Calyptorhynchus latirostris</i>), Baudin's Cockatoo (<i>Calyptorhynchus baudinii</i>) and the Forest Red-tailed Black Cockatoo (<i>Calyptorhynchus banksii naso</i>) (DSEWPac 2012)	Details distribution, ecology and recommended survey methodology.	The Department of Environment and Energy
Western Australia		
<i>Biodiversity Conservation Act 2016</i> (BC Act) and Biodiversity Conservation Regulations 2018	Western Australia's central environmental legislation. Came into effect 1 January 2019 and replaces the <i>Wildlife Conservation Act 1950</i> . Fauna taking (scientific or other purposes) licence	Department of Biodiversity, Conservation and Attractions
<i>Wildlife Conservation Act 1950</i> (WC Act)	Now defunct and replaced by the BC Act, however the most recently published Wildlife Conservation (Specially Protected Fauna) Notice 2018 under this act is current at time of writing.	Department of Biodiversity, Conservation and Attractions
Environmental Factor Guideline: Terrestrial Fauna (EPA 2016a).	Overall aim of the study is to provide adequate information to assess the proposal against the objective of the environmental factor Terrestrial Fauna; stated to be "To protect terrestrial fauna so that biological diversity and ecological integrity are maintained".	Environmental Protection Authority
Western Ringtail Possum (<i>Pseudocheirus occidentalis</i>) Recovery Plan. Wildlife Management Program No. 58 (Department of Parks and Wildlife 2017)	Details ecology of the species and priority survey objectives.	Department of Biodiversity, Conservation and Attractions

4.4 Nomenclature

Consistent with the EPA (2016b) nomenclature for amphibians, reptiles and mammals follows the standards of the WA Museum fauna taxonomic checklist, which is revised and released every six months or as necessary while avifauna nomenclature is in accordance with Christidis and Boles (2008).

4.5 Timing, Team and Permits

The field survey was conducted in five phases over the course of spring and summer 2018, and winter 2019 as detailed in Table 4.4. Multiple phases were conducted as access to private land became available.

In relation to the timing of typical black-cockatoo presence on the Swan Coastal Plain, the surveys in September, October and November should have been well placed to record foraging activity of all species. The timing of breeding peaks in summer for all three species, although this can be flexible in Forest Red-tailed Black-cockatoo, so there was also the possibility of recording the onset of breeding.

Table 4.4: Summary of survey timing and weather conditions.

Date	Methods	Personnel	Minimum Temperature (°C)	Maximum Temperature (°C)	Rainfall (mm)
1/10/18	Black cockatoo habitat assessment, Nocturnal searches	Victoria Ford, Michael Greenham, Joshua Keen, Brandon King	11.3	20.9	0
2/10/18			9.6	21.8	0
3/10/18			10.2	21	0
4/10/18			12.4	22.7	4.4
5/10/18			15.1	20.9	0.2
6/10/18			12.7	21.2	0.6
Avg./Total			11.9	21.4	5.2
30/10/18	Black cockatoo habitat assessment,	Victoria Ford, Joshua Keen, Brandon King	10.7	23.1	0
31/10/18			9.8	22.6	0
1/11/18			7.7	19.4	0
2/11/18			12.1	19.8	0
3/11/18			11.5	22.4	0.2
4/11/18			7.9	20	0
5/11/18			10.6	18.2	0.6
Avg./Total			10.0	20.8	0.8
28/11/18	RPA survey of hollow-bearing trees	Joshua Keen, Shane Priddle	10.3	22.4	0
29/11/18			9.8	24.2	0
30/11/18			7.3	21.3	0
1/12/18			12.7	21.8	0
2/12/18			7.3	24.2	0
3/12/18			11.1	32.3	0
4/12/18			13.8	22.2	0
5/12/18			11.5	21.9	0
6/12/18			12.6	20.7	4.8
7/12/18			7.8	22.1	0
8/12/18			11.8	24.7	0
9/12/18			12.4	29.9	0
Avg./Total			10.7	24.1	4.8
12/12/18			14.6	23.8	0
29/01/19	Black cockatoo habitat and hollow assessment	Jacinta King, Joshua Keen	11.2	28.3	0
30/01/19			10.4	30.9	0
1/02/19	RPA assessment	Joshua Keen,	17.7	35.0	0

Date	Methods	Personnel	Minimum Temperature (°C)	Maximum Temperature (°C)	Rainfall (mm)
		Shane Priddle			
17/08/19	Western Ringtail Possum Strip Searching	Joshua Keen Pierre-Louis de Kock	7.3	15.7	18.8
18/08/19			2	17.4	0
19/08/19			3.1	18	0
20/08/19			3.3	19.6	0
Avg./Total			3.9	17.7	18.8

Data from Bureau of Meteorology recording station Carey Park (No. 9965), near Bunbury. Conditions in the year preceding the survey were typical of long-term averages, although the winter immediately preceding the 2018 spring/summer survey work was slightly wetter than average (Figure 4.1). This would be expected to have a positive effect on foliage productivity and food resources for the Western Ringtail Possum and black-cockatoo species.

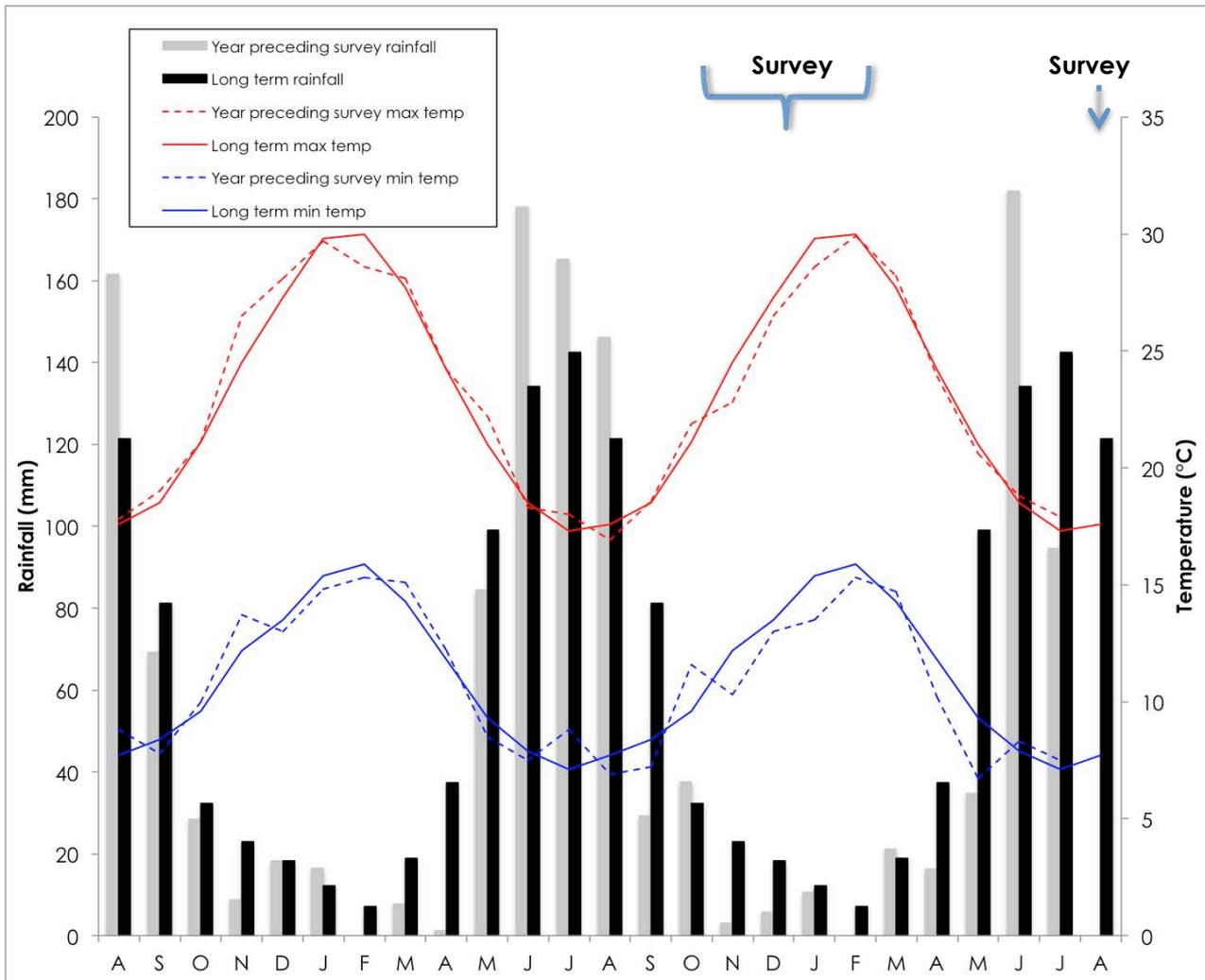


Figure 4.1: Average monthly weather conditions in the year preceding the field surveys (October 2017 through August 2019) compared with long-term climatological averages (data from the Bureau of Meteorology station at Carey Park, 1995–2018).

With the exception of RPA pilot Shane Priddle (SW Environmental), all team members were Biota biologists. GIS mapping and calculations were undertaken by Paul Sawers and Brandon King of Biota.

The fauna survey was conducted under Regulation 17 "Licence to Take Fauna for Scientific Purposes" Permit No. 08-002773-2 issued by the DBCA to Dr Victoria Ford (Appendix 2).

4.6 Western Ringtail Possum

The Proposal area was searched for Western Ringtail Possums using a strip-sampling approach, whereby areas of vegetation were mapped and divided into 20 m wide strips using GIS. Strips were loaded onto tablets with a GPS accuracy within 1.5 m and each strip was searched by a zoologist, who walked down the middle of the strip and treated the two edges of the 20 m strip as boundaries. The survey was conducted by two zoologists for four nights from 17 to 21 August 2019. Survey work commenced when conditions became effectively dark (30 minutes after sunset) and were typically complete by 1:00 am. Searching for possums was conducted using a high-powered head torch. In the case of road reserves and where roadside vegetation was continuous, one person walked through the middle of the vegetation. In areas where the road reserve comprised only scattered single trees, spotlighting was conducted from a vehicle. In all cases, the location of an observed possum was recorded while standing directly below the animal.

A 20 m strip-width was used based on modeling of Distance sampling data accumulated from over three thousand detections of Western Ringtail Possums, indicating a probability of detection of greater than 98% at a distance of up to 10 m from a transect (Biota 2018c, 2018d). We are therefore confident that the number of recorded individuals is an accurate estimate of total abundance.

In open pasture with scattered trees, searching individual paddock trees was undertaken in favour of strips searches.

From GPS tracklogs taken during the exercise, 66.5 km was walked on foot while 7.5 km of road reserve was spotlighted from a vehicle. The total area searched for possums was 100 ha. Due to property access restrictions, some small areas of vegetation shown in Figure 5.3 could not be sampled. These restrictions affected 39.8 ha of the Proposal area although not all of this area was vegetated.

4.6.1 Data Collected

The following information was recorded with every Western Ringtail Possum (and other species) observation

- Species;
- Observer;
- Animal location using GPS, taken while standing directly underneath;
- Time;
- Number of individuals;
- Age class: Subadult independent, Adult, Adult with young at heel, or Female with young on back;
- Cue: Seen (eyeshine), Seen (no eyeshine), Heard, or Silhouette;
- Drey or hollow at observation point; and
- Dominant habitat.

4.7 Brush-tailed Phascogale and Chuditch

The spotlighting methods applied to the sampling of Western Ringtail Possum were considered equally applicable to the Brush-tailed Phascogale and Chuditch.

4.8 Black-cockatoos

4.8.1 Breeding Habitat Assessment

At the time of writing this report, the field assessment relating to black-cockatoos had been completed over the survey area as shown Figure 3.1 and Figure 4.2, which includes much of the Proposal area but does not wholly encompass it. The unsurveyed gap between the survey area and Proposal area was 109.73 ha, however based on aerial imagery 81.48 ha of this is cleared land, leaving 28.25 ha of remnant vegetation within the Proposal area that is yet to be assessed.

This report provides a synthesis of the black-cockatoo breeding habitat assessment conducted in the Jilley Road to Bussell Highway portion of the survey area in 2017 (Biota 2017) and further surveys to assess the remainder of the survey area in spring 2018 and summer 2018/2019 (see Table 4.4 for dates of survey phases).

The Commonwealth "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*" defines breeding habitat as those species of trees known to support breeding within the range of the species, which either have a suitable nest hollow or are of a suitable diameter at breast height (DBH) to develop a nest hollow (DBH greater than 50 cm for most eucalypts, or 30 cm DBH in the case of Wandoo and Salmon Gum) (DSEWPaC 2012a). With regard to foraging habitat for black-cockatoos, the referral guideline states that any area within the range of the black cockatoos that contains known food or nesting plant species is considered to be potential habitat for the species.

The aim was to assess, as far as practicable, all potential breeding habitat trees and foraging habitat quality and extent within the survey area. Two approaches were taken:

1. Larger areas of continuous vegetation were identified from aerial imagery and overlain with 25 m spaced transects in GIS. Using a GPS, a biologist walked up the middle of each 25 m wide transect assessing all trees within it;
2. For smaller areas (e.g. narrow roadside reserves) or areas comprising scattered trees in paddocks, a biologist would maintain a GPS track file while using aerial imagery to visit as many trees as possible.

All individual trees of species with potential to form hollows (primarily Jarrah, Marri, Tuart and Flooded Gum) and with sufficient diameter to be considered breeding habitat trees (DBH >50 cm) were recorded using a GPS (accurate to within 3 m). Furthermore, the position of trees observed to contain hollows potentially suitable for black-cockatoo nesting was recorded using differential GPS (accurate to within 1.5 m) and the following parameters were scored:

- DBH (diameter at breast height; approximately 1.3 m above the ground);
- tree height using a laser rangefinder;
- tree species;
- the number and height above the ground of observed hollows;
- the diameter of each hollow;
- signs of cockatoo use (including wear around hollows, nut chews, scarring, scratch marks on trunks and branches, secondary evidence of feeding sites and moulted feathers); and
- photographs were also taken as a visual reference and to aid future identification of the tree.

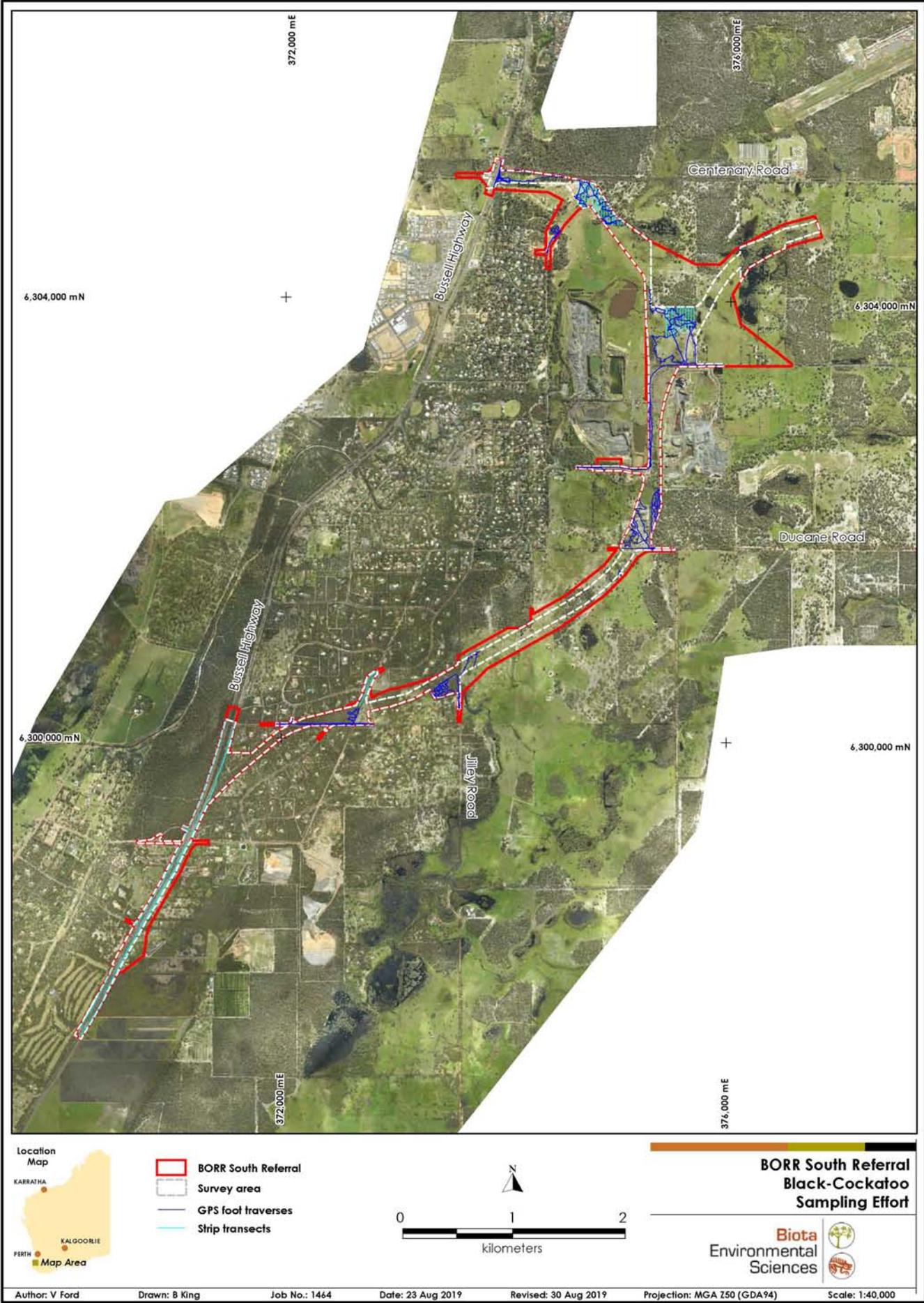


Figure 4.2: Survey effort applied to assessing black-cockatoo habitat within the Proposal area.

4.8.1.1 Black-Cockatoo Breeding Hollow Assessment Field Methodology

Black-cockatoos on the Swan Coastal Plain breed in large hollow-bearing trees, generally within woodlands and forests (Johnstone and Kirkby 2011). Hollow formation results from a number of processes including fungal infection, termite activity and fire, and propensity for hollow formation varies between eucalyptus species (Whitford and Williams 2002). Studies on hollow formation in Jarrah/Marri forests identified a minimum tree age of 130 years before a tree would be suitable for hollow-dependent fauna (Whitford and Williams 2002). Habitat destruction, and the subsequent loss of suitable breeding hollows, has been identified as a process leading to population decline of black-cockatoos (Johnstone and Kirkby 2008). Furthermore, increased competition with both native and introduced species (e.g. ducks, Galahs and European Honey Bees) continues to reduce the availability of such trees for breeding sites (Johnstone et al. 2013).

Studies of the breeding behaviours of the three threatened black-cockatoo species have identified variation between the tree species and characteristics of hollows chosen for nesting (Table 4.5). For example, hollows formed in Jarrah are typically smaller than those in Marri, and Forest Red-tailed Black-cockatoos breed predominantly in Marri in the Jarrah-Marri forest of the Southwest of WA (Johnstone et al. 2013). Breeding records of Carnaby's Black-cockatoo on the Swan Coastal Plain indicate that the majority of their nests are in Tuart (Johnstone and Kirkby 2011).

Table 4.5: Breeding habitat for the three Threatened black-cockatoo species.

	Baudin's	Carnaby's	Forest Red-Tailed
Specific breeding habitat for the three black-cockatoo species	Nest in hollows in live or dead trees of Karri, Marri, Wandoo and Tuart.	Nest in hollows in live or dead trees of Salmon Gum, Wandoo, Tuart, Jarrah, Flooded Gum, York Gum, Powderbark, Karri and Marri.	Nest in hollows in live or dead trees of Karri, Marri, Bullich, Swan River Blackbutt, Tuart and Jarrah.
Hollow Characteristics			
Aspect	No preference. Does not affect nesting success (Saunders 1979).	No preference. Does not affect nesting success (Saunders 1979).	–
Depth	Ranges from 0.1 to 2.5+ m (Johnstone and Kirkby 2011).	Majority between 0.5 and over 2.0 m, average just over 1 m (Saunders 1979).	1.0 - 5.0 m (Johnstone and Kirkby 2011).
Height above ground	No preference (Serventy and Whittell 1976).	No evidence that higher hollows are preferred (Saunders 1979).	No preference (Johnstone and Kirkby 2011).
Living or dead	No preference (Saunders 1979).	No preference (Saunders 1979).	No preference (Saunders 1979).
Entrance Diameter	–	–	>12 cm (Johnstone and Kirkby 2011).

For all hollow-bearing trees >50 cm DBH, which also contained hollows greater than approximately 12 cm dimension, a follow-up survey was conducted using a remotely-piloted aircraft (RPA; DJI Mavic Pro) to assess the suitability of these hollows for black-cockatoo breeding. The RPA assessment was applied both to hollows identified during the earlier study in 2017 (Biota 2017) and those recorded in the more recent assessment of additional areas.

The RPA exercise was carried out by two biologists, one of whom was also an experienced RPA pilot (Shane Priddle of SW Environmental). A pre-flight assessment of the tree was completed to ensure proper flight conditions and confirm the order in which hollows would be assessed. Prior to flight, the side of the tree was raked with a branch, which will generally cause any black-cockatoo or other bird species within a hollow to emerge. Not only does this provide an indication of hollow use but also reduces the likelihood of RPA-fauna collision.

During the flight stage of the RPA survey, the pilot was responsible for flying the RPA and the spotter monitored the surroundings to ensure the aircraft was not in close proximity to branches and informed the pilot if any birds fled the hollows.

Photographs of the hollows were then assessed in detail to determine if they actually represented suitable hollows and/or if they showed any signs of current or previous use by black-cockatoos (e.g. chew marks around the hollow entrance).

Breeding suitability of the hollows examined was categorised as per Table 4.6.

Table 4.6: Categories of hollow suitability for black-cockatoo nesting.

Category	Characteristics
Suitable	<ul style="list-style-type: none"> Entrance greater than 12 cm. Branch width and depth large enough to support a suitably-sized nesting chamber. Angle of entrance allows egress for black-cockatoo. Entrance is clear of large branches and excessive foliage that would block access for black-cockatoo.
Suitable with evidence of use	<p>As for "Suitable" above, but also showing evidence of use that may be from black-cockatoos. The following represent the types of use that were observed:</p> <ul style="list-style-type: none"> Fresh chews around the rim and inside of the hollow. Freshly cleared vegetation around the entrance. Eggs that were similar in appearance to those of black-cockatoos. <p>Neither black-cockatoos at/in hollows or fledglings were observed during the survey, however this may reflect timing of the survey, which preceded the peak breeding period.</p>
Limited suitability	Hollows with an entrance greater than 12 cm, and which included some, but not all of the characteristics of a "Suitable" hollow.
Not Suitable	Not a hollow, or hollow not suitable for black-cockatoo nesting.
Ground assessment only	The hollow could only be assessed from the ground due to limitations with RPA access (e.g. proximity to road traffic, within a prescribed no-fly zone, foliage covering hollow).

4.8.2 Foraging Habitat Assessment

Foraging habitat is defined as areas including plants of species known to support foraging within the range of each cockatoo species. While a broader range of species is utilised for foraging (including introduced species such as pines, **Pinus* spp.), Marri and Jarrah woodlands are particularly important to Baudin's Black-cockatoo and the Forest Red-tailed Black-cockatoo, while proteaceous heaths (i.e. shrublands dominated by *Banksia*, *Hakea* and *Grevillea* species) are also utilised by Carnaby's Black-cockatoo (DSEWPac 2012a).

While conducting assessments of breeding habitat in the areas shown in Figure 4.2, foraging habitat and foraging evidence were opportunistically recorded. Not all locations of foraging evidence were recorded, as these were too numerous for this to be practicable. However, generally any first encounter with foraging evidence within a vegetation fragment was recorded and subsequent encounters were also recorded if they were indicative of an additional species utilising the area.

4.9 Limitations

A number of potential limitations, including those identified in EPA (2016b), have been considered in relation to the study (Table 4.7).

Table 4.7: Assessment against potential survey limitations.

Potential Limitation	Assessment
Availability of contextual information at a regional and local scale	<ul style="list-style-type: none"> To provide context for estimates of Western Ringtail Possum numbers in the Proposal area, additional sites outside the Proposal area were sampled using consistent methodology. Seven surveys targeting Western Ringtail Possums and/or black-cockatoos have been conducted within 20 km of the Proposal area and were reviewed to provide local context. Contextual information was not considered a limitation.
Competency/ experience of the team carrying out the survey, including experience in the bioregion surveyed	<ul style="list-style-type: none"> The field personnel conducting the work were all suitably qualified. A core group of personnel completed all survey phases to standardise recording as far as practicable. Competency was not considered to be a limitation.
Proportion of fauna recorded and/or collected, any identification issues	<ul style="list-style-type: none"> This study targeted specific fauna species of conservation significance. The study comprehensively sampled the occurrence of habitat for these species within the Proposal area. There is potential for suitable breeding hollows to be missed, as recorders were limited in detecting hollows from ground level and their view may have been blocked by foliage or the aspect of the hollow entrance. Within the Proposal area, seven trees could not be assessed using the RPA due to foliage obstructing the hollow.
Appropriate area fully surveyed (effort and extent)	<ul style="list-style-type: none"> As detailed in Section 3.0, the survey area represented a large portion of the Proposal area but not the entirety. The extent of survey was considered to be a limitation in relation to the black-cockatoo habitat assessment of the Proposal area, but was not a limitation for the Western Ringtail Possum targeted work, which were surveyed over the whole Proposal area.
Access restrictions within the survey area	<ul style="list-style-type: none"> Access was not permitted for some properties occurring within the Proposal area when conducting the Western Ringtail Survey of August 2019, comprising a total of 39.8 ha. This was not considered a limitation to the assessment of WRP occurrence.
Survey timing, rainfall, season of survey timing / weather / season / cycle	<ul style="list-style-type: none"> Survey timing was not considered to be a limitation to the assessment of breeding habitat for black-cockatoos and the survey of Western Ringtail Possum.
Disturbances (e.g. fire, flood, accidental human intervention etc.) which affected results of survey	<ul style="list-style-type: none"> Disturbances were not considered a limitation to the survey.

5.0 Results

5.1 Desktop Review

Tables detailing all species returned from the desktop review are presented as Appendix 3. Database search results, together with four studies within 10 km of the Proposal area, yielded a combined species inventory of 223 vertebrate fauna species, comprising 25 mammals (14 native non-volant mammals, one bat and 10 non-native species), 159 birds (63 of which are largely reliant on freshwater or marine habitats), 29 reptiles and 10 amphibians.

A total of 21 of these species are of conservation significance; these are considered in more detail in Section 6.0.

5.2 Fauna Habitats

Approximately 192.8 ha of the 296.8 ha Proposal area represents land historically cleared for agriculture, housing and road infrastructure while 104.0 ha of predominantly native vegetation remains. Of this 104.0 ha of native vegetation, ground-truthing and habitat mapping was conducted over the 75.72 ha occurring within the survey area as illustrated in Figure 5.1 and Figure 5.2.

Three broad fauna habitats were described from on-site descriptions and vegetation mapping conducted by the BORR Integrated Project Team (2019). Some refinement of fauna habitat within vegetation units was necessary; for example, Eucalypts within a road reserve were considered to represent a different fauna habitat to a large fragment. The three broad fauna habitats described for the survey area are detailed in Table 5.1, while their extent is illustrated in Figure 5.1 and Figure 5.2. The habitats comprised Marri/*Eucalyptus* woodland (42.55 ha), Marri/*Eucalyptus* scattered trees in paddocks and road reserves and (16.81 ha), and Dampland with *Melaleuca* shrubland and/or woodland (16.36 ha). The mid-storey and lower strata of the Marri/*Eucalyptus* woodland varied throughout the survey area, particularly in the predominance of *Agonis* and *Banksia*.

The Marri/*Eucalyptus* woodland habitat of the survey area was dominant in the Jilley Road to Bussell Highway portion of the Proposal area. Dampland was for the most part located in the northern portion of the survey area. Only one area was found to support free water, despite much higher than average winter rainfall preceding the survey, indicating that these dampland areas are rarely inundated.

A considerable proportion of the vegetation occurred as single trees or small stands within paddocks and road reserves. Both of these habitat types have the potential to represent linkages that allow fauna to disperse throughout the landscape, although their usefulness is likely to vary considerably between species depending on their mobility (e.g. black-cockatoos greater than Western Ringtail Possum). For paddock remnants, their usefulness as stepping-stones may be reduced in instances where they are fenced or there is little or no understorey due to grazing. Utilisation of this habitat type by Western Ringtail Possums was demonstrated in this study, with a relatively high density recorded within Lot 100 Bussell Highway (see Figure 5.3). Although much of the understorey had been grazed and the canopy was not continuous, the possums were distributed throughout. This area of broken habitat was contiguous with Manea Park, an area of continuous woodland habitat also supporting the Western Ringtail Possum.

The Jilley Road to Bussell Highway portion of the Proposal contains areas of uninterrupted woodland. The residential properties surrounding this south-western section of the alignment are also heavily wooded, although they do not support the same degree of canopy connectivity and are subject to anthropogenic disturbance. The Shire of Capel Reserve 23000 directly west of the Bussell Highway at the southern end of the Proposal area also contains areas of similar undisturbed habitat where the Western Ringtail Possum has been recorded.

A limitation of any habitat classification system is that it is not specific to any one species. Rather, the classification provides a convenient framework to summarise species occurrence. When considering habitat for individual species of elevated conservation significance, the habitat availability within the Proposal area has been considered in relation to particular species requirements and this is detailed in Section 6.0.

Table 5.1: Broad fauna habitats of the survey area.

Broad Fauna Habitat	Area (ha)	Example Photographs	
<p>Marri/<i>Eucalyptus</i> woodland</p> <p>Jarraah (<i>Eucalyptus marginata</i>) and Marri (<i>Corymbia calophylla</i>) dominated overstorey, varying understorey of Banksia (<i>Banksia attenuata</i> and <i>B. grandis</i>) and/or Peppermint (<i>Agonis flexuosa</i>).</p>	42.55		
<p>Dampland with <i>Melaleuca</i> shrubland and/or woodland</p> <p>Shrubland or woodland of Moonah (<i>Melaleuca preissiana</i>) or Swamp Paperbark (<i>Melaleuca raphiophylla</i>), typically over sedges or introduced grasses.</p>	16.36		

Broad Fauna Habitat	Area (ha)	Example Photographs
<p data-bbox="118 140 584 196">Marri/<i>Eucalyptus</i> in paddocks and road reserves</p> <p data-bbox="118 240 645 483">Typically occurring as widely spaced trees or occasionally as small stands in paddocks; comprising a mosaic of scattered trees of Marri and/or Flooded Gum. When occurring as small stands, the midstorey typically comprised <i>Melaleuca</i> or Peppermint and the heavily grazed understorey comprised introduced grasses.</p>	16.81	

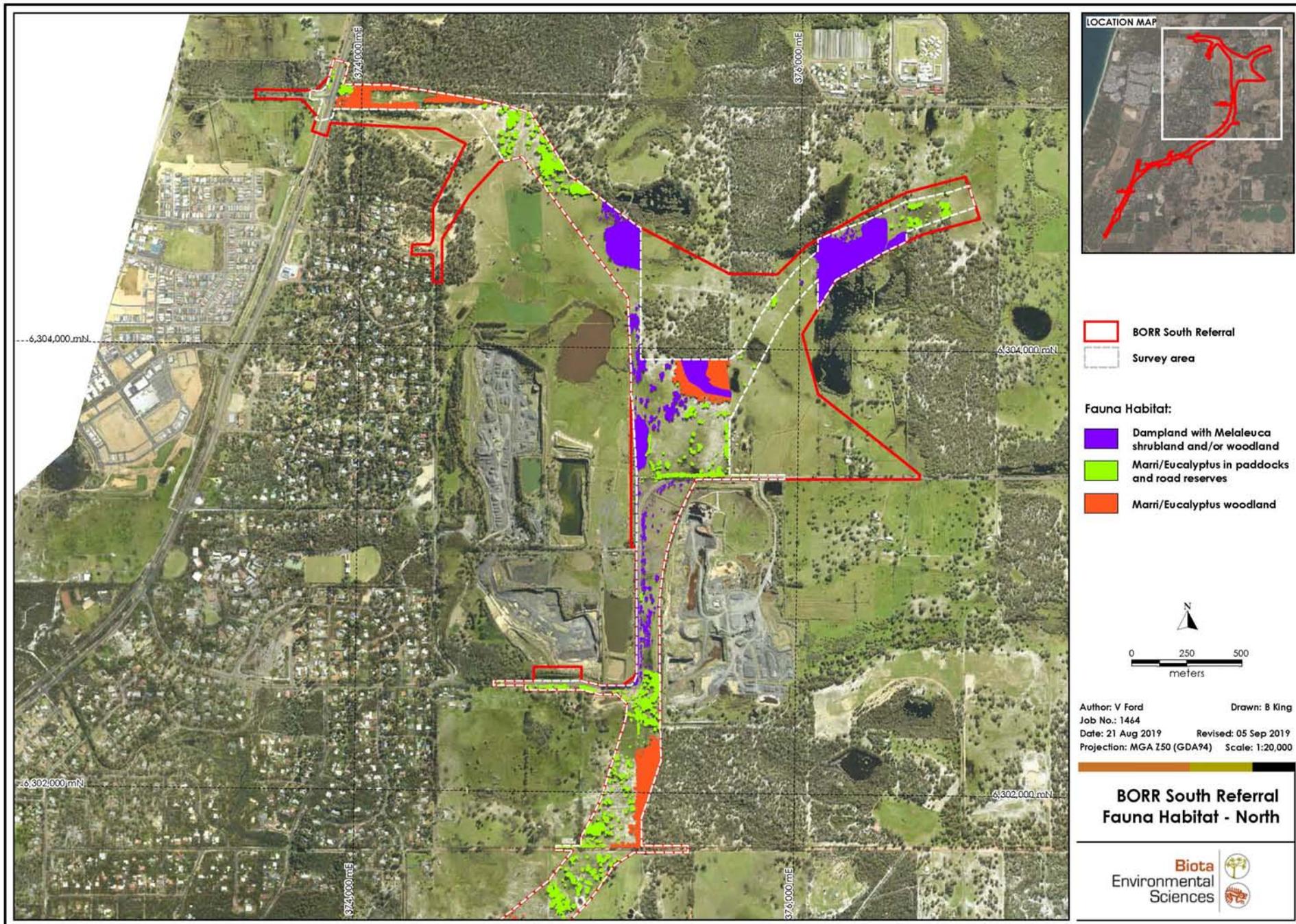


Figure 5.1: Broad fauna habitats of the Proposal area (north map 1/2).

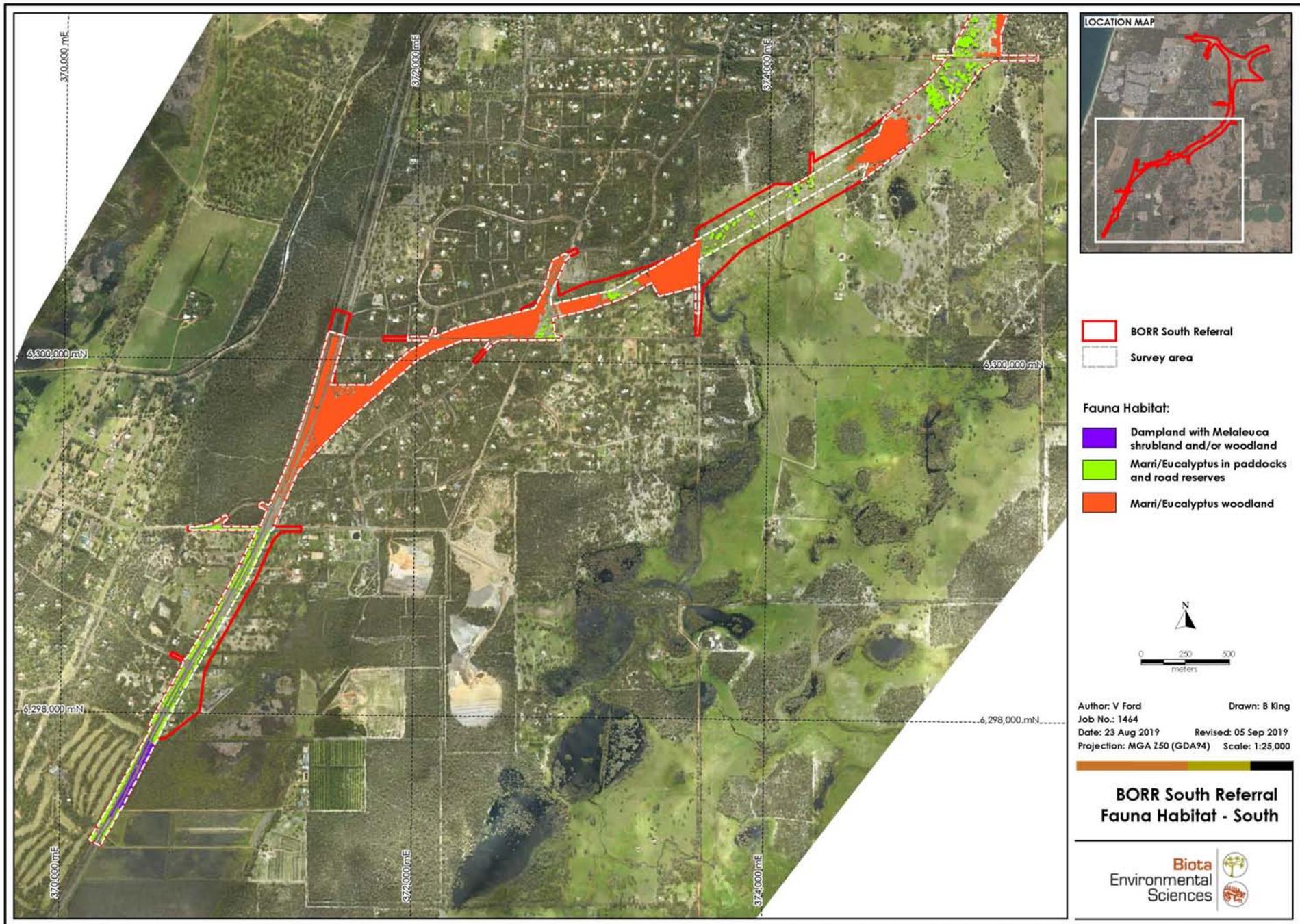


Figure 5.2: Broad fauna habitats of the Proposal area (south map 2/2).

5.3 Western Ringtail Possum

The strip sampling of the Proposal area yielded 73 individual Western Ringtail Possums from 59 observations. There were a total of 45 observations of singular adults, while the 14 remaining observations comprised pairs of possums; of the latter, four appeared to be female with young, and there were 10 pairs of adults.

Within the Proposal area, Western Ringtail Possums were found in habitats ranging from relatively isolated individual trees through to remnant vegetation strips (along road reserves and riparian belts) surrounded by cleared land, to larger remnants either isolated from or broadly contiguous with much larger remnants. Observations of possums were predominantly from Jarrah/Marri woodland habitat (28 observations), Peppermint (16 observations) and Banksia (11 observations), with four observations from other habitat types. Generally, the only habitat from which the Western Ringtail Possum was absent was seasonally inundated swamp, although they were found to occur in Peppermint trees bordering this habitat type.

The sampling effort as a track file and locations of observations of Western Ringtail Possums is shown in Figure 5.3. Examination of the track file in relation to vegetation mapped indicates that 81.3 ha of vegetation was searched for a density of 0.98 individuals per hectare searched. However, densities were not uniform throughout the Proposal area, with the highest density occurring in the corridor between Jilley Road and Bussell Highway; a total of 38 individuals were recorded within this 25.1 ha area, giving a density of 1.57 individuals per hectare.

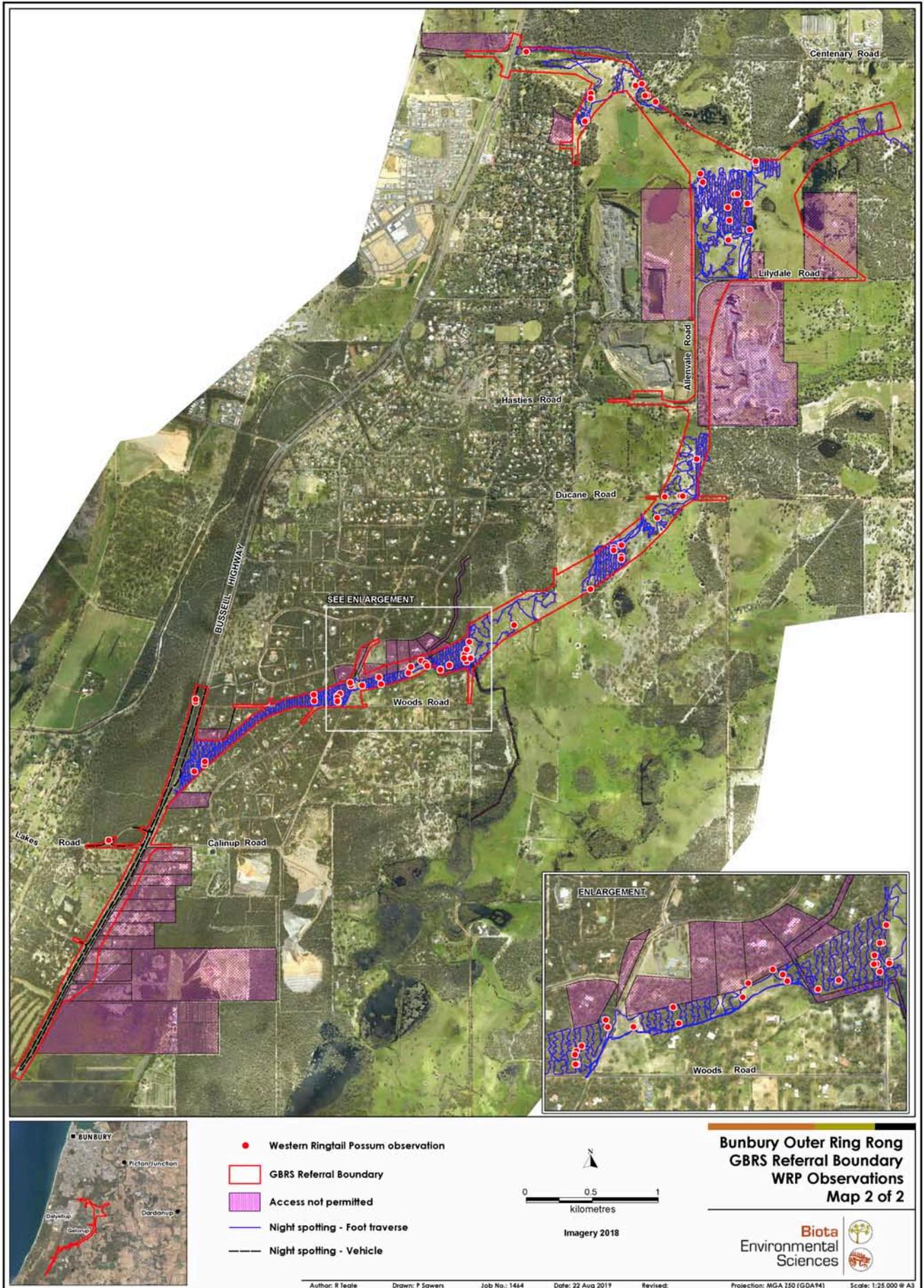


Figure 5.3: Records of Western Ringtail Possums from strip transects across the Proposal area.