Holcim Gosnells Quarry -
Fauna Assessment of the Quarry Area

Potential active Black-Cockatoo breeding hollow. Photo by Wesley Bancroft.

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1 Introduction

1.1 Overview

Bamford Consulting Ecologists was commissioned by Holcim to conduct a fauna assessment (desktop review, site inspection and targeted fauna surveys) of the remaining Maximum Development Area (hereafter referred to as quarry area) at Holcim's Gosnells Quarry. The Maximum Development Area was cited in the approved 1982 Environmental Review and Management Programme and refers to an area that could be operational for a period of at least 100 years. The targeted fauna surveys focussed on species of conservation significance, particularly three species of black-cockatoo: Carnaby's Black-Cockatoo, *Calyptorhynchus latirostris*, the Forest Red-tailed Black-Cockatoo, *C. banksii naso* and Baudin's Black-Cockatoo *C. baudinii*.

The aim of this assessment was to identify the key fauna values within the quarry area. Key fauna values (described in detail in Appendix 1) are:

- Assemblage characteristics (uniqueness, completeness and richness);
- Species of conservation significance;
- Recognition of ecotypes or vegetation/substrate associations (VSAs);
- Patterns of biodiversity across the landscape; and
- Ecological processes upon which the fauna depend.

This report presents an overview of the fauna assemblage, species of conservation significance and black-cockatoo assessment (including breeding, foraging and roosting habitat) within the quarry area.

1.2 Description of the quarry area

The quarry area is located on the Darling Scarp east of Tonkin Highway, approximately 19 kilometres south-east of the Perth CBD. The quarry study site covers an area of 198.8 ha, which includes the current operational pit and cleared areas (Figure 1). The area of native vegetation within the quarry study site is approximately 138 ha, with an additional 6.9 ha of open regrowth and 54.1 ha of cleared area. The vegetation is broadly eucalypt woodland (mostly Jarrah *Eucalyptus marginata* and Marri *Corymbia calophylla*) and mixed heath on granite outcrops.

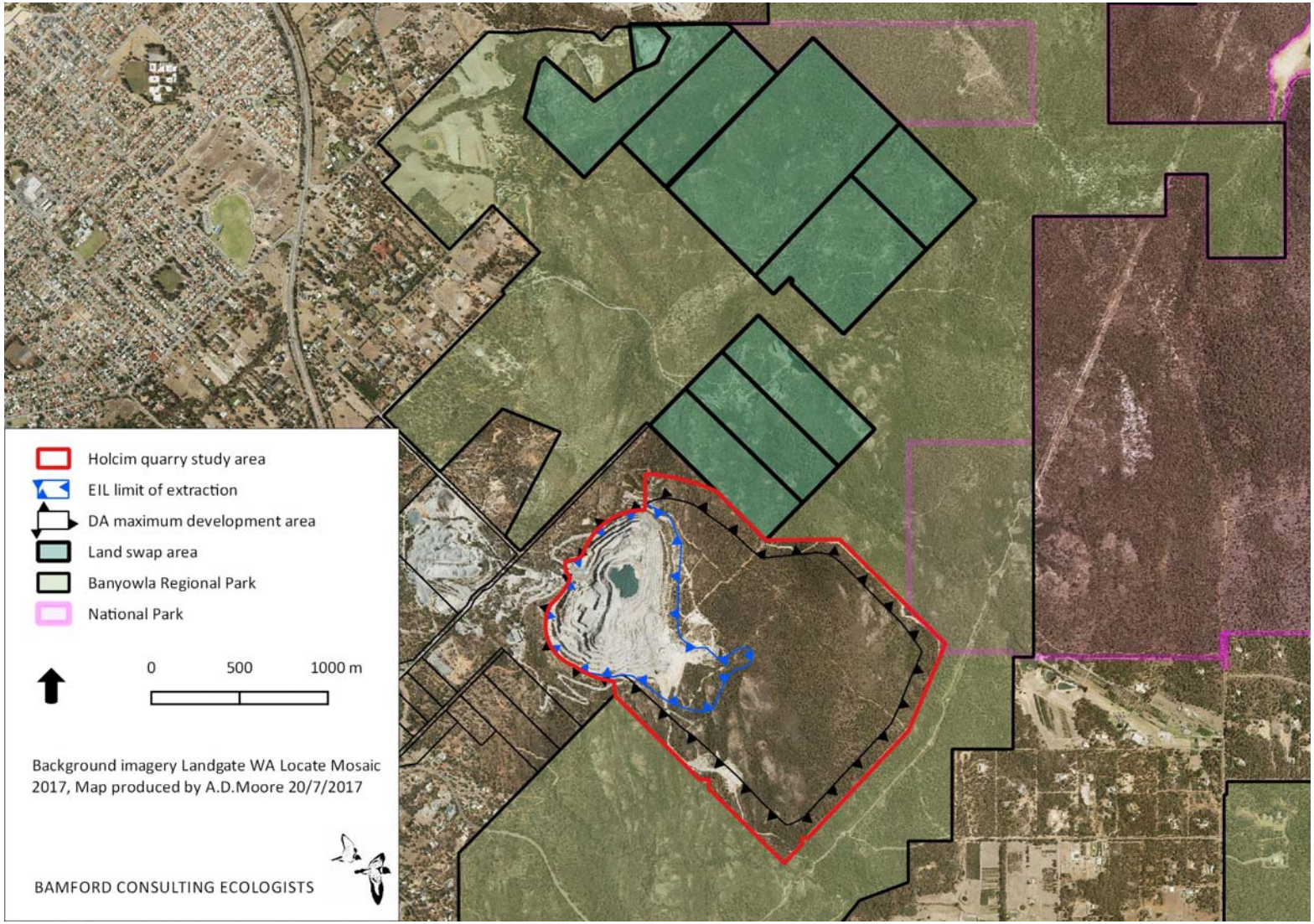

Figure 1. Location of the study area.

2 Background

2.1 Regional description

The Interim Biogeographic Regionalisation of Australia (IBRA) (Environment Australia 2000) has identified 26 bioregions in Western Australia (Figure 2). Bioregions are classified on the basis of climate, geology, landforms, vegetation and fauna (Thackway and Cresswell 1995). IBRA Bioregions are affected by a range of different threatening processes and have varying levels of sensitivity to impact (EPA 2004).

The quarry area lies in the Jarrah Forest IBRA Bioregion, in the Northern Jarrah Forest 1 (JAF01) subregion. The Northern Jarrah Forest overlies Archaean granite and metamorphic rocks capped by an extensive lateritic duricrust. It is also interrupted by occasional granite outcrops in the form of isolated hills. Vegetation consists of Jarrah-Marri forest in the west (with Bullich and Blackbutt in the valleys), and grades into Wandoo woodlands in the east. There are extensive but localised sand sheets with Banksia low woodlands. Heath is found on granite rocks and as a common understorey of forests and woodlands (Mckenzie *et al*. 2003). Ecosystems affected by Jarrah dieback (*Phytophthora cinnamomi*) are considered to be ecosystems at risk (Williams and Mitchell 2001). Dieback impacts several plant families including Proteaceae and Myrtaceae.

Figure 2. IBRA Subregions in Western Australia.

Note the survey area lies in the JAF01 IBRA subregion.

3 Methods

3.1 Desktop Assessment

3.1.1 Sources of information

Information on the fauna assemblage of the area was drawn from a wide range of sources. These included state and federal government databases and results of regional studies. Databases accessed were the DPaW Naturemap (incorporating the Western Australian Museum's FaunaBase and the DPaW Threatened and Priority Fauna Database), BirdLife Australia's Atlas Database (BA), the EPBC Protected Matters Search Tool and the BCE database (Table 1). Information from the above sources was supplemented with species expected in the area based on general patterns of distribution. Sources of information used for these general patterns were:

- Frogs: Tyler *et al.* (2000);
- Reptiles: Storr *et al.* (1983;1990; 1999 and 2002) and Wilson and Swan (2008);
- Birds: Blakers *et al.* (1984); Johnstone and Storr (1998, 2004) and Barrett *et al.* (2003); and
- Mammals: Menkhorst & Knight (2001); Churchill (2008); and Van Dyck and Strahan (2008).

Table 1. Sources of information used for the desktop assessment.

Database	Type of records held on database	Area searched
Atlas of Living Australia (ALA 2016)	Records provided by collecting institutions, individual collectors and community groups	32° 4' 26"S, 116° 2' 26"E – plus 20 km buffer.
NatureMap (DPaW 2016)	Records in the WAM and DPaW databases. Includes historical data and records on Threatened and Priority species in WA.	32° 4' 26"S, 116° 2' 26"E – plus 20 km buffer.
BirdLife Australia Atlas Database (Birdlife 2016)	Records of bird observations in Australia, 1998-2016.	Species list for area containing: 32° 4' 26"S, 116° 2' 26"E – plus 20km buffer
EPBC Protected Matters (DotE 2016)	Records on matters of national environmental significance protected under the EPBC Act.	32° 4' 26"S, 116° 2' 26"E – plus 20 km buffer

3.1.2 Previous Fauna Surveys

Fauna surveys were conducted in the Holcim area by ERM (2005), Astron (2012a; 2012b; 2013) and more recently by Bamford and Moore (2014), Bamford and Everard (2015) and Bamford *et al.* (2016). These included general fauna and habitat assessments, black-cockatoo nest tree assessment, foraging habitat assessment, roosting survey and searching for signs of the Quenda *Isoodon obesulus*, a priority species.

3.1.3 Nomenclature and taxonomy

As per the recommendations of EPA (2004), the nomenclature and taxonomic order presented in this report are based on the Western Australian Museum's (WAM) *Checklist of the Fauna of Western Australia 2016*. The authorities used for each vertebrate group were: amphibians (Doughty *et al*. 2016), reptiles (Doughty *et al*. 2016), birds (Johnstone and Darnell 2016), and mammals (Travouillon 2016). In some cases, more widely-recognised names and naming conventions have been followed, particularly for birds where there are national and international naming conventions in place (e.g. the BirdLife Australia working list of names for Australian Birds). English names of species, where available, are used throughout the text; Latin species names are presented with corresponding English names in tables in the appendices.

3.1.4 Interpretation of species lists

Species lists generated from the review of sources of information are generous as they include records drawn from a large region and possibly from environments not represented in the survey area. Therefore, some species that were returned by one or more of the data searches have been excluded because their ecology, or the environment within the survey areas, meant that it is highly unlikely that these species will be present. Such species can include, for example, seabirds that might occur as extremely rare vagrants at a terrestrial, inland site, but for which the site is of no importance. Species returned from databases but excluded from species lists are presented in Appendix 6.

Species returned from the databases and not excluded on the basis of ecology or environment are therefore considered potentially present or expected to be present in the survey area at least occasionally, whether or not they were recorded during field surveys, and whether or not the survey area is likely to be important for them. This list of expected species is therefore subject to interpretation by assigning each a predicted status in the survey area.

The status categories used are:

- Resident: species with a population permanently present in the survey area;
- Regular migrant or visitor: species that occur within the survey area regularly in at least moderate numbers, such as part of annual cycle;
- Irregular Visitor: species that occur within the survey area irregularly such as nomadic and irruptive species. The length of time between visitations could be decades but when the species is present, it uses the survey area in at least moderate numbers and for some time;
- Vagrant: species that occur within the survey area unpredictably, in small numbers and/or for very brief periods. Therefore, the survey area is unlikely to be of importance for the species; and
- Locally extinct: species that would have been present but has not been recently recorded in the local area and therefore is almost certainly no longer present in the survey area.

These status categories make it possible to distinguish between vagrant species, which may be recorded at any time but for which a site is not important in a conservation sense, and species which use a site in other ways but for which the site is important at least occasionally. This is

particularly useful for birds that may naturally be migratory or nomadic, and for some mammals that can also be mobile or irruptive, and further recognises that even the most detailed field survey can fail to record species which will be present at times. The status categories are assigned conservatively. For example, a lizard known from the general area is assumed to be a resident unless there is very good evidence the site will not support it, and even then it may be classed as a vagrant rather than assumed to be absent if the site might support dispersing individuals.

3.2 Field survey

3.2.1 Overview

The field survey included several components:

- identification of major Vegetation and Substrate Associations (VSAs);
- black-cockatoo habitat assessment;
- targeted searching for other conservation significant fauna; and
- opportunistic fauna observations.

3.2.2 Dates and Personnel

The quarry area was visited on the 16th and 19th of August 2016 and 28th June 2017. Survey personnel include [redacted]. This fauna assessment document was prepared by Mike Bamford, Andrew Moore and Katherine Chuk.

3.2.3 Vegetation and Substrate Associations

Vegetation and Substrate Associations (VSAs) were assessed during the desktop review and as part of the field investigations. Within the quarry area, all major VSAs were visited to develop an understanding of the range of environments providing habitats for fauna and to assess the likelihood of conservation significant species being present in the area.

3.2.4 Assessment of nesting habitat for black-cockatoos

The suitability of the area for nesting by black-cockatoos was assessed by conducting a survey for potential hollow-bearing (nest) trees consistent with the recommendations of DSEWPaC (2012a, b, c, d). Transects located within the quarry area were examined for the presence of suitable nest trees; tree species known to be used for nesting in the area (e.g. Wandoo *Eucalyptus wandoo*, Jarrah *E. marginata* and Marri *Corymbia calophylla*) and with a diameter-at-breast-height (DBH) greater than 400 mm (Wandoo) or 500 mm (other species; see Appendix 2). The total area of transect surveys conducted in the quarry area was 36 ha.

For any tree that met this criterion:

- DBH was measured;
- trees were assessed (from the ground) for presence of hollows suitable for black-cockatoos (entrance diameter greater than 100 mm, see Appendix 2);
- trees were given a score based on their likely value as a breeding site (see below); and

- tree location was recorded (UTM, zone 50, datum WGS84).

The score given to trees meeting the DBH criterion reflects their likely value for breeding and has been developed by Bamford Consulting Ecologists. These scores are:

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. While it cannot with certainty be assumed that such chew marks were made by a black-cockatoo, they indicate activity of a parrot at a hollow potentially suitable for use by black-cockatoos.
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.

The suitability of the area for foraging by black-cockatoos was assessed by inspecting the site on foot and determining the presence of preferred forage plants (as set out in Appendix 2). Each survey area was assigned a foraging value score (out of six) based upon vegetation characteristics. Descriptions of foraging value scores for each black-cockatoo species are provided in Table 2. While a different score can be assigned to the same vegetation type for each species, all species are relying largely on Marri and Jarrah and thus a single foraging value score could be assigned to cover all species.

Table 2. Scoring system for the assessment of foraging value of vegetation for Carnaby's, Baudin's and Forest Red-tailed Black-Cockatoos.

Site score	Description of vegetation		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
0	No foraging value. No Proteaceae, eucalypts or other potential sources of food. Examples would be salt lakes and bare ground.	No foraging value. No eucalypts or other potential sources of food.	No foraging value. No eucalypts (i.e. Marri, Jarrah, Wandoo, Blackbutt or Karri) or other potential sources of food.
1	Negligible to low foraging value. Scattered specimens of known food plants but projected foliage cover of these <2%. Could include urban areas with scattered foraging trees. Blue Gum plantations are considered to have a score of 1 as foraging by Black-Cockatoos has been reported but appears to be unusual.	Negligible to low foraging value. Scattered specimens of known food plants (e.g. Marri and Jarrah) but projected foliage cover of these <1%. Could include urban areas with scattered foraging trees.	Negligible to low foraging value. Scattered specimens of known food plants but projected foliage cover of these <1%. Could include urban areas with scattered foraging trees.
2	Low foraging value. Examples: • Shrubland in which species of foraging value, such as shrubby banksias, with <10% projected foliage cover. • Open eucalypt woodland/mallee of small-fruited species. • Paddocks with melons or other weeds (a short-term, seasonal food source).	Low foraging value. Example: • Woodland or forest with scattered specimens of known food plants (e.g. Marri and Jarrah) but projected foliage cover of these 1-<5%. Could include urban areas with scattered foraging trees.	Low foraging value. Examples: • Open eucalypt woodland (i.e. Marri, Jarrah, Wandoo, Blackbutt or Karri). Projected foliage cover of these 1-<5% • Urban areas with scattered food plants such as Cape Lilac, *Eucalyptus caesia* and *Eucalyptus erythrocorys*.
3	Low to Moderate foraging value. Examples: • Shrubland in which species of foraging value, such as shrubby banksias, with 10-20% projected foliage cover. • Woodland with tree banksias 2-10% projected foliage cover. • Eucalypt woodland/mallee of small-fruited species; Marri, if present, <10% project foliage cover.	Low to Moderate foraging value. Examples: • Eucalypt woodland with known food plants (and in particular Marri) with a projected foliage cover of 5-<10%. • Parkland-cleared eucalypt woodland with projected foliage cover of known food plants of 10-<20% can be considered low-to-moderate because of poor long-term viability without management.	Low to Moderate foraging value. Examples: • Eucalypt woodland (i.e. Marri, Jarrah, Wandoo, and Blackbutt), if present, <10% project foliage cover.

Site score	Description of vegetation		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
4	Moderate foraging value. Examples: • Woodland with tree banksias 20-40% projected foliage cover. • Eucalypt woodland/forest with Marri 20-40% projected foliage cover.	Moderate foraging value. Examples: • Eucalypt woodland with known food plants (and in particular Marri) with a projected foliage cover of 10-<20%. • Parkland-cleared eucalypt woodland with projected foliage cover of known food plants of 20-<40% can be considered moderate because of poor long-term viability without management. • Areas of orchards and especially those with apples can be considered of moderate value.	Moderate foraging value. Examples: • Eucalypt woodland/forest (i.e. Marri, Jarrah, Wandoo, and Blackbutt) with 20-40% projected foliage cover.
5	Moderate to High foraging value. Examples: • Banksia woodlands with tree banksias >40%. Vegetation condition moderate due to weed invasion and some tree deaths.	Moderate to High foraging value. Examples: • Eucalypt woodland with known food plants (and in particular Marri) with a projected foliage cover of 20-<40%. Parkland-cleared eucalypt woodland with projected foliage cover of known food plants of >40% can be considered moderate because of poor long-term viability without management.	Moderate to High foraging value. Examples: • Eucalypt woodland/forest (i.e. Marri, Jarrah, Wandoo, and Blackbutt) with >40% projected foliage cover. Vegetation condition moderate due to weed invasion and some tree deaths.
6	High foraging value. Example: • Banksia woodlands of key species (e.g. *B. attenuata, B. menziesii*) with projected foliage cover >60%. Vegetation condition good with low weed invasion and low tree death to indicate it is robust and unlikely to decline in the medium term.	High foraging value. Example: • Eucalypt woodland/forest with a high proportion of Marri (>40% projected foliage cover). Vegetation condition good with low weed invasion and low tree death to indicate it is robust and unlikely to decline in the medium term.	High foraging value. Example: • Eucalypt woodland/forest (i.e. Marri, Jarrah, Wandoo, and Blackbutt) with >60% projected foliage cover. Vegetation condition good with low weed invasion and low tree death to indicate it is robust and unlikely to decline in the medium term.

Proteaceous plants include species such as *Banksia*, *Hakea* and *Grevillea.*

3.2.5 Other conservation significant species

The Quenda or Southern Brown Bandicoot and other conservation significant species such as the Chuditch and Brush-tailed Phascogale may be present in the quarry area. Opportunistic sightings of tracks, scats, diggings and other signs were recorded and three motion sensitive cameras were set for 21 nights; a total of 63 camera-nights. Camera locations were; 6451254mE 409404mS, 6450218mE 409167mS and 6450664mE 409882mS (Zone 50, datum WGS84) (Appendix 7, Figure 16).

3.2.6 Opportunistic observations

At all times, observations of fauna were noted when they contributed to the accumulation of information on the fauna of the site. These included such casual observations as birds or reptiles seen while walking through the survey area.

3.3 Survey limitations

The EPA Guidance Statement 56 (EPA 2004) outlines a number of limitations that may arise during surveying. These limitations are discussed in the context of the fauna survey in Table 3.

Table 3. Survey limitations as outlined by EPA (2004).

EPA Limitation	BCE Comment
Level of survey.	Level 1 (desktop study with reconnaissance survey). Survey intensity was deemed adequate due to the small area and availability of previous studies in the area.
Competency/experience of the consultant(s) carrying out the survey.	The authors have had extensive experience in conducting desktop reviews, fauna surveys and Black-Cockatoo assessments in the Perth Region.
Scope. (What faunal groups were sampled and were some sampling methods not able to be employed because of constraints?)	The site investigation targeted descriptions of the environment and fauna values for significant species.
Proportion of fauna identified, recorded and/or collected.	Key significant species were identified and the desktop provided information on other species
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	Sources include previous fauna surveys in the area: ERM (2005), Astron (2012a; 2012b; 2013), Bamford and Moore (2014), Bamford and Everard (2015) and Bamford *et al.* (2016; 2017). Databases checked include: ALA, BA, DPaW, EPBC and BCE.
The proportion of the task achieved and further work which might be needed.	This report provides fauna values for significant species
Timing/weather/season/cycle.	There were no constraints from the weather and mild conditions allowed personnel to move around readily.
Disturbances (e.g. fire, flood, accidental human intervention etc.) which affected results of survey.	None
Intensity. (In retrospect, was the intensity adequate?)	All major Vegetation and Substrate Associations (VSAs) were visited and intensive targeted surveys for significant species carried out.
Completeness (e.g. was relevant area fully surveyed).	Survey intensity was moderate, but supported by previous studies in nearby and similar habitats. Desktop study covered survey area and adjacent habitats. All suitable habitat within the survey area were visited and assessed.
Resources (e.g. degree of expertise available in animal identification to taxon level).	Field personnel have extensive experience with fauna in the region
Remoteness and/or access problems.	There were no remoteness/access problems encountered.
Availability of contextual (e.g. biogeographic) information on the region.	Extensive regional information was available and was consulted.

4 Results

4.1 Vertebrate Fauna

4.1.1 Overview of fauna assemblage

The desktop study identified 194 vertebrate fauna species as potentially occurring in the quarry area (see **Error! Reference source not found.**Appendix 5; Table 4 presents a summary): 13 frogs, 42 reptiles, 106 birds, 23 native and 10 introduced mammals. This does not include species considered to be locally extinct (listed in Table 16 of Appendix 5). Species returned from databases but which are not considered to be part of the fauna assemblage are presented in Appendix 6. No fish species are likely to occur in the quarry area due to the lack of suitable habitat.

The 13 frog species are all locally common, considered resident or regular visitors and are regionally widespread. Some of the smaller species (*Crinia pseudinsignifera*, *Pseudophryne guentheri*) may be able to breed in temporary pools formed at the base of granites within the survey area. All the frog species are capable of dispersing through upland environment and most are residents of upland environments outside the mostly winter breeding season. The most terrestrial of the frogs are the *Heleioporus* species that would occur throughout the survey area.

The 42 reptile species are all considered resident except for the Long-necked Tortoise, which may occasionally visit nearby Ellis Brook. The terrestrial species are widespread but the assemblage is distinctive with the presence of several species associated with granite outcrops (e.g. Ornate Dragon and Tree Dtella), one at the western edge of its range (the gecko *Diplodactylus granariensis*) and several with restricted distributions along the Darling Escarpment (Darling Range Ctenotus and Granite Worm-Lizard). The quarry area provides different areas of a range of environments that provide habitat for reptiles, with areas of granites and associated shallow soils that may favour the species with more restricted distributions.

Of 106 bird species the vast majority are woodland species which are considered resident in the quarry area. Several migrants may use the area seasonally such as the Rainbow Bee-eater and Carnaby's Black-Cockatoo; it is also possible that these species may breed in the quarry area. A suite of woodland species that are declining in the Perth region due to habitat loss may also be resident in the quarry area. Eight introduced bird species may be present. Large numbers of bird species returned from the database search were excluded (Appendix 6, Table 16) due to the small area of wetland environment within the quarry area.

Of 33 mammal species expected at the site almost one third are introduced. Of those the Red Fox and Cat in particular are likely to be having a negative impact on the local fauna and, along with habitat loss, have played a significant role in several local extinctions. A small group (three or four) of semi-wild cattle was observed in the survey area during the site work. Most of the native species are considered resident and are likely to be most abundant in the woodland areas with an intact understorey. The motion-sensitive cameras confirmed the presence of several species, notably the Brush-tailed Phascogale. There may be five locally extinct species that are not included in the assemblage total, but those locally extinct species of conservation significance are included in the relevant section below.

The overall fauna assemblage is not as rich as nearby locations due to the virtual lack of wetland environments. Key features of the fauna assemblage are:

- Uniqueness: The assemblage is likely to be typical of Jarrah woodlands in the Northern Jarrah Forest subregion.
- Completeness: The assemblage of species from the survey area is missing a significant number of native mammal species. Some bird species may make limited use of the site because of nearby cleared areas (quarry, residential and rural).
- Richness: The assemblage is likely to vary annually and seasonally according to climatic conditions. The nearby cleared areas mean some species may be absent or uncommon visitors, but the location of the study area connected to large areas of better quality bushland may offset this effect.

As a fauna value, the site's assemblage is likely to be typical for the region but slightly depauperate due to nearby cleared areas.

Table 4. Composition of vertebrate fauna assemblage of the quarry area.

Taxon	Number of species	Number of species in each status category (number in parenthesis is number confirmed present)				
		Resident	Migrant or regular visitor	Irregular visitor	Vagrant	Locally extinct
Fish	0	-	-	-	-	-
Frogs	13	13 (2)	-	-	-	-
Reptiles	42	41 (5)	1	-	-	-
Birds	106 (8 introduced)	49 (27)	35 (2)	20	2	?
Native Mammals	23	21 (9)	1	-	1	5
Introduced Mammals	10	5 (4)	3 (1)	1	1	-
Total	**194**	**129**	**40**	**21**	**4**	

NB. Locally extinct species not included in total.

4.1.2 Species of conservation significance

The current vertebrate assemblage potentially includes 34 species of conservation significance, with a further five conservation significant species considered to be locally extinct (**Error! Reference source not found.** and 6). Significant species returned from databases but for which the survey area provide no habitat, such as waterbirds and fish, have been excluded (but are presented in Appendix 6). Numbers and classes of significant species broken down by major taxonomic group and still expected to be present are summarised in Table 5.

Table 5. Number and class of conservation significant fauna species.

Taxon	Conservation Significance (CS) Level			
	CS1	CS2	CS3	Total
FISH	0	0	0	0
FROGS	0	0	0	0
REPTILES	0	2	1	3
BIRDS	6	2	16	24
MAMMALS*	3	4	0	7
Total	**9**	**8**	**17**	**34**

*Excludes five locally extinct CS1 species

As outlined in Appendix 3, species classed as CS1 are those listed under legislation, while those classed as CS2 are listed as Priority by the Department of Parks and Wildlife. The CS3 class is more subjective, but includes species that have declined extensively in nearby urban areas. The CS3 class also includes potential short range endemic (SRE) invertebrates and the potential for these is discussed with other CS3 species below. All significant species are discussed below.

Table 6. Conservation status of significant fauna species expected to occur in the quarry area.

Their expected status is indicated (as per section 3.1.4), as are those recorded during field investigations.

CS Species		Status	CS Level	Confirmed	Expected Status
REPTILES					
Darling Range South-west Ctenotus	*Ctenotus delli*	P4	CS2		Resident
Carpet Python	*Morelia spilota imbricata*		CS3		Resident
Common Death Adder	*Acanthophis antarcticus*	P3	CS2		Resident
BIRDS					
Fork-tailed Swift	*Apus pacificus*	M S5	CS1		Migrant
Painted Button-quail	*Turnix varius*		CS3		Resident
Peregrine Falcon	*Falco peregrinus*	S7	CS1		Resident
Masked Owl	*Tyto novaehollandiae*	P3	CS2		Irregular visitor
Barking Owl	*Ninox connivens*	P2	CS2		Irregular visitor
Rainbow Bee-eater	*Merops ornatus*	S5	CS1		Migrant
Forest Red-tailed Black-Cockatoo	*Calyptorhynchus banksii naso*	V S3	CS1	X	Resident

CS Species		Status	CS Level	Confirmed	Expected Status
Baudin's Black-Cockatoo	*Calyptorhynchus baudinii*	V S2	CS1		Migrant
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	E S2	CS1		Migrant
Rufous Treecreeper	*Climacteris rufus*		CS3		Irregular visitor
Red-winged Fairy-wren	*Malurus elegans*		CS3		Visitor
Splendid Fairy-wren	*Malurus splendens*		CS3	X	Resident
Southern Emu-wren	*Stipiturus malachurus*		CS3		Resident
Inland Thornbill	*Acanthiza apicalis*		CS3		Resident
Western Thornbill	*Acanthiza inornata*		CS3		Resident
White-browed Scrubwren	*Sericornis frontalis*		CS3	X	Resident
Grey Shrike-thrush	*Colluricincla harmonica*		CS3	X	Resident
Crested Shrike-tit	*Falcunculus frontatus*		CS3		Visitor
White-breasted Robin	*Eopsaltria georgianus*		CS3		Visitor
Western Yellow Robin	*Eopsaltria griseogularis*		CS3		Visitor
Hooded Robin	*Melanodryas cucullata*		CS3		Irregular visitor
Red-capped Robin	*Petroica goodenovii*		CS3		Visitor
Scarlet Robin	*Petroica multicolor*		CS3		Resident
Red-eared Firetail	*Stagonopleura oculata*		CS3		Visitor
MAMMALS					
Chuditch	*Dasyurus geoffroii*	V S3	CS1		Resident
Brush-tailed Phascogale	*Phascogale tapoatafa tapoatafa*	S3	CS1	X	Resident
Numbat	*Myrmecobius fasciatus*	V S2	CS1		Locally extinct
Woylie	*Bettongia penicillata ogilbyi*	E S1	CS1		Locally extinct
Boodie	*Bettongia lesueur*	Ex V S4 S6	CS1		Locally extinct
Brush Wallaby	*Macropus irma*	P4	CS2	X	Resident
Tammar Wallaby	*Macropus eugenii*	P4	CS2		Locally extinct
Quokka	*Setonix brachyurus*	V S3	CS1		Vagrant
Western Ringtail Possum	*Pseudocheirus occidentalis*	V S1	CS1		Locally extinct
Quenda	*Isoodon obesulus*	P4	CS2	X	Resident
Western False Pipistrelle	*Falsistrellus mackenziei*	P4	CS2	X	Resident
Rakali	*Hydromys chrysogaster*	P4	CS2		Visitor
Total Number of Species:	**39**			**8**	

See Appendix 3 for descriptions of conservation significance levels.

EPBC Act listed species: V = Vulnerable, E = Endangered, Ex = Extinct, M = Migratory.

WC Act listed species: S1 – S7 = Schedule 1 - 7, DPaW Priority Species: P1 – P5 = Priority 1 - 5.

Conservation Significance Level 1

Migratory Bird Species

Fork-tailed Swift (*Apus pacificus*)

Rainbow Bee-eater (*Merops ornatus*)

These bird species are listed under one or more of the agreements/conventions relating to the protection of migratory species that Australia is signatory to i.e. JAMBA, CAMBA, ROKAMBA and the Bonn Convention. As such, the swift is listed as migratory under both the *WA Wildlife Conservation Act* and the Federal *EPBC Act*, but the bee-eater was recently removed from the EPBC migratory list and is therefore not a Matter of National Environmental Significance. It remains listed as migratory under the State Act. The Rainbow Bee-eater is a regular summer breeding migrant that may construct nesting burrows in sandy substrates; including in cleared land and along road verges. The species was recorded in the quarry area by ERM (2005), although may not breed in the area due to the lack of sandy substrate. The Fork-tailed Swift may pass over the area but is a largely aerial species mostly independent of terrestrial ecosystems.

Peregrine Falcon (*Falco peregrinus*)

This species is found in a wide variety of habitats, with its distribution often linked to the abundance of prey. Blakers *et al.* (1984) consider that Australia is one of the strongholds of the species, since it has declined in many other parts of the world. Suitable habitat exists for this species in the region and quarry area. It nests on cliffs or in very large trees and has the potential to nest in the quarry area. The quarry area may also be part of the foraging range of a pair.

Black-Cockatoos (*Calyptorhynchus banksii naso, C. baudinii* and *C. latirostris*)

The Forest Red-tailed Black-Cockatoos was recorded. All three Black-Cockatoo species have been recorded in the region (DPaW 2016) and suitable foraging and breeding habitat occurs in the quarry area. The value of the quarry area as foraging and breeding habitat for three Black-Cockatoo species is assessed in detail in Section 4.1.3.

Chuditch (*Dasyurus geoffroii*)

This species inhabits a variety of habitats in the region, especially riparian and Jarrah forests, and is known from the region (DPaW 2016). Suitable habitat (i.e. Marri and Jarrah Woodland) occurs in the quarry area and therefore may be resident.

Brush-tailed Phascogale (*Phascogale tapoatafa tapoatafa*)

The Brush-tailed Phascogale inhabits Jarrah forests in the region and is confirmed to be resident in the quarry area. Suitable habitat for this species occurs in the quarry area. This species was recorded in the quarry area with a motion-sensitive camera (Figure 3).

Figure 3. Brush-tailed Phascogale recorded in the quarry area.

Conservation Significance Level 2

CS2 Reptiles (*Ctenotus delli* and *Acanthophis antarcticus*)

The Darling Range South-west Ctenotus and Common Death Adder are both at the western and northern extent of their range in the quarry area. The Ctenotus is found only in the Darling Range in Jarrah and Marri Woodland, while the Common Death Adder is found in open woodland, heathland and shrubland throughout the Darling Range. Both species are considered resident in the quarry area due to the presence of suitable habitat.

Barking Owl and Masked Owl (*Ninox connivens connivens* and *Tyto novaehollandiae*)

These species are patchily distributed in the Darling Range and may be resident in the quarry area where they may breed in hollows in the larger trees (i.e. Jarrah, Marri and Wandoo Woodland).

Brush Wallaby (*Notamacropus irma*)

The Brush Wallaby is likely to be resident in eucalypt woodland in the region and was recorded on the motion-sensitive cameras in the quarry area (Figure 4).

Figure 4. Brush Wallaby in the quarry area.

Quenda (*Isoodon obesulus*)

The Quenda is known to occur in dense shrubland, eucalypt woodland near drainage lines and low lying areas. The Quenda is likely to be resident in the region and was recorded on the motion-sensitive cameras in the quarry area (Figure 5). Suitable habitat occurs throughout the quarry area for this species.

Figure 5. Quenda in the quarry area.

Western False Pipistrelle (*Falsistrellus mackenziei*)

The Western False Pipistrelle occurs in Jarrah and Marri Woodland and roosts in tree hollows. This species is a known resident in the region and may utilise parts of the quarry area for foraging or roosting. The species was confirmed in the quarry area during the 2015 surveys.

Rakali (*Hydromys chrysogaster*)

The Rakali is a known from watercourses of the region, but is unlikely to visit ephemeral drainage lines in the quarry area.

Conservation Significance Level 3

Carpet Python (*Morelia spilota imbricata*)

The Carpet Python occurs throughout the Darling Range with no clear environmental preferences, although for shelter it relies on tree hollows, especially those on the ground, and rocky areas. As suitable habitat is present and it has been previously recorded in the area, the Carpet Python is likely to be a resident in the quarry area.

Conservation Significance level 3 birds

This suite of birds is considered to be of local conservation significance (CS3) because they have been identified in the Bush Forever Report (Dell and Banyard 2000) as declining in the Perth region and being reliant on native vegetation. For many of the species this has been reinforced by Davis *et al.* (2012). These are species reliant to varying degrees on large and interconnected areas of native vegetation within the urban landscape. Many of these species are known to occur in habitats found in the Darling Range (e.g. Marri and Jarrah woodland, associated shrublands and drainage lines). They make up a large proportion of the significant birds that may use the quarry area. Just two of these species have been recorded, the White-browed Scrubwren and the Splendid Fairy-wren in 2015 and 2016, but a further six species are expected to be resident.

4.1.3 Cockatoo presence and foraging habitat

4.1.3.1 Carnaby's Black-Cockatoo

Carnaby's Black-Cockatoos are expected to be regular migrants in the quarry area. Main food species present were: Marri, Jarrah, Wandoo, *Banksia (Dryandra) sessilis* and Hakea. Other species were present which may be used for foraging such as some low banksias in the heathland. The majority of vegetation within the quarry area is in excellent condition (AECOM 2016). The foraging value of the quarry area varied from 2-4 (Low to Moderate; see Table 2 for descriptions of foraging value) and consists of approximately 99.7 ha of Jarrah/Marri woodland (VSA 1) (foraging value 4), 5.1 ha of Wandoo woodland (VSA 2) (foraging value 2) and 33 ha of mixed heath, thicket and granite outcrops (VSA 3) (foraging value 2). As much of the area consisted of Jarrah/Marri woodland (foraging value 4), the overall value for the site was 3-4 (Low/Moderate to Moderate). Approximately 6.9 ha is planted non-native species and 54.1 ha is cleared within the quarry area and has effectively no foraging value. Foraging values for Carnaby's Black-Cockatoo are presented in Figure 6. Further discussion of VSAs is provided in Section 4.2.

4.1.3.2 Forest Red-tailed Black-Cockatoo

Forest Red-tailed Black-Cockatoos are expected to be resident in the quarry area, with foraging habitat well-represented due to the presence of preferred native food sources (such as Marri and Jarrah). The foraging value of the quarry area varied from 1-4 (Negligible to Moderate) with approximately 99.7 ha of Jarrah/Marri woodland (foraging value 4), 5.1 ha of Wandoo woodland (VSA 2) (foraging value 1) and 33 ha of heath (forging value 1); the overall value for the site was 3 (Low/Moderate). Foraging values for the Forest Red-tailed Black-Cockatoo are presented in Figure 7.

4.1.3.3 Baudin's Black-Cockatoo

Baudin's Black-Cockatoo is expected to be at least an occasional visitor to the quarry area as it occurs regularly nearby and the area provides suitable foraging habitat. Foraging requirements of Baudin's Black-cockatoo are similar to those of the Forest Red-tailed Black-Cockatoo (refer to Figure 7). The foraging value of the quarry area varied from 1-5 (Negligible to Moderate/High), comprising of approximately 99.7 ha of Jarrah/Marri woodland (foraging value 5), 5.1 ha of Wandoo woodland (foraging value 1) and 33 ha of heath and granite outcrops (foraging value 1). The overall value for the site was 4 (Moderate).

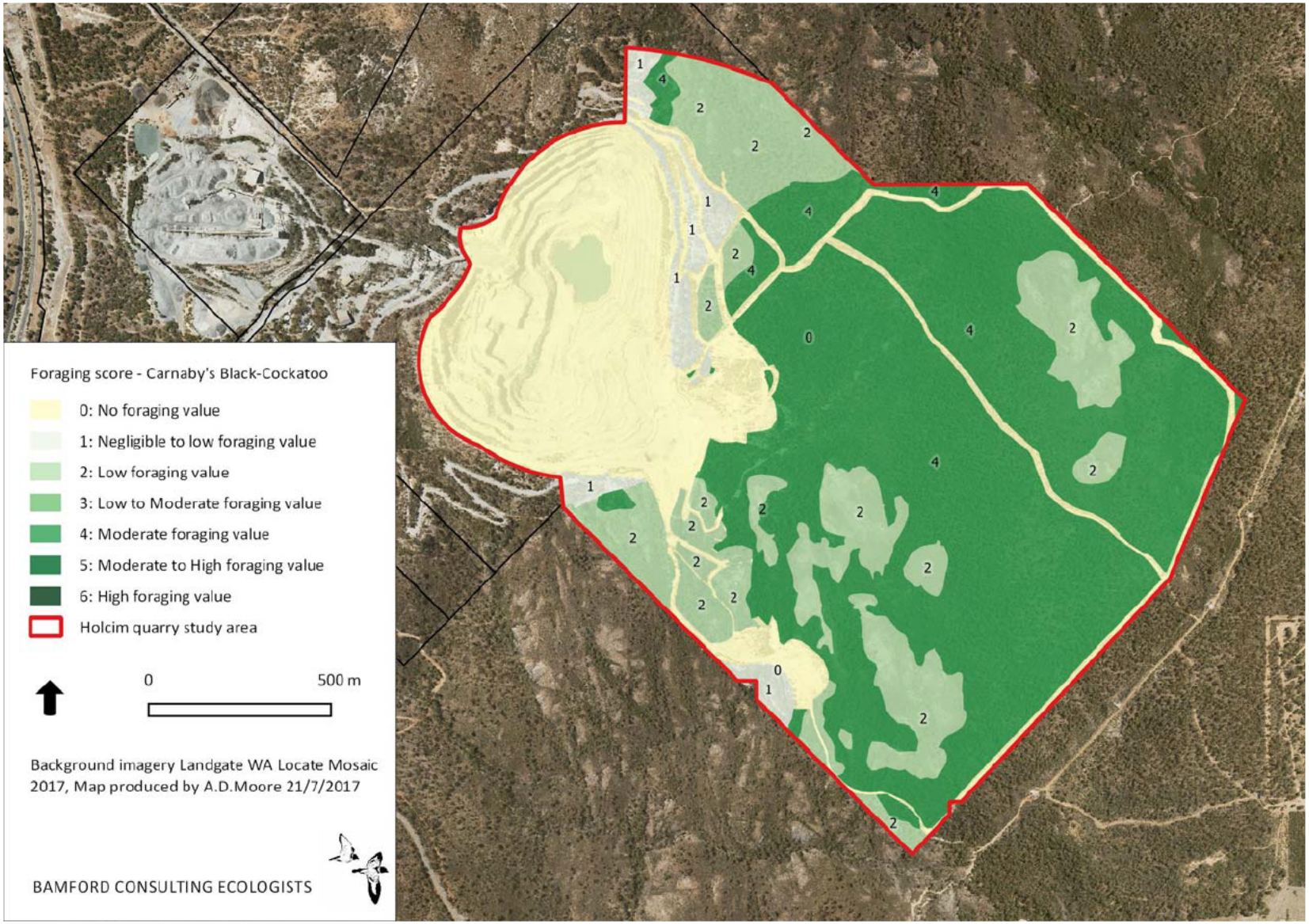

Figure 6. Foraging values for Carnaby's Black-Cockatoo.

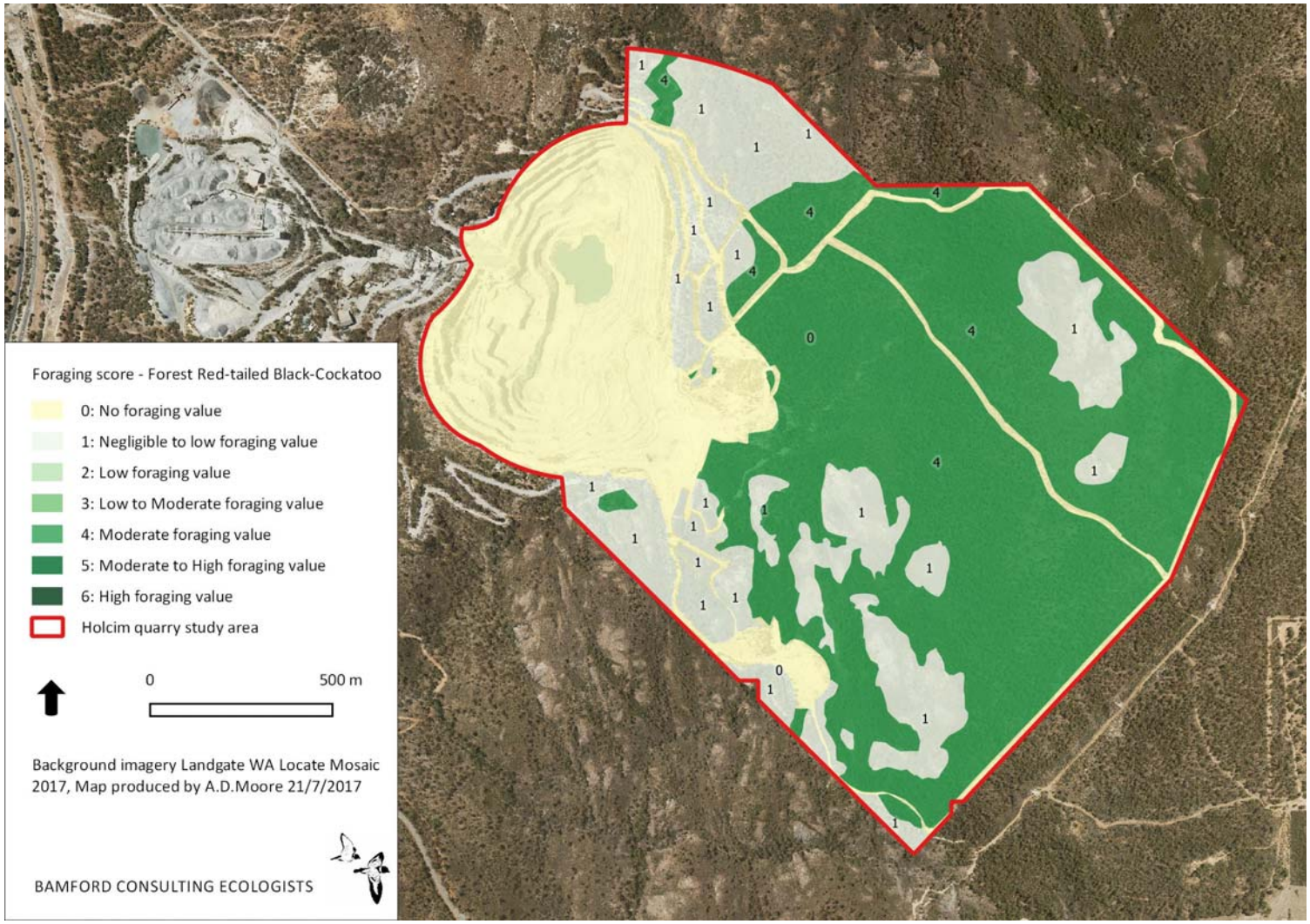

Figure 7. Foraging values for the Red-tailed Black-Cockatoo.

4.1.4 Roosting and breeding habitat

Most of the trees in the quarry area are regrowth which are not yet big enough to serve as roosting or breeding habitat, however remnant large trees are present throughout the quarry area, particularly in VSA1 (see Section 4.2).

The breeding tree transects found that the quarry area had a density of 11.6 potential breeding trees per hectare (Table 7). These estimates assume that the areas covered by the transects are representative of the total area. The presence of large trees makes the site appear suitable for roosting or breeding by black-cockatoos. It is thus possible that black-cockatoos roost and breed in the quarry area. Two trees with a score of 2 (large hollow with recent chew-marks around entrance) were found in the quarry area (see cover photo). These are not confirmed but are highly likely to be active or recently active black-cockatoo nests. Two adult Forest Red-tailed Black-Cockatoos with a dependent chick were observed within the quarry area and may well have used one of these hollows.

Table 7. Summary of results from breeding tree transects.

Site	BCE score					Total	Trees/ha	Estimated total trees
	1	2	3	4	5			
Quarry Area	0	2	72	91	253	418	11.6	1679

Breeding tree score categories are discussed in Section 3.2.4. Density calculations do not include cleared areas.

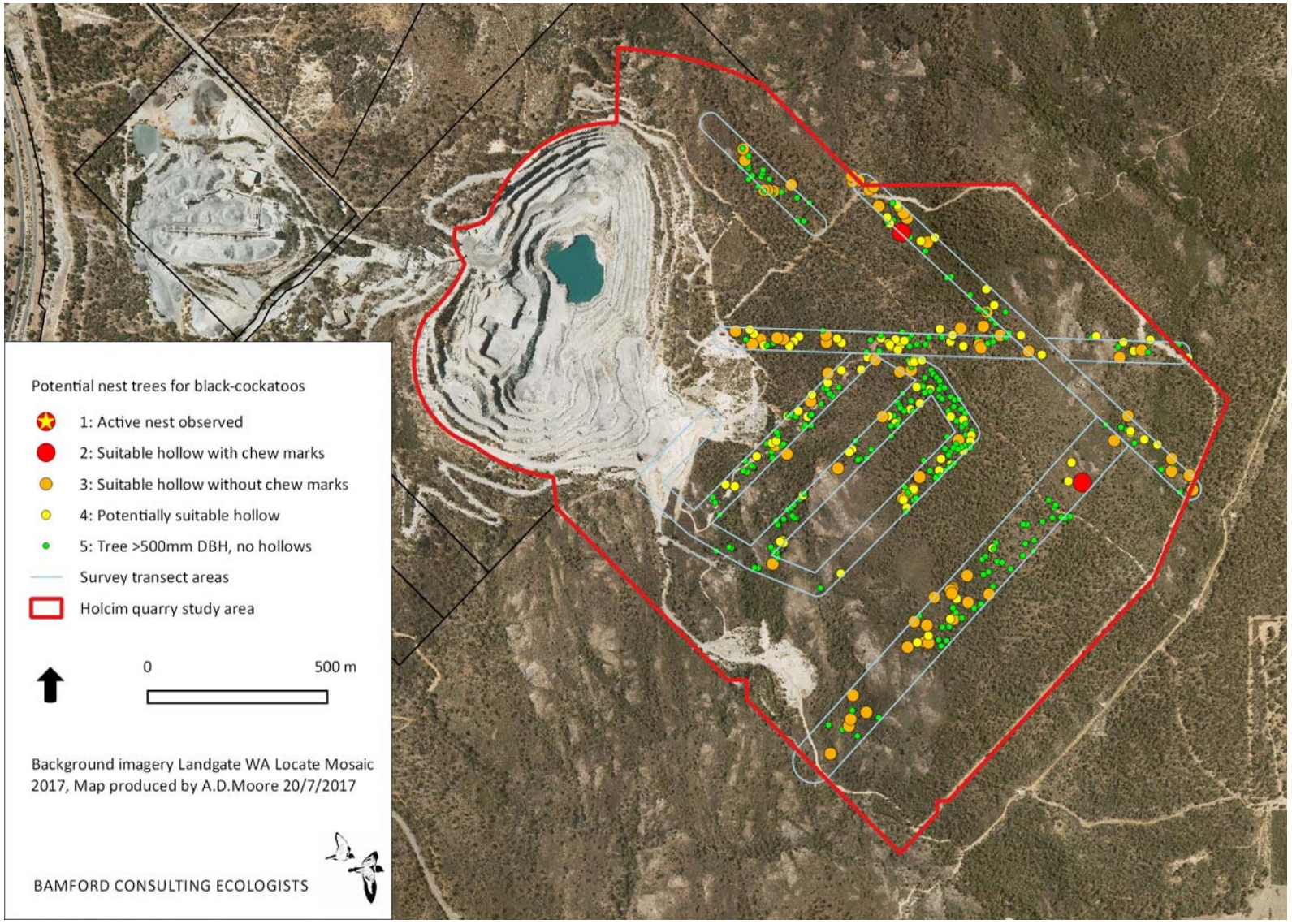

Figure 8. Potential breeding trees found in the survey transects.

BCE scores are as follows: green – 5, yellow – 4, orange – 3 and red – 2. No trees were given a score of 1 (i.e. no trees confirmed with active nests).

4.1.5 Invertebrate Species

Six conservation significant invertebrates are known to occur in the region (Table 8). No conservation significant species were recorded during the site visit. Species recorded were the widespread Marri Millipede *Antichiropus variabilis*, the SRE woodlouse *Buddelundia '04'* and the SRE land snail *Bothriembryon kendricki*. The SRE woodlouse is common in Jarrah forests around Perth and the SRE land snail is not uncommon on the Perth Coastal Plain and adjacent Scarp. The Millipede *Dinocambala ingens* was also recorded and is mostly restricted to granite outcrops of the northern Darling Escarpment, but is locally common and moderately widespread. The granite outcrops have the characteristics that should encourage the evolution of SRE invertebrate species, and V. Framinau (pers comm.) has suggested that *Synsphyronus* spp. pseudoscorpions and *Karaops* spp. spiders may be of interest in this regard.

Of the six conservation significant invertebrate species returned from database searches (Table 8), the scorpionfly *Austromerope poultoni* is most likely to occur. The species is associated with Jarrah woodland which is widespread in the quarry area, and it has been recorded 18km to the north and 20km to the east.

The biting midge *Austroconops mcmillani* has been recorded at only a handful of sites, the closest being a record from Armadale in 1934; the next closest records are from Yanchep, over 60km to the north-west. This species is unlikely to occur in the quarry area as it is associated with the coastal plain. The cricket *Kawaniphila pachomai* is known from only two records, one of which is from only 5km to the east from 1981, with the only other record from near Augusta. The bees *Leioproctus bilobatus*, *Leioproctus douglasiellus* and *Neopasiphae simplicior* have all been recorded within 10km of the quarry area however they appear to be associated with the coastal plain and are unlikely to be present on the scarp.

Table 8. Conservation significant invertebrate species returned from database searches .

Common Name	Latin Name	Conservation Status	Likelihood in the quarry area
Scorpionfly	*Austromerope poultoni*	P2 (CS2)	Likely
Biting midge	*Austroconops mcmillani*	P2 (CS2)	Unlikely
Cricket	*Kawaniphila pachomai*	P1 (CS2)	Unlikely
Bee	*Leioproctus bilobatus*	P2 (CS2)	Unlikely
Bee	*Leioproctus douglasiellus*	Cr S2 (CS1)	Unlikely
Bee	*Neopasiphae simplicior*	Cr S2 (CS1)	Unlikely

4.1.6 Introduced / Feral Species

The desktop study identified 18 introduced fauna species as potentially occurring in the quarry area (Table 9). Several of these were confirmed and two important feral predators, the Fox and Cat, are almost certainly resident.

Table 9. Introduced fauna species expected to occur in the quarry area.

Common Name	Latin Name	Expected Status
BIRDS		
Rock Dove	*Columba livia*	Resident
Spotted Dove	*Streptopelia chinensis*	Resident
Laughing Dove	*Streptopelia senegalensis*	Resident
Laughing Kookaburra	*Dacelo novaeguineae*	Resident
Sulphur-crested Cockatoo	*Cacatua galerita*	Occasional visitor
Long-billed Corella	*Cacatua tenuirostris*	Occasional visitor
Rainbow Lorikeet	*Trichoglossus moluccanus*	Visitor
Red-browed Finch	*Neochmia temporalis*	Visitor
MAMMALS		
Cattle	*Bos taurus*	Visitor
Dog	*Canis lupus familiaris*	Visitor
Goat	*Capra hircus*	Irregular visitor
Cat	*Felis catus*	Resident
House Mouse	*Mus musculus*	Resident
Rabbit	*Oryctolagus cuniculus*	Resident
Brown Rat	*Rattus norvegicus*	Vagrant
Black Rat	*Rattus rattus*	Resident
Pig	*Sus scrofa*	Visitor
Fox	*Vulpes vulpes*	Resident

Figure 9. Cat recorded in the quarry area.

Figure 10. Red Fox recorded in the quarry area.

4.2 Vegetation and Substrate Associations (VSAs)

Key VSAs in the quarry study area are:

- VSA 1. Open Jarrah/Marri woodland to forest over open banksia and mixed shrub understorey on lateritic gravels high in the landscape. VSA 1 consists of 99.7 ha.
- VSA 2. Open Wandoo woodland over a mixed high to low shrub understorey on lateritic gravels. VSA 2 covers an area of 5.1 ha.
- VSA 3. Mixed heath and thicket on sandy-gravels around granite outcrops; scattered trees include Jarrah, Marri and Wandoo. VSA 3 consists of 33 ha.
- VSA 4. Open regrowth and rehabilitation (including planted non-native species in some areas) with few remnant trees over disturbed understorey. VSA 4 covers an area of 6.9 ha.
- Cleared, disturbed and operational areas (54.1 ha).

VSAs 1 and 2 (eucalypt woodland) and 3 (heathland) are present within the quarry area and the surrounding areas to the east, although consists mostly of VSA 1 (Figure 11), with a small area of VSA 2 located in the north and VSA 3 in the east and south. VSA 4 is only found in a few small areas adjacent to the pit, situated in the western area of the site. Photographs of the key VSAs are provided in Figures 12 to 14. A detailed assessment of the vegetation and flora in the quarry area is provided in AECOM (2016).

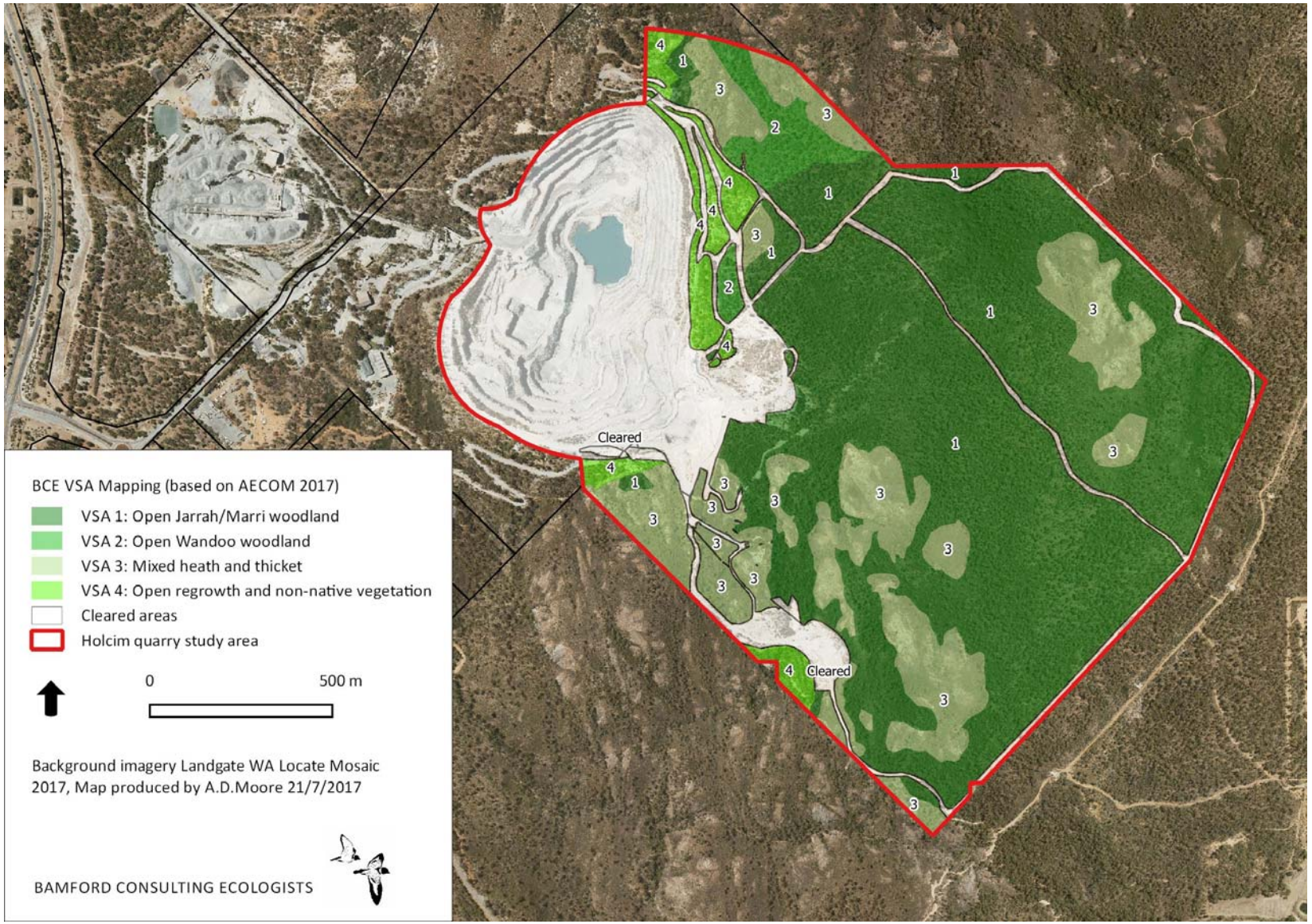

Figure 11. Vegetation and Substrate Associations (VSAs) in the quarry area.

Figure 12. VSA 1 - Open Jarrah/Marri woodland.

Figure 13. VSA 2 - Wandoo woodland.

Figure 14. VSA 3 - Mixed heath and thicket on sandy-gravels around granite outcrops.

4.3 Patterns of biodiversity

Investigating patterns of biodiversity can be complex and are often beyond the scope even of level 2 investigations. However, the quarry area contains more woodland than heath and therefore more species dependant on woodland habitat i.e. Black-Cockatoos, possums and some owls. The heath would be seasonally important for nectar feeding birds and mammals, while the heaths and thickets around outcrops may have SRE invertebrate species. As there were no major drainage lines in the expansion area it is of lesser value to aquatic and wetland fauna.

4.4 Ecological processes

The nature of the landscape and the fauna assemblage indicate some of the ecological processes that may be important for ecosystem function (see Appendix 4 for descriptions and other ecological processes). These include:

Local hydrology. The quarry area has no major drainage lines and is high in the landscape. However, some elements of the vegetation in the quarry area, such as the banksias, may be reliant upon groundwater. In addition, the granites close to the surface mean that local sub-surface hydrology is likely to be complex.

Fire. Jarrah woodlands of the Northern Jarrah Forest are fire-adapted but the flora and fauna assemblages can be altered by too-frequent fires; and even by fire exclusion. Fire season may also be important. The quarry area has been burnt in the past and as a result the fauna assemblage has almost certainly been altered by fire. The heaths (VSA 3) are probably more sensitive to fire as much of the biomass is close to the ground.

Feral species and interactions with over-abundant native species. The fauna assemblage of the quarry area has already been impacted by feral species (loss of a major component of the mammal fauna), and both feral and domestic herbivores are likely leading to some degradation of native vegetation. The presence of cattle in the quarry area is a concern and trampling by them was evident.

Habitat degradation due to weed invasion. Most of the quarry area has very low levels of weed invasion, in particular, the granite outcrop was more or less pristine (no trampling or disturbance of rocks as occurs where such outcrops can be accessed by the public).

Connectivity and landscape permeability. The quarry area lies on the western end of a larger area of native vegetation running from north to south, and is likely to provide a connectivity function for fauna.

4.5 Summary of fauna values

The desktop study identified 194 vertebrate fauna species as potentially occurring in the quarry area: 13 frogs, 42 reptiles, 106 birds, 23 native and 10 introduced mammals. The vertebrate assemblage includes 34 species of conservation significance, of particular importance and the most likely to heavily use the site being the Forest Red-tailed and Carnaby's Black-Cockatoos.

Fauna values within the quarry area can be summarised as follows:

Fauna assemblage. Not especially rich due to scarcity of wetland environments, and also lacking some mammal species, but distinctive because of location on edge of escarpment and presence of granite outcrops.

Species of conservation significance. Significant species of note that are likely to occur in the quarry area regularly include the Brush-tailed Phascogale and both the Forest Red-tailed and Carnaby's Black-Cockatoos. There may be SRE invertebrates associated with the granite outcrops. The quarry expansion area had a density of 11.6 potential breeding trees per hectare.

Vegetation and Substrate Associations (VSAs). The quarry area contains open woodland with Jarrah and Marri (VSA 1), Wandoo woodland (VSA 2), heath on shallow soils over granite (VSA 3) and open regrowth/rehabilitation (VSA 4). VSA 1 (Marri/Jarrah woodland) is best-represented in the quarry area, with small areas of VSA 2 located in the north and VSA 3 in the east and south.

Patterns of biodiversity. Detailed patterns of biodiversity could not be examined, but it can be predicted that biodiversity will differ across the landscape because of the different proportions of VSAs present. The quarry area contains more woodland than heath and therefore more species dependant on woodland habitat i.e. Black-Cockatoos, possums and some owls. The heath would be seasonally important for nectar feeding birds and mammals.

Key ecological processes. Main processes currently affecting the fauna assemblage in the quarry area include local hydrology, fire, feral species and connectivity.

4.6 Regional context

At a regional level, the proposed quarry area is situated on the western edge of the Darling Scarp. A largely contiguous landscape dominated by Marri, Jarrah and Wandoo woodland/forest occurs to the north-east, east and south-east. Urban development dominates the landscape to the west of the quarry area.

Several conservation estates (i.e. Regional Parks and National Parks) occur in the region and provide critical foraging, breeding and roosting habitat for black-cockatoos. These include:

- Banyowla Regional Park, to the north and south of the quarry area;
- Korung National Park, four km east of the quarry area;
- Darling Range Regional Park, three km south of the quarry area; and
- Wungong Regional Park, 10 km south-east of the quarry area.

As conservation estates, these are likely to remain intact in the long-term, providing foraging, breeding and roosting habitat for all three Black-Cockatoo species, and supporting other conservation significant fauna species such as Brush-tailed Phascogale, Quenda, Chuditch, Brush Wallaby and Carpet Python. To provide some context, vegetation was assessed at a regional level (i.e. within a radius of five km). Based on the work of Heddle *et al.* (1980), the following three vegetation complexes were identified by AECOM (2016) as present in the expansion area:

1. **Darling Scarp** – Consists of *Eucalyptus wandoo* with *E. laeliae* in the north, *E. haematoxylon* in the south, with *Corymbia calophylla* occurring throughout the region;

2. **Dwellingup** – Mostly open forest of Jarrah (*E. marginata*) and Marri (*C. calophylla*); and
3. **Murray** - Consists of open forest of Jarrah (*E. marginata*), Marri (*C. calophylla*) and Swan River Blackbutt (*E. patens*) on valley slopes to a fringing woodland of Flooded Gum (*E. rudis*) and Swamp Paperbark (*Melaleuca rhaphiophylla*) on the valley floors.

The amount of land within a five km radius of the quarry area that is managed for conservation by the DPaW (based on the three vegetation complexes Darling Scarp, Dwellingup and Murray) is 1,483 ha (of 4,373.2 ha) or 33.9% (Table 10 and Figure 15). The development of the quarry will result in clearing 138 ha of native vegetation and represents approximately 3.2% of similar vegetation in the five km area.

With respect to Black-Cockatoos, which are key significant species in the region, several other vegetation complexes occur within the five km radius that are suitable for foraging but are not represented in the quarry area (Table 10 and Figure 15). The vegetation complexes Cook (81.9 ha), Yarragil (620.2 ha), and Helena (469.7 ha) contain Marri, Jarrah and other plant species useful for foraging by black-cockatoos. If these additional areas are included, then clearing 138 ha would represent 2.5% of foraging vegetation in the five km area. Several other conservation significant fauna (e.g. the Brush-tailed Phascogale, Quenda, Chuditch, Brush Wallaby and Carpet Python) are likely to be associated with these vegetation complexes. Of the 5,545 ha within the five km radius, approximately 1,785.3 ha (or 32.2%) is currently managed by DPaW.

The Darling Scarp, Dwellingup and Murray complexes have greater than 30% of their pre-European extent remaining and the vegetation within the quarry area is therefore not considered to be of regional significance or below the critical threshold in accordance with EPA Position Statement 2 (EPA 2000) (AECOM 2016).

Table 10. Regional vegetation context analysis.

Heddle vegetation types within 5 km radius	ha	% of radius	DPaW Managed Land within 5 km radius				Total managed by DPaW	Total % of vegetation type within radius managed by DPaW
			Crown Freehold	National Park	SRT - River Reserve	State Forest		
Darling Scarp Complex*	**1651**	**21.0%**	**357.4**	**0.1**	**0**	**0**	**357.5**	**21.7%**
Dwellingup Complex*	**2077.6**	**26.5%**	**93**	**580.6**	**0**	**0**	**673.6**	**32.4%**
Murray Complex*	**644.6**	**8.2%**	**28.6**	**375.4**	**0**	**47.9**	**451.9**	**70.1%**
Total	**4,373.2**	**55.7%**	**479**	**956.1**	**0**	**47.9**	**1,483**	**33.9%**
Cook Complex+	81.9	1.0%	0	63.1	0	0	63.1	77.0%
Yarragil Complex+	620.2	7.9%	0	174.2	0	0.2	174.4	28.1%
Helena Complex+	469.7	6.0%	46.6	18.2	0	0	64.8	13.8%
Forrestfield Complex	1187.7	15.1%	18.5	0	1.9	0	20.4	1.7%
Swan Complex	467.5	6.0%	1.2	0	12.3	0	13.5	2.9%
Guildford Complex	392.3	5.0%	0	0	0	0	0	0.0%
Southern River Complex	261	3.3%	0	0	0	0	0	0.0%
Total	7853.5	100.0%	545.3	1211.6	14.2	48.1	1819.2	23.2%
% of 5 km radius	100.0%	-	6.9%	15.4%	0.2%	0.6%	23.2%	23.2%

*Vegetation types recorded within the quarry area.

+ Vegetation types not present within quarry area but provide potential foraging habitat for black-cockatoos.

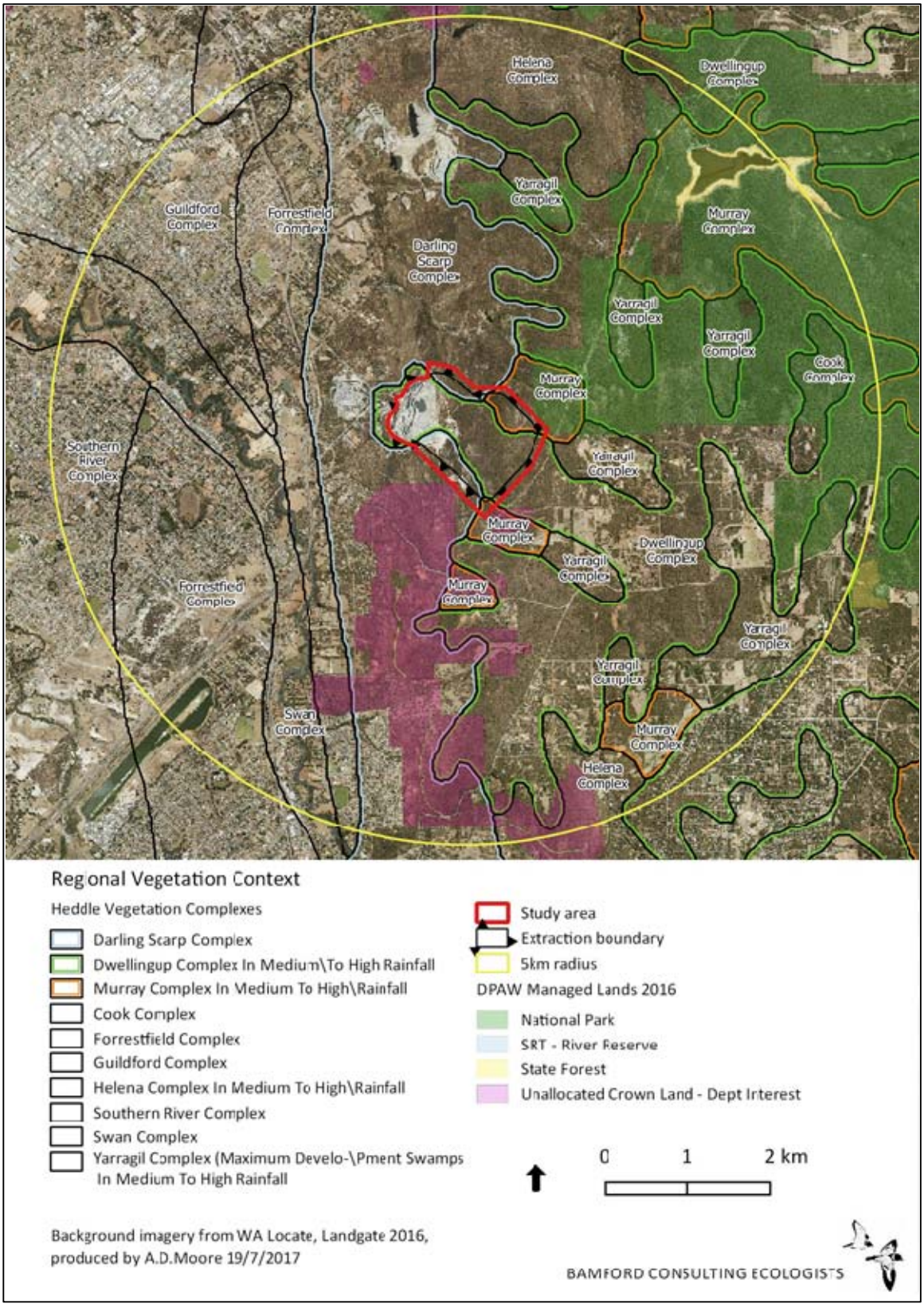

Figure 15. Regional vegetation within a five km radius of the quarry area.

5 Conclusion

The quarry area encompasses eucalypt woodland and forest, heaths and granite outcrops, and is typical of landscapes in the immediate region. It is situated on the western edge of the Darling Scarp and a largely contiguous landscape dominated by Marri, Jarrah and Wandoo woodland/forest occurs to the north-east, east and south-east.

At a regional level, the quarry will result in clearing of up to 138 ha of native vegetation, representing approximately 3.2% of similar native vegetation within a five km radius. Approximately 33.9% of this regional native vegetation (1,483 ha of 4,373.2 ha) is managed for conservation by the DPaW.

Key significant species in the quarry area are Carnaby's Black-Cockatoo and the Forest Red-tailed Black-Cockatoo, with both expected to be present regularly in the area, with foraging and nesting habitat (such as Marri and Jarrah) well-represented in the quarry area. Baudin's Black-Cockatoo is also expected to be at least an occasional visitor to the area as it occurs regularly nearby and suitable foraging habitat is present in the quarry area.

The foraging value of the quarry area for Black-Cockatoos varied from 1-5 (Negligible to Moderate/High). However, there was approximately 99.7 ha of Jarrah/Marri woodland (foraging value 4-5), 5.1 ha of Wandoo woodland (foraging value 1-2) and 33 ha of mixed heathland (foraging value 1-2), therefore the overall value for the site was averaged at 4 (Moderate value).

Transect surveys found that the quarry area had a density of 11.6 potential breeding trees for Black-Cockatoos per hectare (not including cleared areas). This also assumes that the areas covered by the transects are representative of the total area. The presence of large trees makes the site appear suitable for roosting or breeding by black-cockatoos. Two trees with a score of 2 (large hollow with recent chew-marks around entrance) were found in the quarry area. These are not confirmed but are highly likely to be active or recently active Black-Cockatoo nests. Two adult Forest Red-tailed Black-Cockatoos with a dependent chick were observed within the quarry area and may well have used one of these hollows.

Large areas of similar breeding and foraging habitat are available outside the quarry area in conservation estates such as the Banyowla Regional Park, Korung National Park, Darling Range Regional Park and Wungong Regional Park.

Similarly, other conservation significant fauna species such as the Brush-tailed Phascogale, Quenda, Chuditch, Brush Wallaby and Carpet Python are likely to be represented in the adjacent conservation estates and in similar vegetation complexes in the Darling Range.

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7 Appendices

Appendix 1. Explanation of fauna values.

Fauna values are the features of a site and its fauna that contribute to biodiversity, and it is these values that are potentially at threat from a development proposal. Fauna values can be examined under the five headings outlined below. It must be stressed that these values are interdependent and should not be considered equal, but contribute to an understanding of the biodiversity of a site. Understanding fauna values provides opportunities to predict and therefore mitigate impacts.

Assemblage characteristics

Uniqueness. This refers to the combination of species present at a site. For example, a site may support an unusual assemblage that has elements from adjacent biogeographic zones, it may have species present or absent that might be otherwise expected, or it may have an assemblage that is typical of a very large region. For the purposes of impact assessment, an unusual assemblage has greater value for biodiversity than a typical assemblage.

Completeness. An assemblage may be complete (i.e. has all the species that would have been present at the time of European settlement), or it may have lost species due to a variety of factors. Note that a complete assemblage, such as on an island, may have fewer species than an incomplete assemblage (such as in a species-rich but degraded site on the mainland).

Richness. This is a measure of the number of species at a site. At a simple level, a species rich site is more valuable than a species poor site, but value is also determined, for example, by the sorts of species present.

Vegetation/substrate associations (VSAs)

VSAs combine broad vegetation types, the soils or other substrate with which they are associated, and the landform. In the context of fauna assessment, VSAs are the environments that provide habitats for fauna. The term habitat is widely used in this context, but by definition an animal's habitat is the environment that it utilises (Calver *et al.* 2009), not the environment as a whole. Habitat is a function of the animal and its ecology, rather than being a function of the environment. For example, a species may occur in eucalypt canopy or in leaf-litter on sand, and that habitat may be found in only one or in several VSAs. VSAs are not the same as vegetation types since these may not incorporate soil and landform, and recognise floristics to a degree that VSAs do not. Vegetation types may also not recognise minor but often significant (for fauna) structural differences in the environment. VSAs also do not necessarily correspond with soil types, but may reflect some of these elements.

Because VSAs provide the habitat for fauna, they are important in determining assemblage characteristics. For the purposes of impact assessment, VSAs can also provide a surrogate for detailed information on the fauna assemblage. For example, rare, relictual or restricted VSAs should automatically be considered a significant fauna value. Impacts may be significant if the VSA is rare, a large proportion of the VSA is affected and/or the VSA supports significant fauna.

The disturbance of even small amounts of habitat in a localised area can have significant impacts to fauna if rare or unusual habitats are disturbed.

Patterns of biodiversity across the landscape

This fauna value relates to how the assemblage is organised across the landscape. Generally, the fauna assemblage is not distributed evenly across the landscape or even within one VSA. There may be zones of high biodiversity such as particular environments or ecotones (transitions between VSAs). There may also be zones of low biodiversity. Impacts may be significant if a wide range of species is affected even if most of those species are not significant per se.

Species of conservation significance

Species of conservation significance are of special importance in impact assessment. The conservation status of fauna species in Australia is assessed under Federal and State Acts such as the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Western Australian *Wildlife Conservation Act 1950* (Wildlife Conservation Act). In addition, the Western Australian Department of Parks and Wildlife (DPaW) recognises priority levels, while local populations of some species may be significant even if the species as a whole has no formal recognition. Therefore, three broad levels of conservation significance can be recognised and are used for the purposes of this report, and are outlined below. A full description of the conservation significance categories, schedules and priority levels mentioned below is provided in Appendix 3.

Conservation Significance (CS) 1: Species listed under State or Commonwealth Acts.

Species listed under the EPBC Act are assigned to categories recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN) and reviewed by Mace and Stuart (1994), or are listed as migratory. Migratory species are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA), the Republic of South Korea Australia Migratory Bird Agreement (ROKAMBA), and/or the Convention on the Conservation of Migratory Species of Wild Animals (CMS; also referred to as the Bonn Convention). The Wildlife Conservation Act uses a series of Schedules to classify status, but also recognizes the IUCN categories and ranks species within the Schedules using the categories of Mace and Stuart (1994).

Conservation Significance (CS) 2: Species listed as Priority by the DPaW but not listed under State or Commonwealth Acts.

In Western Australia, the DPaW has produced a supplementary list of Priority Fauna, being species that are not considered threatened under the Wildlife Conservation Act but for which the DPaW feels there is cause for concern. Some Priority species are also assigned to the Conservation Dependent category of the IUCN.

Conservation Significance (CS) 3: Species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution.

This level of significance has no legislative or published recognition and is based on interpretation of distribution information, but is used here as it may have links to preserving biodiversity at the genetic level (EPA 2002). If a population is isolated but a subset of a widespread (common)

species, then it may not be recognised as threatened, but may have unique genetic characteristics. Conservation significance is applied to allow for the preservation of genetic richness at a population level, and not just at a species level. Species on the edge of their range, or that are sensitive to impacts such as habitat fragmentation, may also be classed as CS3, as may colonies of waterbirds. The Western Australian Department of Environmental Protection, now DPaW, used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of the Perth Bushplan (DEP 2000).

Invertebrate species considered to be short range endemics (SREs) also fall within the CS3 category, as they have no legislative or published recognition and their significance is based on interpretation of distribution information. Harvey (2002) notes that the majority of species that have been classified as short-range endemics have common life history characteristics such as poor powers of dispersal or confinement to discontinuous habitats. Several groups, therefore, have particularly high instances of short-range endemic species: Gastropoda (snails and slugs), Oligochaeta (earthworms), Onychophora (velvet worms), Araneae (mygalomorph spiders), Pseudoscorpionida (pseudoscorpions), Schizomida (schizomids), Diplopoda (millipedes), Phreatoicidea (phreatoicidean crustaceans), and Decapoda (freshwater crayfish). The poor understanding of the taxonomy of many of the short-range endemic species hinders their conservation (Harvey 2002).

Introduced species

In addition to these conservation levels, species that have been introduced (INT) are indicated throughout the report. Introduced species may be important to the native fauna assemblage through effects by predation and/or competition.

Ecological processes upon which the fauna depend

These are the processes that affect and maintain fauna populations in an area and as such are very complex; for example, populations are maintained through the dynamic of mortality, survival and recruitment being more or less in balance, and these are affected by a myriad of factors. The dynamics of fauna populations in a project may be affected by processes such as fire regime, landscape patterns (such as fragmentation and/or linkage), the presence of feral species and hydrology. Impacts may be significant if processes are altered such that fauna populations are adversely affected, resulting in declines and even localised loss of species. Threatening processes as outlined below are effectively the ecological processes that can be altered to result in impacts upon fauna.

Appendix 2. Background information - Black-cockatoos.

Species, ecology, habitat requirements and threats

The three south-western Western Australian taxa of black-cockatoo are listed in Table i. All species are listed under both the Federal Environment Protection and Biodiversity Conservation Act (1999) and the Western Australian Wildlife Conservation Act (1950), as indicated in Table i. These three species are likely to occur in the survey area.

Table i. Black-cockatoos likely to occur in the survey area.

The status of each species under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and the Western Australian Wildlife Conservation Act 1950 (WC Act) is shown.

Species		EPBC Act	WC Act
Calyptorhynchus banksii naso	Forest Red-tailed Black-Cockatoo	Vulnerable	Schedule 1 (Vulnerable)
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	Endangered	Schedule 1 (Endangered)
Calyptorhynchus baudinii	Baudin's Black-Cockatoo	Vulnerable	Schedule 1 (Endangered)

There is considerable published information on the ecology of, and threats to, these black-cockatoo species. Key references include:

- Action plans (Garnett *et al*. 2011);
- Recovery plans (DPaW 2013);
- EPBC guidelines (DEWHA 2010; DSEWPaC 2012d);
- Federal listing and conservation advice (DEWHA 2009a, b);
- The federal Department of Sustainability, Environment, Water, Population and Communities' (SEWPaC; formerly DEWHA) Species Profile and Threats (SPRAT) Database (DSEWPaC 2012a, b, c);
- Scientific literature (Davies 1966; Saunders 1974, 1979a, b, 1980; Saunders *et al.* 1982; Saunders 1986; Johnstone and Storr 1998; Higgins 1999; Johnstone and Kirkby 1999, 2008); and
- Major reports (Johnstone *et al.* 2011; Kabat et al. 2012).

Much of this information has been compiled by DSEWPaC (2012a, b, c, d). Summarising this work further, there are several salient points for assessing the potential value of the survey area for black-cockatoos:

Key ecology

- All species are long-lived with low annual reproduction rates and cannot, therefore, rapidly increase their population size.
- Carnaby's and Baudin's Black-Cockatoos undergo regular, seasonal migration between breeding and non-breeding areas.
- Forest Red-tailed Black-Cockatoos are currently considered not to undergo regular migration. In recent years there appears to have been a distinct expansion of the range of this species on to the Swan Coastal Plain, including many suburbs within the Perth metropolitan area.

- In recent years there have been considerable shifts in the breeding ecology, distribution and movement patterns of Forest Red-tailed and Carnaby's Black-Cockatoos. These may be a response to habitat degradation/clearing and/or climatic factors.

Key habitat requirements

- All species are reliant on large tree-hollows in eucalypts, in which they breed. Each species has its own preference for nesting tree species and its own geographical breeding range (although these overlap between species). There is a solid understanding of these preferences (see Table ii for summary).
- All species primarily feed on plant seeds and flowers, but also consume wood-boring insect larvae when available. Each species has its own preference for food plant species (with considerable overlap). There is a solid understanding of these preferences (see Table ii for summary).

Key threats

- Key threatening processes include illegal shooting, habitat loss, habitat degradation, nest hollow shortage, competition for available nest hollows from other parrots and feral Honeybees (*Apis mellifera*), and illegal trade.

Table ii. Plants known to be used for foraging, roosting and nesting by black-cockatoos in south-western Western Australia.

Data compiled from the literature (Davies 1966; Saunders 1974, 1979a, b, 1980; Saunders 1986; Johnstone and Storr 1998; Higgins 1999; Johnstone and Kirkby 1999, 2008; Groom 2011; Johnstone *et al.* 2011; DSEWPaC 2012a, b, c, d, R. Johnstone pers. comm.).

FRTBC = Forest Red-tailed Black-Cockatoo, CBC = Carnaby's Black-Cockatoo, BBC = Baudin's Black-Cockatoo (see **Error! Reference source not found.** for scientific names).

Plant status: blank = Western Australian native, AN = Australian native (but not naturally occurring in Western Australia), E = exotic (i.e. not native to Australia).

F = foraging, R = roosting, N or n = nesting (main and less commonly used species, respectively).

Plant Species	Plant Status	FRTBC	CBC	BBC
Acacia baileyana (Cootamundra Wattle)	AN		F	
Acacia pentadenia (Karri Wattle)			F	
Acacia saligna (Orange Wattle)			F	
Agonis flexuosa (Peppermint Tree)			F	
Allocasuarina fraseriana (Sheoak)		F		F
Anigozanthos flavidus (Tall Kangaroo Paw)				F
Araucaria heterophylla (Norfolk Island Pine)	E		F	
Banksia ashbyi (Ashby's Banksia)			F	
Banksia attenuata (Slender Banksia)			F	
Banksia baxteri (Baxter's Banksia)			F	
Banksia carlinoides (Pink Dryandra)			F	
Banksia coccinea (Scarlet Banksia)			F	
Banksia dallanneyi (Couch Honeypot Dryandra)			F	

Plant Species	Plant Status	FRTBC	CBC	BBC
Banksia ericifolia (Heath-leaved Banksia)	AN		F	
Banksia fraseri (Dryandra)			F	
Banksia gardneri (Prostrate Banksia)			F	
Banksia grandis (Bull Banksia)			F	F
Banksia hookeriana (Hooker's Banksia)			F	
Banksia ilicifolia (Holly Banksia)			F	F
Banksia kippistiana (Dryandra)			F	
Banksia leptophylla			F	
Banksia lindleyana (Porcupine Banksia)				F
Banksia littoralis (Swamp Banksia)			F	F
Banksia menziesii (Firewood or Menzie's Banksia)			F	
Banksia mucronulata (Swordfish Dryandra)			F	
Banksia nivea (Honeypot Dryandra)			F	
Banksia nobilis (Golden Dryandra)			F	
Banksia praemorsa (Cut-leaf Banksia)			F	F
Banksia prionotes (Acorn Banksia)			F	
Banksia quercifolia (Oak-leaved Banksia)			F	F
Banksia sessilis (Parrot Bush)			F	F
Banksia speciosa (Showy Banksia)			F	
Banksia squarrosa (Pingle)			F	F
Banksia tricuspis (Lesueur Banskia or Pine Banksia)			F	
Banksia undata (Urchin or Cut-leaf Dryandra)			F	
Banksia verticillata (Granite Banksia)			F	
Brassica campestris (Canola, Rape)	E		F	
Callistemon spp.				F
Callistemon viminalis (Captain Cook Bottlebrush)	AN		F	
Callitris sp.			F	
Carya illnoinensis (Pecan)	E		F	F
Casuarina cunninghamiana (River Sheoak)	AN		F	
Citrullus lanatus (Pie or Afghan Melon)	E		F	
Corymbia calophylla (Marri)		F,N	F,n,R	F,n
Corymbia ficifolia (Red Flowering Gum)			F	
Corymbia haematoxylon (Mountain Marri)			F	
Corymbia maculata (Spotted Gum)			R	
Darwinia citriodora (Lemon-scented Darwinia)	AN		F	F
Diospryros sp. (Sweet Persimmon)	E		F	F
Eremophila glabra (Tarbush)			F	
Erodium aureum (Corkscrew Grass or Storksbill)	E		F	
Erodium botrys (Corkscrew Grass or Storksbill)	E		F	F
Eucalyptus caesia (Silver Princess)			F	

Plant Species	Plant Status	FRTBC	CBC	BBC
Eucalyptus camaldulensis (River Red Gum)	AN		R	
Eucalyptus citriodora (Lemon Scented Gum)	AN	F	F,R	F
Eucalyptus diversicolor (Karri)		n	n	N
Eucalyptus globulus (Tasmaniam Blue Gum)	AN		R	
Eucalyptus gomphocephala (Tuart)		n	F,n,R	
Eucalyptus grandis (Flooded Gum, Rose Gum)	AN		R	
Eucalyptus longicornis (Red Morrell)			n	
Eucalyptus loxophleba (York Gum)			F,n	
Eucalyptus marginata (Jarrah)		F,N	F,n,R	F
Eucalyptus megacapa (Bullich)		n		n
Eucalyptus occidentalis (Swamp Yate)			n	
Eucalyptus patens (Blackbutt)		F	F,R	
Eucalyptus pleurocarpa (Tallerack)			F	
Eucalyptus preissiana (Bell-fruited Mallee)			F	
Eucalyptus robusta (Swamp Mahogany)			F,R	
Eucalyptus rudis (Flooded Gum)			R	
Eucalyptus salmonophloia (Salmon Gum)			F,N	
Eucalyptus salubris (Gimlet)			n	
Eucalyptus todtiana (Coastal Blackbutt or Prickley Bark)			F	
Eucalyptus wandoo (Wandoo)			F,N,R	F,n
Ficus sp. (Fig)			F	
Grevillea armigera (Prickly Toothbrushes)			F	
Grevillea bipinnatifida (Fuschia Grevillea)			F	
Grevillea hookeriana (Red Toothbrushes)			F	
Grevillea hookeriana subsp. *apiciloba* (Black Toothbrushes)			F	
Grevillea paniculata (Kerosene Bush)			F	
Grevillea paradoxa (Bottlebrush Grevillea)			F	
Grevillea petrophiloides (Pink Poker)			F	
Grevillea robusta (Silky Oak)			F	
Grevillea wilsonii (Native Fuchsia)				F
Hakea auriculata			F	
Hakea candolleana			F	
Hakea circumalata (Coastal Hakea)			F	
Hakea commutata			F	
Hakea conchifolia			F	
Hakea costata (Ribbed Hakea)			F	
Hakea cristata (Snail Hakea)			F	F
Hakea cucullata (Snail Hakea)			F	
Hakea cyclocarpa (Ramshorn)			F	

Plant Species	Plant Status	FRTBC	CBC	BBC
Hakea eneabba			F	
Hakea erinacea (Hedgehog Hakea)			F	F
Hakea falcata (Sickle Hakea)			F	
Hakea flabellifolia (Fan-leaved Hakea)			F	
Hakea gilbertii			F	
Hakea incrassata (Golfball or Marble Hakea)			F	
Hakea lasiantha (Woolly Flowered Hakea)			F	
Hakea lasianthoides			F	F
Hakea laurina (Pin-cushion hakea)			F	
Hakea lissocarpha (Honeybush)			F	F
Hakea marginata				F
Hakea megalosperma (Lesueur Hakea)			F	
Hakea multilineata (Grass Leaf Hakea)			F	
Hakea obliqua (Needles and Corks)			F	
Hakea oleifolia (Dungyn or Olive-leaved Hakea)			F	
Hakea pandanicarpa subsp. *crassifolia* (Thick-leaved Hakea)			F	
Hakea petiolaris (Sea Urchin Hakea)			F	
Hakea polyanthema			F	
Hakea preissii (Needle Tree)			F	
Hakea prostrata (Harsh Hakea)			F	F
Hakea psilorrhyncha			F	
Hakea ruscifolia (Candle Hakea)			F	F
Hakea scoparia (Kangaroo Bush)			F	
Hakea smilacifolia			F	
Hakea spathulata			F	
Hakea stenocarpa (Narrow-fruited Hakea)			F	F
Hakea sulcata (Furrowed Hakea)			F	
Hakea trifurcata (Two-leaved Hakea)			F	F
Hakea undulata (Wavy-leaved Hakea)			F	
Hakea varia (Variable-leaved Hakea)			F	F
Helianthus annuus (Sunflower)	E		F	
Hibiscus sp. (Hibiscus)	E		F	
Isopogon scabriusculus			F	
Jacaranda mimosifolia (Jacaranda)	E		F	F
Jacksonia furcellata (Grey Stinkwood)			F	
Kingia australis (Kingia)				F
Lambertia inermis (Chittick)			F	
Lambertia multiflora (Many-flowered Honeysuckle)			F	
Liquidamber styraciflua (Liquid Amber)	E		F	

Plant Species	Plant Status	FRTBC	CBC	BBC
Lupinus sp. (Lupin)	E		F	
Macadamia integrifolia (Macadamia)	E		F	F
Malus domestica (Apple)	E		F	F
Melaleuca leuropoma			F	
Melia azedarach (Cape Lilac or White Cedar)	E	F	F	
Mesomeleana sp.			F	
Persoonia longifolia (Snottygobble)		F		
Pinus canariensis (Canary Island Pine)	E		F	
Pinus caribea (Caribbean Pine)	E		F	
Pinus pinaster (Pinaster or Maritime Pine)	E		F,R	
Pinus radiata (Radiata Pine)	E		F,R	F
Protea 'Pink Ice'	E		F	
Protea repens	E		F	
Prunus amygdalus (Almond Tree)	E		F	
Pyrus communis (European Pear)	E			F
Quercus spp. (Oak spp.)	E			F
Raphanus raphanistrum (Wild Radish)	E		F	
Reedia spathacea				F
Tipuana tipu (Tipu or Rosewood Tree)	E		F	
Xanthorrhoea preissii (Grass Tree)			F	F

Nesting tree size and hollow dimensions

Black-cockatoos require tree hollows that have an entrance diameter of more than 100 mm (Whitford 2001). Internal dimensions may be more important than entrance diameter, although these are much more difficult to assess (Whitford 2001; Gibbons and Lindenmayer 2002; Whitford and Williams 2002). For Forest Red-tailed Black-Cockatoos, the minimum height of a nesting hollow was 4.4 m above the ground (Whitford 2001). The minimum diameter at breast height (DBH) of a nesting tree was 608 mm and the minimum age of an actual nesting tree was 214 years (Whitford 2002). In the study by Whitford and Williams (2002) the youngest tree to bear a hollow that was potentially suited to Forest Red-tailed Black-Cockatoos was 131 years (although this was not used). In general, hollows of sufficient size to support black-cockatoos do not form until trees at least 230 years old, and the majority of nests are found in 300-500 year old trees (Johnstone 2006).

DSEWPaC (2012a, b, c, d) recommend that surveys for potential hollow-bearing trees should identify trees greater than 500 mm DBH (to include trees that are likely to become hollow-bearing in the next 50 years).

Appendix 3. Categories used in the assessment of conservation status.

IUCN categories (based on review by Mace and Stuart 1994) as used for the *Environment Protection and Biodiversity Conservation Act 1999* and the Western Australian *Wildlife Conservation Act 1950*.

Extinct	Taxa not definitely located in the wild during the past 50 years.
Extinct in the Wild	Taxa known to survive only in captivity.
Critically Endangered	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
Endangered	Taxa facing a very high risk of extinction in the wild in the near future.
Vulnerable	Taxa facing a high risk of extinction in the wild in the medium-term future.
Near Threatened	Taxa that risk becoming Vulnerable in the wild.
Conservation Dependent	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.
Data Deficient (Insufficiently Known)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
Least Concern.	Taxa that are not Threatened.

Schedules used in the WA *Wildlife Conservation Act 1950*

Schedule 1 (S1)	Critically Endangered fauna.
Schedule 2 (S2)	Endangered fauna
Schedule 3 (S3)	Vulnerable Migratory species listed under international treaties.
Schedule 4 (S4)	Presumed extinct fauna
Schedule 5 (S5)	Migratory birds under international agreement
Schedule 6 (S6)	Conservation dependant fauna
Schedule 7 (S7)	Other specially protected fauna

WA Department of Parks and Wildlife Priority species (species not listed under the *Wildlife Conservation Act 1950*, but for which there is some concern).

Priority 1	Taxa with few, poorly known populations on threatened lands.
Priority 2	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3	Taxa with several, poorly known populations, some on conservation lands.
Priority 4.	Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.
Priority 5.	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years (IUCN Conservation Dependent).

Appendix 4. Ecological and threatening processes identified under legislation and in the literature.

Ecological processes are processes that maintain ecosystems and biodiversity. They are important for the assessment of impacts of development proposals, because ecological processes make ecosystems sensitive to change. The issue of ecological processes, impacts and conservation of biodiversity has an extensive literature. Following are examples of the sorts of ecological processes that need to be considered.

Ecological processes relevant to the conservation of biodiversity in Australia (Soule *et al.* 2004):

- Critical species interactions (highly interactive species);
- Long distance biological movement;
- Disturbance at local and regional scales;
- Global climate change;
- Hydroecology;
- Coastal zone fluxes;
- Spatially-dependent evolutionary processes (range expansion and gene flow); and
- Geographic and temporal variation of plant productivity across Australia.

Threatening processes (EPBC Act)

Under the EPBC Act, a key threatening process is an ecological interaction that threatens or may threaten the survival, abundance or evolutionary development of a threatened species or ecological community. There are currently 20 key threatening processes listed by the federal Department of the Environment (DotE 2014):

- Competition and land degradation by rabbits.
- Competition and land degradation by unmanaged goats.
- Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*).
- Incidental catch (bycatch) of Sea Turtle during coastal otter-trawling operations within Australian waters north of 28 degrees South.
- Incidental catch (or bycatch) of seabirds during oceanic longline fishing operations.
- Infection of amphibians with chytrid fungus resulting in chytridiomycosis.
- Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris.
- Invasion of northern Australia by Gamba Grass and other introduced grasses.
- Land clearance.
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.
- Loss of biodiversity and ecosystem integrity following invasion by the Yellow Crazy Ant (*Anoplolepis gracilipes*) on Christmas Island, Indian Ocean.
- Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases.
- Novel biota and their impact on biodiversity.
- Predation by European red fox.
- Predation by exotic rats on Australian offshore islands of less than 1000 km^2 (100,000 ha).
- Predation by feral cats.

- Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs.
- Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species.
- The biological effects, including lethal toxic ingestion, caused by Cane Toads (*Bufo marinus*).
- The reduction in the biodiversity of Australian native fauna and flora due to the red imported fire ant, *Solenopsis invicta* (fire ant).

General processes that threaten biodiversity across Australia (The National Land and Water Resources Audit):

- Vegetation clearing;
- Increasing fragmentation, loss of remnants and lack of recruitment;
- Firewood collection;
- Grazing pressure;
- Feral animals;
- Exotic weeds;
- Changed fire regimes;
- Pathogens;
- Changed hydrology—dryland salinity and salt water intrusion;
- Changed hydrology— such as altered flow regimes affecting riparian vegetation; and
- Pollution.

In addition to the above processes, DSEWPaC has produced Significant Impact Guidelines that provide criteria for the assessment of the significance of impacts. These criteria provide a framework for the assessment of significant impacts. The criteria are listed below.

- Will the proposed action lead to a long-term decrease in the size of a population?
- Will the proposed action reduce the area of occupancy of the species?
- Will the proposed action fragment an existing population?
- Will the proposed action adversely affect habitat critical to the survival of a species?
- Will the proposed action disrupt the breeding cycle of a population?
- Will the proposed action modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?
- Will the proposed action result in introducing invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?
- Will the proposed action introduce disease that may cause the species to decline?
- Will the proposed action interfere with the recovery of the species?

Appendix 5. Fauna expected to occur in the quarry area (Table 11 to Table 15).

These lists are derived from the results of database and literature searches and from previous field surveys conducted in the local area. Results do not include returned marine species. Data sources are:

- Naturemap = Naturemap Database, searched September 2016;
- BA = Birdlife Australia's Birdata database, searched September 2016;
- EPBC = EPBC Protected Matters Search, searched September 2016;
- BCE 2015 = Previous investigations at Holcim Quarry (Bamford and Everard 2015) and other BCE records from sites in the region;
- BCE 2016 = Current field investigation, September 2016.

Status codes:

- Cons. Status: CS1, CS2, CS3 = (summary) levels of conservation significance. See Appendix 3 for full explanation. Details on species of conservation significance are given in Table 6.
- Int: introduced.

Table 11. Frog species expected to occur in the quarry area.

English name	Latin name	Cons Status	Int.	Expected status in expansion area	Database and survey records				
					ALA	Nat map	EPBC	BCE 2015	BCE 2016
HYLIDAE									
Slender Tree Frog	*Litoria adelaidensis*			Resident/regular visitor	X	X			
Motorbike Frog	*Litoria moorei*			Resident/regular visitor	X	X			
MYOBATRACHIDAE									
Quacking Frog	*Crinia georgiana*			Resident/regular visitor	X	X			X
Glauert's Froglet	*Crinia glauerti*			Resident/regular visitor	X	X			X
Squelching Froglet	*Crinia insignifera*			Resident/regular visitor	X	X			
Bleating Froglet	*Crinia pseudinsignifera*			Resident/regular visitor	X	X			
Lea's Frog	*Geocrinia leai*			Resident/regular visitor	X	X			
Western Marsh Frog	*Heleioporus barycragus*			Resident/regular visitor	X	X			
Moaning Frog	*Heleioporus eyrei*			Resident/regular visitor	X	X			
Chocolate Frog	*Heleioporus inornatus*			Resident/regular visitor	X	X			
Sand Frog	*Heleioporus psammophilus*			Resident/regular visitor	X	X			
Banjo Frog	*Limnodynastes dorsalis*			Resident/regular visitor	X	X			
Gunther's Toadlet	*Pseudophryne guentheri*			Resident/regular visitor	X	X			
Total Number of Species Expected:	**13**	**0**	**0**		**13**	**13**	**0**	**0**	**2**

Table 12. Reptile species expected to occur in the quarry area.

English name	Latin name	Cons Status	Int.	Expected status in expansion area	Database and survey records				
					ALA	Nat map	EPBC	BCE 2015	BCE 2016
CHELIDAE									
South-West Long-necked Tortoise	*Chelodina colliei*			Visitor	X	X			
AGAMIDAE									
Ornate Dragon	*Ctenophorus ornatus*			Resident	X	X			X
Dwarf Bearded Dragon	*Pogona minor*			Resident	X	X			
DIPLODACTYLIDAE									
Clawless Gecko	*Crenadactylus ocellatus*			Resident		X			X
	Diplodactylus granariensis			Resident		X			
Speckled Stone Gecko	*Diplodactylus lateroides*			Resident	X				
Soft Spiny-tailed Gecko	*Strophurus spinigerus*			Resident	X	X			
CARPHODACTYLIDAE									
Barking Gecko	*Underwoodisaurus milii*			Resident	X	X			
GEKKONIDAE									
Marbled Gecko	*Christinus marmoratus*			Resident	X	X			
Tree Dtella	*Gehyra variegata*			Resident	X	X			X
PYGOPODIDAE									
Granite Worm-lizard	*Aprasia pulchella*			Resident	X	X			
Fraser's Delma	*Delma fraseri*			Resident	X	X			
Burton's Snake-lizard	*Lialis burtonis*			Resident	X	X			
Common Scaly-foot	*Pygopus lepidopodus*			Resident	X	X			
SCINCIDAE									
Western Three-lined Skink	*Acritoscincus trilineatus*			Resident	X	X			
Buchanan's Snake-eyed Skink	*Cryptoblepharus buchananii*			Resident	X	X			

English name	Latin name	Cons Status	Int.	Expected status in expansion area	Database and survey records				
					ALA	Nat map	EPBC	BCE 2015	BCE 2016
Darling Range South-west Ctenotus	*Ctenotus delli*	CS2		Resident	X	X			
Odd-striped Ctenotus	*Ctenotus impar*			Resident	X	X			
Common South-west Ctenotus	*Ctenotus labillardieri*			Resident	X	X			
King's Skink	*Egernia kingii*			Resident	X	X			
South-western Crevice-skink	*Egernia napoleonis*			Resident	X	X			
	Hemiergis initialis			Resident		X			
South-western Orange-tailed Slider	*Lerista distinguenda*			Resident	X	X			
Common Dwarf Skink	*Menetia greyii*			Resident	X	X			
Shrubland Morethia Skink	*Morethia obscura*			Resident	X	X			
Bobtail	*Tiliqua rugosa*			Resident	X	X			X
VARANIDAE									
Gould's Goanna	*Varanus gouldii*			Resident	X	X			
Heath Monitor	*Varanus rosenbergi*			Resident	X	X			
Black-headed Monitor	*Varanus tristis*				X	X			
TYPHLOPIDAE									
Southern Blind Snake	*Anilios australis*			Resident	X				
Fat Blind Snake	*Anilios pinguis*			Resident	X				
BOIDAE									
Stimson's Python	*Antaresia stimsoni*			Resident		X			
Carpet Python	*Morelia spilota imbricata*	CS3		Resident		X			
ELAPIDAE									
Common Death Adder	*Acanthophis antarcticus*	CS2		Resident	X	X			
Southern Shovel-nosed Snake	*Brachyurophis semifasciatus*			Resident	X	X			
Yellow-faced Whip Snake	*Demansia psammophis*			Resident	X	X			

English name	Latin name	Cons Status	Int.	Expected status in expansion area	Database and survey records				
					ALA	Nat map	EPBC	BCE 2015	BCE 2016
Bardick	*Echiopsis curta*			Resident	X	X			
Western Crowned Snake	*Elapognathus coronatus*			Resident	X	X			
Tiger Snake	*Notechis scutatus*			Resident	X	X			
Gould's Hooded Snake	*Parasuta gouldii*			Resident	X	X			X
Mitchell's Short-tailed Snake	*Parasuta nigriceps*			Resident	X	X			
Dugite	*Pseudonaja affinis*			Resident		X			
Total Number of Species Expected:	**42**	**3**			**37**	**40**	**0**	**0**	**5**

Table 13. Bird species expected to occur in the quarry area.

English name	Latin name	Cons Status	Int	Expected status in expansion area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
CASUARIIDAE										
Emu	*Dromaius novaehollandiae*			Irregular visitor	X	X		X		
COLUMBIDAE										
Rock Dove	*Columba livia*		X	Irregular visitor	X	X	X			
Crested Pigeon	*Ocyphaps lophotes*			Irregular visitor	X	X		X		
Common Bronzewing	*Phaps chalcoptera*			Resident	X	X		X	X	X
Brush Bronzewing	*Phaps elegans*			Visitor	X	X		X		
Spotted Dove	*Streptopelia chinensis*		X	Irregular visitor	X	X	X	X		
Laughing Dove	*Streptopelia senegalensis*		X	Irregular visitor	X	X	X	X		
CUCULIDAE										
Fan-tailed Cuckoo	*Cacomantis flabelliformis*			Migrant	X	X		X		
Pallid Cuckoo	*Cacomantis pallidus*			Migrant	X	X		X		
Horsfield's Bronze-Cuckoo	*Chalcites basalis*			Migrant	X			X		
Shining Bronze-Cuckoo	*Chalcites lucidus*			Migrant	X	X		X		X
PODARGIDAE										
Tawny Frogmouth	*Podargus strigoides*			Resident	X	X		X		
CAPRIMULGIDAE										
Spotted Nightjar	*Eurostopodus argus*			Migrant	X	X		X		

English name	Latin name	Cons Status	Int	Expected status in expansion area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
AEGOTHELIDAE										
Australian Owlet-nightjar	*Aegotheles cristatus*			Resident	X	X		X		
APODIDAE										
Fork-tailed Swift	*Apus pacificus*	CS1		Migrant	X		X	X		
TURNICIDAE										
Painted Button-quail	*Turnix varius*	CS3		Resident	X	X		X		
Little Button-quail	*Turnix velox*			Irregular visitor				X		
ACCIPITRIDAE										
Collared Sparrowhawk	*Accipiter cirrocephalus*			Resident	X	X		X		X
Brown Goshawk	*Accipiter fasciatus*			Resident	X	X		X		
Wedge-tailed Eagle	*Aquila audax*			Resident	X	X		X	X	X
Black-shouldered Kite	*Elanus axillaris*			Irregular visitor	X	X		X		
Whistling Kite	*Haliastur sphenurus*			Visitor	X	X		X		
Little Eagle	*Hieraaetus morphnoides*			Visitor	X	X		X		
Square-tailed Kite	*Lophoictinia isura*			Migrant	X	X		X		X
FALCONIDAE										
Brown Falcon	*Falco berigora*			Visitor	X	X		X		
Nankeen Kestrel	*Falco cenchroides*			Visitor	X	X		X		
Australian Hobby	*Falco longipennis*			Resident		X		X		
Peregrine Falcon	*Falco peregrinus*	CS1		Resident	X	X		X		

English name	Latin name	Cons Status	Int	Expected status in expansion area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
TYTONIDAE										
Barn Owl	*Tyto alba*			Visitor	X	X		X		
Masked Owl	*Tyto novaehollandiae*	CS2		Irregular visitor	X			X		
STRIGIDAE										
Southern Boobook	*Ninox boobook*			Resident	X	X		X		
Barking Owl	*Ninox connivens*	CS2		Irregular visitor	X	X		X		
MEROPIDAE										
Rainbow Bee-eater	*Merops ornatus*	CS1		Migrant	X	X	X	X		
HALCYONIDAE										
Laughing Kookaburra	*Dacelo novaeguineae*		X	Resident	X	X		X		X
Sacred Kingfisher	*Todiramphus sanctus*			Migrant	X	X		X		
CACATUIDAE										
Sulphur-crested Cockatoo	*Cacatua galerita*		X	Irregular visitor	X	X		X		
Western Corella	*Cacatua pastinator*			Vagrant	X	X		X		
Little Corella	*Cacatua sanguinea*		X	Irregular visitor		X		X		
Long-billed Corella	*Cacatua tenuirostris*		X	Irregular visitor	X	X		X		
Forest Red-tailed Black-Cockatoo	*Calyptorhynchus banksii naso*	CS1		Resident	X	X	X	X		X
Baudin's Black-Cockatoo	*Calyptorhynchus baudinii*	CS1		Migrant	X	X	X	X		
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	CS1		Migrant	X	X	X	X		
Galah	*Eolophus roseicapilla*			Resident	X	X		X	X	X

English name	Latin name	Cons Status	Int	Expected status in expansion area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
PSITTACIDAE										
Australian Ringneck	*Barnardius zonarius*			Resident	X	X		X		X
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*			Irregular visitor	X	X		X		
Elegant Parrot	*Neophema elegans*			Visitor	X	X		X		X
Western Rosella	*Platycercus icterotis*			Visitor	X	X		X		
Regent Parrot	*Polytelis anthopeplus*			Irregular visitor	X			X		
Red-capped Parrot	*Purpureicephalus spurius*			Resident	X	X		X	X	X
Rainbow Lorikeet	*Trichoglossus moluccanus*		X	Visitor	X	X		X		
CLIMACTERIDAE										
Rufous Treecreeper	*Climacteris rufus*	CS3		Irregular visitor	X	X		X		
MALURIDAE										
Red-winged Fairy-wren	*Malurus elegans*	CS3		Visitor	X	X		X		
Splendid Fairy-wren	*Malurus splendens*	CS3		Resident	X	X		X	X	X
Southern Emu-wren	*Stipiturus malachurus*	CS3		Resident	X	X		X		
ACANTHIZIDAE										
Inland Thornbill	*Acanthiza apicalis*	CS3		Resident		X		X		
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*			Resident	X	X		X		
Western Thornbill	*Acanthiza inornata*	CS3		Resident	X	X		X		
Western Gerygone	*Gerygone fusca*			Resident	X	X		X		X
White-browed Scrubwren	*Sericornis frontalis*	CS3		Resident	X	X		X	X	X

English name	Latin name	Cons Status	Int	Expected status in expansion area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
Weebill	*Smicrornis brevirostris*			Resident	X	X		X	X	X
PARDALOTIDAE										
Spotted Pardalote	*Pardalotus punctatus*			Resident	X	X		X		
Striated Pardalote	*Pardalotus striatus*			Resident	X	X		X	X	X
MELIPHAGIDAE										
Western Spinebill	*Acanthorhynchus superciliosus*			Resident	X	X		X	X	X
Red Wattlebird	*Anthochaera carunculata*			Resident	X	X		X	X	X
Western Wattlebird	*Anthochaera lunulata*			Resident	X	X		X		
Singing Honeyeater	*Gavicalis virescens*			Irregular visitor	X			X		
Tawny-crowned Honeyeater	*Glyciphila melanops*			Visitor	X	X		X		X
Brown Honeyeater	*Lichmera indistincta*			Resident	X	X		X	X	X
Yellow-throated Miner	*Manorina flavigula*			Visitor	X	X		X		
Brown-headed Honeyeater	*Melithreptus brevirostris*			Resident						
Gilbert's (White-naped) Honeyeater	*Melithreptus chloropsis*			Resident						
Yellow-plumed Honeyeater	*Ptilotula ornata*			Visitor						
White-cheeked Honeyeater	*Phylidonyris niger*			Resident	X	X		X	X	X
New Holland Honeyeater	*Phylidonyris novaehollandiae*			Resident	X	X		X		X
NEOSITTIDAE										
Varied Sittella	*Daphoenositta chrysoptera*			Resident	X	X		X		

English name	Latin name	Cons Status	Int	Expected status in expansion area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
CAMPEPHAGIDAE										
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*			Visitor	X	X		X		
White-winged Triller	*Lalage tricolor*			Migrant	X			X		
PACHYCEPHALIDAE										
Grey Shrike-thrush	*Colluricincla harmonica*	CS3		Resident	X	X		X		X
Crested Shrike-tit	*Falcunculus frontatus*	CS3		Visitor	X					
Western Whistler	*Pachycephala occidentalis*			Resident	X	X		X		X
Rufous Whistler	*Pachycephala rufiventris*			Resident	X	X		X	X	X
ARTAMIDAE										
Black-faced Woodswallow	*Artamus cinereus*			Resident		X		X		
Dusky Woodswallow	*Artamus cyanopterus*			Resident	X	X		X	X	X
Australian Magpie	*Cracticus tibicen*			Resident	X	X		X	X	X
Grey Butcherbird	*Cracticus torquatus*			Resident	X	X		X		
Grey Currawong	*Strepera versicolor*			Resident	X	X		X		
RHIPIDURIDAE										
Grey Fantail	*Rhipidura fuliginosa*			Resident	X	X		X	X	X
Willie Wagtail	*Rhipidura leucophrys*			Resident	X	X		X		
CORVIDAE										
Australian Raven	*Corvus coronoides*			Resident		X		X		

English name	Latin name	Cons Status	Int	Expected status in expansion area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
MONARCHIDAE										
Magpie-lark	*Grallina cyanoleuca*			Resident	X	X		X		
Restless Flycatcher	*Myiagra inquieta*			Visitor	X	X		X		
PETROICIDAE										
White-breasted Robin	*Eopsaltria georgianus*	CS3		Visitor	X	X		X		
Western Yellow Robin	*Eopsaltria griseogularis*	CS3		Visitor	X	X		X		
Hooded Robin	*Melanodryas cucullata*	CS3		Irregular visitor	X			X		
Red-capped Robin	*Petroica goodenovii*	CS3		Visitor	X	X		X		
Scarlet Robin	*Petroica multicolor*	CS3		Resident	X	X		X		
LOCUSTELLIDAE										
Rufous Songlark	*Cincloramphus mathewsi*			Migrant	X	X		X		
HIRUNDINIDAE										
White-backed Swallow	*Cheramoeca leucosterna*			Irregular visitor				X		
Fairy Martin	*Hirundo ariel*			Vagrant	X			X		
Welcome Swallow	*Hirundo neoxena*			Migrant	X	X		X		
Tree Martin	*Hirundo nigricans*			Migrant	X	X		X		
NECTARINIIDAE										
Mistletoebird	*Dicaeum hirundinaceum*			Resident	X	X		X		

English name	Latin name	Cons Status	Int	Expected status in expansion area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
ESTRILDIDAE										
Red-browed Finch	*Neochmia temporalis*		X	Irregular visitor	X	X		X		
Red-eared Firetail	*Stagonopleura oculata*	CS3		Visitor	X	X		X		
MOTACILLIDAE										
Australasian Pipit	*Anthus novaeseelandiae*			Irregular visitor	X			X		
ZOSTEROPIDAE										
Silvereye	*Zosterops lateralis*			Resident	X	X		X	X	X
Total Number of Species Expected:	**106**	**24**	**8**		**99**	**93**	**8**	**103**	**17**	**29**

Table 14. Mammal species expected to occur in the quarry area.

English name	Latin name	Cons Status	Int.	Expected status in expansion area	Records from databases and surveys				
					ALA	Nat map	EPBC	BCE 2015	BCE 2016
TACHYGLOSSIDAE									
Short-beaked Echidna	*Tachyglossus aculeatus*			Resident	X	X		X	X
DASYURIDAE									
Mardo	*Antechinus flavipes*			Resident		X			X
Chuditch	*Dasyurus geoffroii*	V S3		Resident		X	X		
Brush-tailed Phascogale	*Phascogale tapoatafa*	S3		Resident		X			X
Gilbert's Dunnart	*Sminthopsis gilberti*			Resident	X	X			
BURRAMYIDAE									
Western Pygmy-possum	*Cercartetus concinnus*			Resident	X	X			
TARSIPEDIDAE									
Honey Possum	*Tarsipes rostratus*			Resident	X	X			
MACROPODIDAE									
Western Grey Kangaroo	*Macropus fuliginosus*			Resident	X	X		X	X
Brush Wallaby	*Notamacropus irma*	P4		Resident	X	X			X
Quokka	*Setonix brachyurus*	V S3		Vagrant		X	X		
PHALANGERIDAE									
Common Brushtail Possum	*Trichosurus vulpecula*			Resident	X	X			
PERAMELIDAE									
Quenda	*Isoodon obesulus*	P4		Resident	X	X		X	X
MOLLOSIDAE									

English name	Latin name	Cons Status	Int.	Expected status in expansion area	Records from databases and surveys				
					ALA	Nat map	EPBC	BCE 2015	BCE 2016
White-striped Bat	*Austronomus australis*			Resident	X				
	Mormopterus kitcheneri			Resident	X	X			
VESPERTILIONIDAE									
Gould's Wattled Bat	*Chalinolobus gouldii*			Resident	X	X			
Chocolate Wattled Bat	*Chalinolobus morio*			Resident				X	
Western False Pipistrelle	*Falsistrellus mackenziei*	P4		Resident				X	
Greater Long-eared Bat	*Nyctophilus major*			Resident				X	
Lesser Long-eared Bat	*Nyctophilus geoffroyi*			Resident		X			
Gould's Long-eared Bat	*Nyctophilus gouldi*			Resident	X	X			
Southern Forest Bat	*Vespadelus regulus*			Resident	X	X			
MURIDAE									
Rakali	*Hydromys chrysogaster*	P4		Visitor	X	X			
Moodit or Bush Rat	*Rattus fuscipes*			Resident					
INTRODUCED MAMMALS									
BOVIDAE									
Cattle	*Bos taurus*		X	Visitor			X		X
Goat	*Capra hircus*		X	Irregular visitor			X		
CANIDAE									
Dog	*Canis lupus familiaris*		X	Visitor			X		
Fox	*Vulpes vulpes*		X	Resident	X	X	X		X
FELIDAE									
Cat	*Felis catus*		X	Resident	X	X	X		X

English name	Latin name	Cons Status	Int.	Expected status in expansion area	Records from databases and surveys				
					ALA	Nat map	EPBC	BCE 2015	BCE 2016
LEPORIDAE									
Rabbit	*Oryctolagus cuniculus*		X	Resident			X	X	X
MURIDAE									
House Mouse	*Mus musculus*		X	Resident	X	X	X		X
Brown Rat	*Rattus norvegicus*		X	Vagrant			X		
Black Rat	*Rattus rattus*		X	Resident	X	X	X		
SUIDAE									
Pig	*Sus scrofa*		X	Visitor			X		
Total Number of Species Expected:	**33**	**7**	**10**		**16**	**21**	**12**	**7**	**5**

Table 15. Mammal species which are locally extinct in the quarry area.

Species		CS	ALA	N	EPBC	BA
MYRMECOBIIDAE						
Numbat	*Myrmecobius fasciatus*	V S2		X		
PSEUDOCHEIRIDAE						
Western Ringtail Possum	*Pseudocheirus occidentalis*	V S2		X	X	
POTOROIDAE						
Woylie	*Bettongia penicillata subsp. ogilbyi*	E S1		X	X	
Boodie	*Bettongia lesueur*	Ex V S4 S6				
MACROPODIDAE						
Tammar Wallaby	*Macropus eugenii*	P4				
Total Number of Species:	**5**	**5**	**0**	**3**	**2**	**0**

Appendix 6. Vertebrate species returned in database searches but unlikely to be found in the quarry area.

Database searches can include species found nearby but that are unlikely to be present in the survey area due to lack of suitable habitat (e.g. aquatic species) or ecological barriers preventing them from reaching the area (e.g. island species). There are also some errors, out-of-date Latin names, zoo specimens and subtleties of distribution that are not recognised in databases. All of the species listed below are considered unlikely to be found in the survey area (note some birds could occur as vagrants).

Table 16. Species returned in database searches which are unlikely to occur in the quarry area.

Species	
FISH	
Common Silver-biddy	*Gerres oyena*
	Hemiramphus robustus
Porbeagle	*Lamna nasus*
Reef Manta Ray	*Manta alfredi*
Giant Manta Ray	*Manta birostris*
	Urocampus carinirostris
Pouched Lamprey	*Geotria australis*
Nightfish	*Bostockia porosa*
Western Pygmy Perch	*Edelia vittata*
Western Minnow	*Galaxias occidentalis*
Freshwater Cobbler	*Tandanus bostocki*
Mosquitofish	*Gambusia holbrooki*
AMPHIBIANS	
Turtle Frog	*Myobatrachus gouldii*
REPTILES	
Loggerhead Turtle	*Caretta caretta*
Green Turtle	*Chelonia mydas*
Leatherback Turtle	*Dermochelys coriacea*
Flatback Turtle	*Natator depressus*
Western Heath Dragon	*Ctenophorus adelaidensis*
South Coast Gecko	*Diplodactylus calcicolus*
Spotted Sandplain Gecko	*Diplodactylus polyophthalmus*
Fine-faced Gecko	*Diplodactylus pulcher*
House Gecko	*Hemidactylus frenatus*
Sand-plain Worm-lizard	*Aprasia repens*
Side-barred Delma	*Delma grayii*
Keeled Legless Lizard	*Pletholax gracilis*
Inland Snake-eyed Skink	*Cryptoblepharus australis*
Metallic Snake-eyed Skink	*Cryptoblepharus metallicus*

Species	
Peron's Snake-eyed Skink	*Cryptoblepharus plagiocephalus*
Tawny Snake-eyed Skink	*Cryptoblepharus ruber*
	Ctenotus fallens
Bar-shouldered Ctenotus	*Ctenotus inornatus*
	Ctenotus ora
Two-toed Earless Skink	*Hemiergis quadrilineata*
Dark-flecked Garden Sunskink	*Lampropholis delicata*
Pale-flecked Garden Sunskink	*Lampropholis guichenoti*
Elegant Slider	*Lerista elegans*
Perth Slider	*Lerista lineata*
West Coast Morethia Skink	*Morethia lineoocellata*
Western Blue-tongue	*Tiliqua occipitalis*
Flowerpot Blind Snake	*Anilios braminus*
Beaked Blind Snake	*Anilios waitii*
Black-naped Snake	*Neelaps bimaculatus*
Black-striped Snake	*Neelaps calonotos*
Mulga Snake	*Pseudechis australis*
Jan's Banded Snake	*Simoselaps bertholdi*
BIRDS	
Malleefowl	*Leipoa ocellata*
Canada Goose	*Branta canadensis*
Plumed Whistling-Duck	*Dendrocygna eytoni*
Greylag Goose	*Anser anser*
Muscovy Duck	*Cairina moschata*
Chestnut Teal	*Anas castanea*
Grey Teal	*Anas gracilis*
Northern Mallard	*Anas platyrhynchos*
Pacific Black Duck	*Anas superciliosa*
Hardhead	*Aythya australis*
Musk Duck	*Biziura lobata*
Australian Wood Duck	*Chenonetta jubata*
Black Swan	*Cygnus atratus*
Pink-eared Duck	*Malacorhynchus membranaceus*
Blue-billed Duck	*Oxyura australis*
Australasian Shoveler	*Spatula rhynchotis*
Freckled Duck	*Stictonetta naevosa*
Australian Shelduck	*Tadorna tadornoides*

Species	
Indian Peafowl	*Pavo cristatus*
Red Junglefowl	*Gallus gallus*
Stubble Quail	*Coturnix pectoralis*
Brown Quail	*Coturnix ypsilophora*
Great Crested Grebe	*Podiceps cristatus*
Hoary-headed Grebe	*Poliocephalus poliocephalus*
Australasian Grebe	*Tachybaptus novaehollandiae*
Diamond Dove	*Geopelia cuneata*
Black-eared Cuckoo	*Chrysococcyx osculans*
White-throated Needletail	*Hirundapus caudacutus*
Australian Pied Oystercatcher	*Haematopus longirostris*
Eurasian Coot	*Fulica atra*
Dusky Moorhen	*Gallinula tenebrosa*
Buff-banded Rail	*Gallirallus philippensis*
Purple Swamphen	*Porphyrio porphyrio*
Australian Spotted Crake	*Porzana fluminea*
Baillon's Crake	*Porzana pusilla*
Spotless Crake	*Porzana tabuensis*
Black-tailed Native-hen	*Tribonyx ventralis*
Banded Stilt	*Cladorhynchus leucocephalus*
Black-winged Stilt	*Himantopus leucocephalus*
Red-necked Avocet	*Recurvirostra novaehollandiae*
Little Ringed Plover	*Charadrius dubius*
Greater Sand Plover	*Charadrius leschenaultii*
Hooded Plover	*Charadrius rubricollis*
Red-capped Plover	*Charadrius ruficapillus*
Black-fronted Dotterel	*Elseyornis melanops*
Red-kneed Dotterel	*Erythrogonys cinctus*
Pacific Golden Plover	*Pluvialis fulva*
Grey Plover	*Pluvialis squatarola*
Masked Lapwing	*Vanellus miles*
Banded Lapwing	*Vanellus tricolor*
Common Sandpiper	*Actitis hypoleucos*
Ruddy Turnstone	*Arenaria interpres*
Sharp-tailed Sandpiper	*Calidris acuminata*
Red Knot	*Calidris canutus*
Curlew Sandpiper	*Calidris ferruginea*

Species	
Pectoral Sandpiper	*Calidris melanotos*
Little Stint	*Calidris minuta*
Ruff	*Calidris pugnax*
Red-necked Stint	*Calidris ruficollis*
Long-toed Stint	*Calidris subminuta*
Swinhoe's Snipe	*Gallinago megala*
Pin-tailed Snipe	*Gallinago stenura*
Bar-tailed Godwit	*Limosa lapponica*
Black-tailed Godwit	*Limosa limosa*
Eastern Curlew	*Numenius madagascariensis*
Little Curlew	*Numenius minutus*
Wood Sandpiper	*Tringa glareola*
Common Greenshank	*Tringa nebularia*
Marsh Sandpiper	*Tringa stagnatilis*
Australian Painted Snipe	*Rostratula australis*
Australian Pelican	*Pelecanus conspicillatus*
Great Egret	*Ardea alba*
Intermediate Egret	*Ardea intermedia*
White-necked Heron	*Ardea pacifica*
Australasian Bittern	*Botaurus poiciloptilus*
Cattle Egret	*Bubulcus ibis*
Little Egret	*Egretta garzetta*
White-faced Heron	*Egretta novaehollandiae*
Eastern Reef Egret	*Egretta sacra*
Australian Little Bittern	*Ixobrychus dubius*
Black Bittern	*Ixobrychus flavicollis*
Nankeen Night-Heron	*Nycticorax caledonicus*
Yellow-billed Spoonbill	*Platalea flavipes*
Royal Spoonbill	*Platalea regia*
Glossy Ibis	*Plegadis falcinellus*
Australian White Ibis	*Threskiornis moluccus*
Straw-necked Ibis	*Threskiornis spinicollis*
Little Pied Cormorant	*Microcarbo melanoleucos*
Great Cormorant	*Phalacrocorax carbo*
Little Black Cormorant	*Phalacrocorax sulcirostris*
Pied Cormorant	*Phalacrocorax varius*
Australasian Darter	*Anhinga novaehollandiae*

Species	
Whiskered Tern	*Chlidonias hybrida*
White-winged Black Tern	*Chlidonias leucopterus*
Silver Gull	*Chroicocephalus novaehollandiae*
Australian Gull-billed Tern	*Gelochelidon macrotarsa*
Caspian Tern	*Hydroprogne caspia*
Crested Tern	*Thalasseus bergii*
Amsterdam Albatross	*Diomedea amsterdamensis*
Grey-headed Albatross	*Diomedea chrysostoma*
Southern Royal Albatross	*Diomedea epomophora*
Wandering Albatross	*Diomedea exulans*
Northern Royal Albatross	*Diomedea sanfordi*
Shy Albatross	*Thalassarche cauta*
Campbell Albatross	*Thalassarche impavida*
Black-browed Albatross	*Thalassarche melanophris*
White-capped Albatross	*Thalassarche steadi*
Southern Giant Petrel	*Macronectes giganteus*
Northern Giant Petrel	*Macronectes halli*
Kerguelen Petrel	*Pterodroma brevirostris*
White-headed Petrel	*Pterodroma lessonii*
Great-winged Petrel	*Pterodroma macroptera*
Fairy Prion	*Pachyptila turtur*
Australian Lesser Noddy	*Anous tenuirostris*
Black-faced Cormorant	*Phalacrocorax fuscescens*
Swamp Harrier	*Circus approximans*
Spotted Harrier	*Circus assimilis*
White-bellied Sea-Eagle	*Haliaeetus leucogaster*
Letter-winged Kite	*Elanus scriptus*
Black-breasted Buzzard	*Hamirostra melanosternon*
Black Kite	*Milvus migrans*
Osprey	*Pandion haliaetus*
Australian Bustard	*Ardeotis australis*
Bush Stone-curlew	*Burhinus grallarius*
Major Mitchell's Cockatoo	*Cacatua leadbeateri*
Cockatiel	*Nymphicus hollandicus*
Budgerigar	*Melopsittacus undulatus*
Rock Parrot	*Neophema petrophila*
Scarlet-chested Parrot	*Neophema splendida*

Species	
Superb Parrot	*Polytelis swainsonii*
Ring-necked Parakeet	*Psittacula krameri*
Variegated Fairy-wren	*Malurus lamberti*
White-winged Fairy-wren	*Malurus leucopterus*
Blue-breasted Fairy-wren	*Malurus pulcherrimus*
Western Bristlebird	*Dasyornis longirostris*
Brown Thornbill	*Acanthiza pusilla*
Chestnut-rumped Thornbill	*Acanthiza uropygialis*
Redthroat	*Pyrrholaemus brunneus*
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*
White-fronted Chat	*Epthianura albifrons*
Lewin's Honeyeater	*Meliphaga lewinii*
White-naped Honeyeater	*Melithreptus lunatus*
White-eared Honeyeater	*Nesoptilotis leucotis*
White-fronted Honeyeater	*Purnella albifrons*
Black Honeyeater	*Sugomel niger*
White-browed Babbler	*Pomatostomus superciliosus*
Chestnut Quail-thrush	*Cinclosoma castanotum*
Ground Cuckoo-shrike	*Coracina maxima*
Masked Woodswallow	*Artamus personatus*
Pied Butcherbird	*Cracticus nigrogularis*
Little Crow	*Corvus bennetti*
Jacky Winter	*Microeca fascinans*
Brown Songlark	*Cincloramphus cruralis*
Little Grassbird	*Megalurus gramineus*
Australian Reed-Warbler	*Acrocephalus australis*
Chestnut-breasted Mannikin	*Lonchura castaneothorax*
Zebra Finch	*Taeniopygia guttata*
House Sparrow	*Passer domesticus*
Eurasian Tree Sparrow	*Passer montanus*
European Goldfinch	*Carduelis carduelis*
Grey Wagtail	*Motacilla cinerea*
Indian Myna	*Acridotheres tristis*
Common Starling	*Sturnus vulgaris*
Common Blackbird	*Turdus merula*
MAMMALS	

Species	
Grey-bellied Dunnart	*Sminthopsis griseoventer*
Common Dunnart	*Sminthopsis murina*
Black Flying-fox	*Pteropus alecto*
Little Red Flying-fox	*Pteropus scapulatus*
Northern Palm Squirrel	*Funambulus pennantii*

Appendix 7. Details of cockatoo breeding tree transects.

All coordinates Zone 50, datum WGS84.

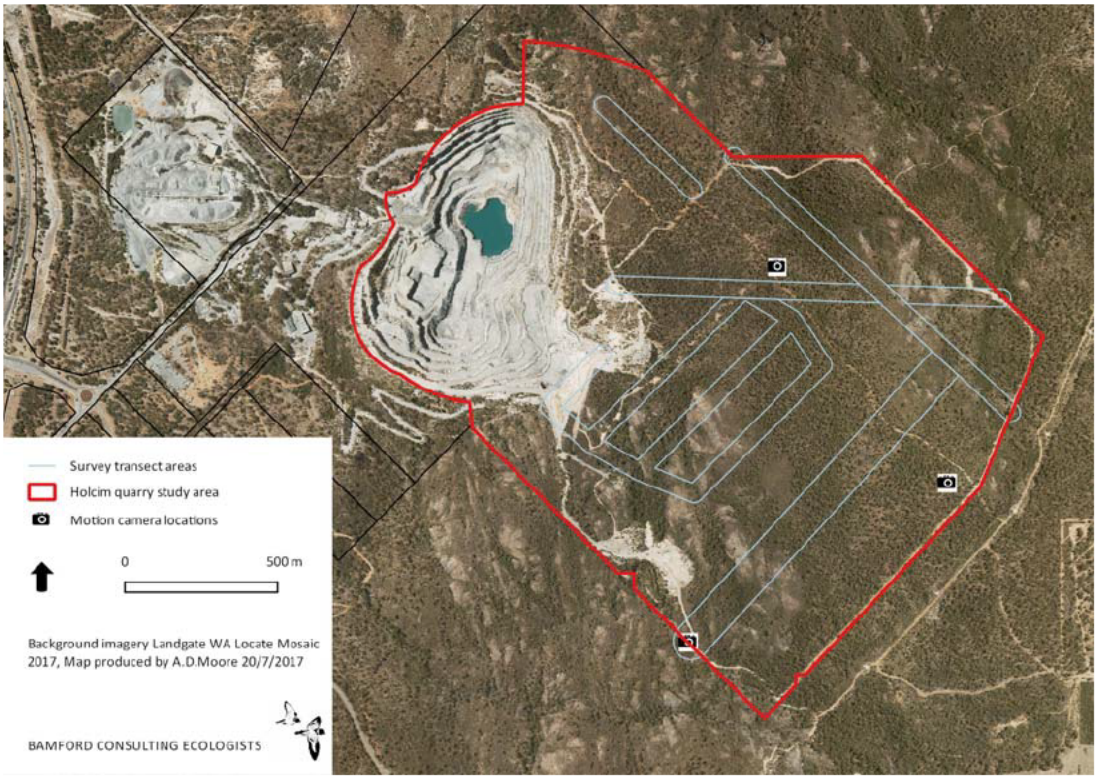

Figure 16. Location of the cockatoo breeding tree transects. Motion camera sites are indicated.

Table 17. Results of cockatoo breeding tree transects in the quarry area (including results from BCE 2015).
BCE Scores are defined in Section 3.2.4.

Date	Easting	Northing	Species	Live or dead	DBH	BCE score	Notes
BCE 2015							
27/05/2015	409186	6450623	Wandoo	Alive	400	5	
27/05/2015	409030	6450669	Marri	Alive	600	5	
27/05/2015	409073	6450678	Marri	Alive	600	3	
27/05/2015	409083	6450693	Wandoo	Alive	300	5	
27/05/2015	409079	6450694	Wandoo	Alive	400	5	
27/05/2015	409082	6450705	Marri	Alive	550	5	
27/05/2015	409075	6450706	Marri	Alive	720	5	
27/05/2015	408940	6450707	Marri	Alive	500	5	
27/05/2015	409075	6450710	Wandoo	Alive	490	5	
27/05/2015	408975	6450714	Marri	Alive	500	5	
27/05/2015	408970	6450716	Marri	Alive	500	5	
27/05/2015	409068	6450717	Marri	Alive	730	5	
27/05/2015	409098	6450727	Marri	Alive	650	4	
27/05/2015	409090	6450730	Wandoo	Alive	600	4	

Date	Easting	Northing	Species	Live or dead	DBH	BCE score	Notes
27/05/2015	409095	6450733	Wandoo	Alive	600	4	
27/05/2015	409084	6450769	Marri	Alive	860	5	
27/05/2015	409080	6450779	Wandoo	Alive	480	5	
27/05/2015	409098	6450782	Wandoo	Alive	780	5	
27/05/2015	409127	6450784	Wandoo	Alive	420	5	Has two trunks (other 330mm).
27/05/2015	409123	6450785	Wandoo	Alive	300	5	
27/05/2015	409118	6450790	Wandoo	Alive	420	5	
27/05/2015	408947	6450791	Wandoo	Alive	400	5	
27/05/2015	409386	6450801	Marri	Alive	600	5	
27/05/2015	409108	6450802	Wandoo	Alive	560	5	
27/05/2015	409107	6450805	Wandoo	Alive	530	5	
27/05/2015	409115	6450809	Marri	Alive	530	5	
27/05/2015	409388	6450811	Marri	Alive	650	4	
27/05/2015	409121	6450815	Wandoo	Alive	370	5	
27/05/2015	408936	6450819	Marri	Alive	500	5	
27/05/2015	409134	6450827	Wandoo	Alive	430	5	
27/05/2015	409136	6450829	Wandoo	Alive	420	5	
27/05/2015	409380	6450829	Marri	Alive	860	4	
27/05/2015	409404	6450830	Marri	Alive	770	5	
27/05/2015	408930	6450831	Marri	Alive	600	5	
27/05/2015	409379	6450832	Marri	Alive	800	3	
27/05/2015	409410	6450834	Jarrah	Alive	550	5	
27/05/2015	409143	6450838	Wandoo	Alive	790	4	
27/05/2015	409146	6450842	Marri	Alive	570	5	
27/05/2015	409391	6450846	Marri	Alive	780	5	
27/05/2015	409390	6450847	Marri	Alive	700	3	
27/05/2015	409403	6450854	Marri	Alive	700	3	
27/05/2015	409404	6450854	Marri	Alive	750	4	
27/05/2015	409383	6450859	Jarrah	Alive	800	5	
27/05/2015	408960	6450861	Marri	Alive	500	4	
27/05/2015	409456	6450881	Jarrah	Alive	680	5	
27/05/2015	409418	6450882	Marri	Alive	900	3	
27/05/2015	409465	6450885	Jarrah	Alive	660	5	
27/05/2015	409002	6450892	Marri	Alive	650	5	
27/05/2015	409442	6450896	Jarrah	Alive	570	5	
27/05/2015	409477	6450897	Jarrah	Alive	650	5	
27/05/2015	409225	6450900	Marri	Alive	600	3	
27/05/2015	409021	6450904	Jarrah	Alive	650	5	
27/05/2015	409488	6450905	Jarrah	Alive	750	5	
27/05/2015	409492	6450911	Jarrah	Alive	500	4	
27/05/2015	409499	6450914	Jarrah	Alive	640	5	
27/05/2015	409272	6450920	Jarrah	Alive	760	5	

Date	Easting	Northing	Species	Live or dead	DBH	BCE score	Notes
27/05/2015	409277	6450922	Marri	Alive	540	5	
27/05/2015	409070	6450923	Jarrah	Alive	500	5	
27/05/2015	409273	6450924	Marri	Alive	620	5	
27/05/2015	409468	6450924	Jarrah	Alive	600	4	
27/05/2015	409033	6450926	Marri	Alive	550	4	
27/05/2015	409104	6450932	Marri	Alive	1100	3	
27/05/2015	409486	6450933	Jarrah	Alive	670	5	
27/05/2015	409068	6450937	Jarrah	Alive	600	5	
27/05/2015	409251	6450938	Marri	Alive	600	4	
27/05/2015	409489	6450939	Jarrah	Alive	640	5	
27/05/2015	409521	6450943	Jarrah	Alive	840	4	
27/05/2015	409258	6450944	Jarrah	Alive	600	4	
27/05/2015	409508	6450946	Jarrah	Alive	590	5	
27/05/2015	409497	6450950	Jarrah	Alive	700	5	
27/05/2015	409537	6450950	Jarrah	Alive	500	5	
27/05/2015	409092	6450951	Jarrah	Alive	600	5	
27/05/2015	409516	6450951	Jarrah	Alive	780	5	
27/05/2015	409077	6450952	Marri	Alive	800	3	
27/05/2015	409531	6450953	Jarrah	Alive	600	5	
27/05/2015	409096	6450955	Jarrah	Alive	600	5	
27/05/2015	409523	6450955	Jarrah	Alive	720	5	
27/05/2015	409536	6450955	Jarrah	Alive	500	5	
27/05/2015	409056	6450956	Jarrah	Alive	570	5	
27/05/2015	409069	6450957	Jarrah	Alive	500	4	
27/05/2015	409503	6450959	Jarrah	Alive	500	5	
27/05/2015	409079	6450962	Marri	Alive	650	4	
27/05/2015	409266	6450964	Jarrah	Alive	500	5	
27/05/2015	409537	6450965	Jarrah	Alive	1250	4	
27/05/2015	409509	6450968	Jarrah	Alive	600	3	
27/05/2015	409083	6450975	Jarrah	Alive	550	5	Potential Possum tree (scratch marks)
27/05/2015	409482	6450975	Jarrah	Alive	900	5	
27/05/2015	409539	6450979	Jarrah	Alive	820	4	
27/05/2015	409526	6450980	Jarrah	Alive	800	5	
27/05/2015	409080	6450982	Marri	Alive	620	5	
27/05/2015	409541	6450990	Marri	Alive	710	5	
27/05/2015	409143	6450993	Marri	Alive	600	5	
27/05/2015	409161	6450999	Jarrah	Alive	700	5	
27/05/2015	409349	6450999	Jarrah	Alive	1020	5	
27/05/2015	409517	6450999	Jarrah	Alive	600	5	
27/05/2015	409147	6451000	Jarrah	Alive	500	5	
27/05/2015	409365	6451001	Marri	Alive	510	5	

Date	Easting	Northing	Species	Live or dead	DBH	BCE score	Notes
27/05/2015	409360	6451006	Marri	Alive	830	4	
27/05/2015	409525	6451006	Marri	Alive	780	5	
27/05/2015	409504	6451012	Jarrah	Alive	700	5	
27/05/2015	409367	6451014	Jarrah	Alive	580	5	
27/05/2015	409520	6451015	Jarrah	Alive	1180	4	
27/05/2015	409125	6451019	Jarrah	Alive	690	5	
27/05/2015	409152	6451019	Jarrah	Alive	800	4	
27/05/2015	409105	6451020	Jarrah	Alive	900	4	
27/05/2015	409107	6451021	Jarrah	Alive	620	5	
27/05/2015	409329	6451021	Marri	Alive	700	3	
27/05/2015	409159	6451022	Marri	Alive	500	5	
27/05/2015	409343	6451022	Marri	Alive	500	4	
27/05/2015	409113	6451023	Jarrah	Alive	800	5	
27/05/2015	409355	6451023	Marri	Alive	600	5	
27/05/2015	409161	6451024	Jarrah	Alive	700	5	
27/05/2015	409524	6451030	Jarrah	Alive	790	5	
27/05/2015	409130	6451032	Jarrah	Alive	870	4	
27/05/2015	409380	6451034	Jarrah	Alive	840	5	
27/05/2015	409401	6451034	Marri	Alive	520	5	
27/05/2015	409484	6451035	Jarrah	Alive	700	5	
27/05/2015	409395	6451038	Jarrah	Alive	1000	4	
27/05/2015	409512	6451039	Jarrah	Alive	600	5	
27/05/2015	409515	6451040	Jarrah	Alive	600	5	
27/05/2015	409371	6451041	Jarrah	Alive	650	5	
27/05/2015	409497	6451045	Jarrah	Alive	790	5	
27/05/2015	409370	6451046	Jarrah	Alive	500	5	
27/05/2015	409184	6451049	Marri	Alive	500	5	
27/05/2015	409417	6451052	Jarrah	Alive	620	4	
27/05/2015	409364	6451054	Jarrah	Alive	600	5	
27/05/2015	409159	6451055	Marri	Alive	1050	3	
27/05/2015	409396	6451058	Jarrah	Alive	770	5	
27/05/2015	409499	6451061	Marri	Alive	560	5	
27/05/2015	409510	6451062	Jarrah	Alive	590	5	
27/05/2015	409469	6451063	Jarrah	Alive	500	5	
27/05/2015	409211	6451067	Marri	Alive	600	5	
27/05/2015	409463	6451068	Jarrah	Alive	700	5	
27/05/2015	409490	6451068	Jarrah	Alive	800	5	
27/05/2015	409162	6451070	Jarrah	Alive	640	4	
27/05/2015	409204	6451072	Jarrah	Alive	600	5	
27/05/2015	409376	6451075	Marri	Alive	600	5	
27/05/2015	409428	6451077	Jarrah	Alive	500	5	
27/05/2015	409441	6451080	Jarrah	Alive	600	5	

Date	Easting	Northing	Species	Live or dead	DBH	BCE score	Notes
27/05/2015	409198	6451084	Jarrah	Alive	600	5	
27/05/2015	409190	6451085	Jarrah	Alive	650	5	
27/05/2015	409441	6451085	Jarrah	Alive	700	4	
27/05/2015	409225	6451088	Jarrah	Alive	1100	5	
27/05/2015	409475	6451089	Jarrah	Alive	680	5	
27/05/2015	409409	6451090	Jarrah	Alive	500	4	
27/05/2015	409424	6451091	Jarrah	Alive	700	5	
27/05/2015	409465	6451091	Marri	Alive	780	5	
27/05/2015	409421	6451094	Jarrah	Alive	700	5	
27/05/2015	409463	6451105	Marri	Alive	540	5	
27/05/2015	409428	6451112	Marri	Alive	600	5	
27/05/2015	409456	6451112	Jarrah	Alive	560	5	
27/05/2015	409456	6451114	Jarrah	Alive	500	5	
27/05/2015	409200	6451120	Jarrah	Alive	1400	3	
27/05/2015	409448	6451120	Jarrah	Alive	610	5	
27/05/2015	409369	6451125	Marri	Alive	600	3	
27/05/2015	409231	6451127	Jarrah	Alive	950	4	
27/05/2015	409278	6451129	Jarrah	Alive	900	4	
27/05/2015	409396	6451129	Marri	Alive	600	3	
27/05/2015	409443	6451129	Marri	Alive	580	5	
27/05/2015	409396	6451136	Jarrah	Alive	500	5	
27/05/2015	409397	6451147	Jarrah	Alive	690	4	
27/05/2015	409403	6451148	Jarrah	Alive	560	4	
27/05/2015	409389	6451151	Marri	Alive	600	5	
27/05/2015	409311	6451152	Jarrah	Alive	600	5	
27/05/2015	409403	6451152	Jarrah	Alive	720	4	
27/05/2015	409421	6451152	Jarrah	Alive	720	4	
27/05/2015	409293	6451158	Jarrah	Alive	800	4	
27/05/2015	409290	6451170	Jarrah	Alive	610	5	
27/05/2015	409320	6451173	Jarrah	Alive	500	5	
27/05/2015	409364	6451176	Jarrah	Alive	700	4	
27/05/2015	409345	6451187	Jarrah	Alive	500	4	
27/05/2015	409341	6451196	Marri	Alive	560	5	
27/05/2015	409299	6451198	Jarrah	Alive	500	5	
27/05/2015	409234	6450657	Jarrah	Dead	750	4	
27/05/2015	409039	6450668	Marri	Dead	600	5	
27/05/2015	409085	6450692	Marri	Dead	590	5	
27/05/2015	408982	6450857	Jarrah	Dead	600	4	
27/05/2015	409422	6450882	Jarrah	Dead	600	5	
27/05/2015	409011	6450889	Jarrah	Dead	800	5	
27/05/2015	409464	6450897	Jarrah	Dead	790	4	
27/05/2015	409025	6450902	Marri	Dead	600	5	

Date	Easting	Northing	Species	Live or dead	DBH	BCE score	Notes
27/05/2015	409006	6450915	Jarrah	Dead	580	5	
27/05/2015	409427	6450920	Jarrah	Dead	900	5	
27/05/2015	409293	6450924	Jarrah	Dead	700	5	
27/05/2015	409303	6450944	Marri	Dead	700	5	
27/05/2015	409477	6450948	Jarrah	Dead	600	5	
27/05/2015	409350	6450976	Jarrah	Dead	700	5	
27/05/2015	409510	6451015	Marri	Dead	700	5	
27/05/2015	409490	6451022	Marri	Dead	700	4	
27/05/2015	409462	6451085	Jarrah	Dead	600	5	
27/05/2015	409199	6451098	Jarrah	Dead	1200	4	
27/05/2015	409311	6451152	Jarrah	Dead	600	3	
27/05/2015	409342	6451191	Jarrah	Dead	650	4	
27/05/2015	409323	6451209	Jarrah	Dead	560	5	
Current Survey							
16/08/2016	409241	6450296	Wandoo	Alive	330	5	
16/08/2016	409256	6450304	Marri	Alive	1000	3	
16/08/2016	409208	6450306	Marri	Alive	550	5	
16/08/2016	409260	6450320	Marri	Alive	750	3	
16/08/2016	409264	6450340	Marri	Alive	510	5	
16/08/2016	409265	6450375	Marri	Alive	600	3	
16/08/2016	409416	6450499	Marri	Alive	750	4	
16/08/2016	409442	6450515	Marri	Alive	700	4	
16/08/2016	409438	6450539	Jarrah	Alive	900	3	
16/08/2016	409408	6450547	Jarrah	Alive	1200	3	
16/08/2016	409493	6450554	Jarrah	Alive	600	4	
16/08/2016	409420	6450561	Jarrah	Alive	560	5	
16/08/2016	409499	6450580	Marri	Alive	510	5	
16/08/2016	409508	6450601	Jarrah	Alive	630	4	
16/08/2016	409455	6450604	Marri	Alive	800	3	
16/08/2016	409567	6450693	Jarrah	Alive	550	5	
16/08/2016	409575	6450700	Marri	Alive	550	5	
16/08/2016	409595	6450718	Jarrah	Alive	680	5	
16/08/2016	409592	6450719	Jarrah	Alive	650	4	
16/08/2016	409599	6450732	Jarrah	Alive	650	5	
16/08/2016	409663	6450775	Jarrah	Alive	550	5	
16/08/2016	409769	6450876	Marri	Alive	700	4	
16/08/2016	409379	6451197	Jarrah	Alive	700	4	
16/08/2016	409358	6451200	Jarrah	Alive	850	4	
16/08/2016	409388	6451201	Jarrah	Alive	520	5	
16/08/2016	409194	6451209	Jarrah	Alive	600	3	
16/08/2016	409024	6451210	Jarrah	Alive	580	4	
16/08/2016	409396	6451211	Jarrah	Alive	520	5	

Date	Easting	Northing	Species	Live or dead	DBH	BCE score	Notes
16/08/2016	409374	6451217	Marri	Alive	550	5	
16/08/2016	409186	6451219	Jarrah	Alive	560	5	
16/08/2016	409014	6451220	Jarrah	Alive	800	4	
16/08/2016	409276	6450281	Marri	Dead	600	5	
16/08/2016	409326	6450324	Marri	Dead	500	5	
16/08/2016	409393	6450488	Marri	Dead	800	3	
16/08/2016	409442	6450498	Marri	Dead	500	3	
16/08/2016	409435	6450500	Marri	Dead	900	3	
16/08/2016	409500	6450554	Marri	Dead	600	3	
16/08/2016	409507	6450570	Jarrah	Dead	550	5	
16/08/2016	409496	6450613	Marri	Dead	700	3	
16/08/2016	409493	6450621	Jarrah	Dead	1000	3	
16/08/2016	409498	6450622	Marri	Dead	750	3	
16/08/2016	409499	6450626	Jarrah	Dead	700	3	
16/08/2016	409532	6450655	Jarrah	Dead	600	3	
16/08/2016	409570	6450658	Marri	Dead	850	5	
16/08/2016	409776	6450918	Marri	Dead	1000	4	
16/08/2016	409346	6451183	Jarrah	Dead	600	4	
16/08/2016	409409	6451189	Jarrah	Dead	600	5	
16/08/2016	409079	6451201	Jarrah	Dead	900	3	
16/08/2016	409324	6451202	Jarrah	Dead	500	4	
16/08/2016	409213	6450239	Marri	Alive	950	3	
16/08/2016	409297	6450336	Marri	Alive	800	3	
16/08/2016	409473	6450491	Marri	Alive	700	5	
16/08/2016	409485	6450504	Marri	Alive	500	5	
16/08/2016	409466	6450505	Jarrah	Alive	550	5	
16/08/2016	409475	6450535	Marri	Alive	550	5	
16/08/2016	409491	6450536	Jarrah	Alive	700	5	
16/08/2016	409520	6450557	Jarrah	Alive	500	5	
16/08/2016	409549	6450580	Jarrah	Alive	500	5	
16/08/2016	409566	6450589	Jarrah	Alive	600	5	
16/08/2016	409535	6450593	Marri	Alive	600	3	
16/08/2016	409584	6450612	Jarrah	Alive	750	3	
16/08/2016	409593	6450631	Jarrah	Alive	500	5	
16/08/2016	409583	6450664	Marri	Alive	800	5	
16/08/2016	409634	6450672	Jarrah	Alive	800	5	Twin trunks.
16/08/2016	409614	6450686	Jarrah	Alive	650	5	
16/08/2016	409602	6450689	Jarrah	Alive	550	5	
16/08/2016	409663	6450703	Jarrah	Alive	700	5	
16/08/2016	409688	6450713	Jarrah	Alive	600	5	
16/08/2016	409669	6450730	Jarrah	Alive	600	5	
16/08/2016	409689	6450739	Jarrah	Alive	500	5	

Date	Easting	Northing	Species	Live or dead	DBH	BCE score	Notes
16/08/2016	409672	6450775	Jarrah	Alive	500	5	
16/08/2016	409709	6450782	Jarrah	Alive	650	5	
16/08/2016	409762	6450790	Marri	Alive	600	5	
16/08/2016	409732	6450791	Marri	Alive	650	5	
16/08/2016	409752	6450792	Jarrah	Alive	500	5	
16/08/2016	409774	6450795	Marri	Alive	550	5	
16/08/2016	409737	6450814	Marri	Alive	800	5	
16/08/2016	409739	6450820	Marri	Alive	600	5	
16/08/2016	409723	6450832	Jarrah	Alive	600	5	
16/08/2016	409802	6450873	Marri	Alive	850	2	Chew marks on vertical entrance.
16/08/2016	409877	6450970	Marri	Alive	650	3	
16/08/2016	409108	6451183	Jarrah	Alive	500	4	
16/08/2016	409055	6451183	Marri	Alive	500	5	
16/08/2016	409048	6451184	Jarrah	Alive	500	4	
16/08/2016	409392	6451185	Jarrah	Alive	500	5	
16/08/2016	409109	6451185	Jarrah	Alive	600	4	
16/08/2016	409369	6451185	Jarrah	Alive	550	4	
16/08/2016	409020	6451186	Jarrah	Alive	650	3	
16/08/2016	409071	6451189	Jarrah	Alive	500	5	
16/08/2016	409429	6451189	Marri	Alive	550	5	
16/08/2016	409231	6451191	Jarrah	Alive	800	4	
16/08/2016	409195	6451192	Jarrah	Alive	600	3	
16/08/2016	409119	6451194	Jarrah	Alive	600	4	
16/08/2016	409339	6451194	Marri	Alive	600	5	
16/08/2016	409005	6451197	Jarrah	Alive	500	5	
16/08/2016	409040	6451197	Marri	Alive	700	3	
16/08/2016	409094	6451199	Marri	Alive	650	3	
16/08/2016	409221	6451201	Jarrah	Alive	650	4	
16/08/2016	409131	6451204	Jarrah	Alive	700	4	
16/08/2016	409025	6451206	Jarrah	Alive	700	5	
16/08/2016	408981	6451216	Jarrah	Alive	600	3	
16/08/2016	408985	6451217	Jarrah	Alive	550	4	
19/08/2016	410031	6450854	Jarrah	Alive	500	5	
19/08/2016	410062	6450859	Marri	Alive	90	3	
19/08/2016	410054	6450892	Marri	Alive	120	3	
19/08/2016	410012	6450901	Marri	Alive	600	3	
19/08/2016	410015	6450919	Marri	Alive	50	5	
19/08/2016	410012	6450929	Marri	Alive	90	3	
19/08/2016	409978	6450962	Marri	Alive	60	4	
19/08/2016	409947	6450974	Marri	Alive	50	4	
19/08/2016	409914	6450988	Jarrah	Alive	600	4	
19/08/2016	409915	6450993	Marri	Alive	60	4	

Date	Easting	Northing	Species	Live or dead	DBH	BCE score	Notes
19/08/2016	409906	6450995	Jarrah	Alive	500	5	
19/08/2016	409892	6451001	Marri	Alive	500	5	
19/08/2016	409857	6451007	Marri	Alive	600	5	
19/08/2016	409908	6451028	Jarrah	Alive	80	3	
19/08/2016	410049	6451164	Marri	Alive	70	4	
19/08/2016	409709	6451166	Marri	Alive	500	5	
19/08/2016	409704	6451168	Marri	Alive	50	4	
19/08/2016	409954	6451176	Jarrah	Alive	55	5	
19/08/2016	409921	6451178	Jarrah	Alive	50	4	
19/08/2016	409939	6451180	Marri	Alive	70	3	
19/08/2016	409518	6451186	Jarrah	Alive	75	4	
19/08/2016	409884	6451188	Marri	Alive	600	5	
19/08/2016	409556	6451189	Marri	Alive	600	3	Bees
19/08/2016	409576	6451193	Jarrah	Alive	500	5	
19/08/2016	410027	6451194	Marri	Alive	500	5	
19/08/2016	409488	6451196	Jarrah	Alive	500	4	
19/08/2016	409589	6451196	Marri	Alive	600	5	
19/08/2016	409483	6451197	Jarrah	Alive	500	5	
19/08/2016	409896	6451199	Marri	Alive	600	4	
19/08/2016	409551	6451203	Jarrah	Alive	600	5	
19/08/2016	409437	6451205	Jarrah	Alive	500	5	
19/08/2016	409468	6451206	Jarrah	Alive	500	5	
19/08/2016	409619	6451207	Jarrah	Alive	500	5	
19/08/2016	409821	6451208	Marri	Alive	600	5	
19/08/2016	409588	6451210	Jarrah	Alive	700	5	
19/08/2016	409493	6451211	Marri	Alive	600	4	
19/08/2016	409605	6451211	Jarrah	Alive	600	3	
19/08/2016	409831	6451212	Marri	Alive	600	4	
19/08/2016	409654	6451212	Jarrah	Alive	500	4	
19/08/2016	409626	6451217	Jarrah	Alive	600	5	
19/08/2016	409458	6451223	Jarrah	Alive	500	5	
19/08/2016	409457	6451223	Jarrah	Alive	600	5	
19/08/2016	409463	6451225	Marri	Alive	900	4	
19/08/2016	409512	6451227	Jarrah	Alive	700	3	
19/08/2016	409594	6451239	Jarrah	Alive	600	5	
19/08/2016	409583	6451250	Jarrah	Alive	600	5	
19/08/2016	409579	6451260	Jarrah	Alive	600	5	
19/08/2016	409574	6451265	Jarrah	Alive	600	3	
19/08/2016	409570	6451265	Jarrah	Alive	500	5	
19/08/2016	409617	6451266	Jarrah	Alive	55	5	
19/08/2016	409572	6451266	Jarrah	Alive	500	5	
19/08/2016	409555	6451271	Jarrah	Alive	600	5	

Date	Easting	Northing	Species	Live or dead	DBH	BCE score	Notes
19/08/2016	409552	6451274	Jarrah	Alive	700	5	
19/08/2016	409590	6451281	Marri	Alive	75	4	
19/08/2016	409533	6451305	Jarrah	Alive	500	5	
19/08/2016	409571	6451318	Marri	Alive	70	4	
19/08/2016	409478	6451344	Jarrah	Alive	600	5	
19/08/2016	409488	6451346	Marri	Alive	600	5	
19/08/2016	409427	6451405	Jarrah	Alive	500	5	
19/08/2016	409432	6451422	Jarrah	Alive	500	5	
19/08/2016	409431	6451426	Marri	Alive	900	3	
19/08/2016	409416	6451429	Jarrah	Alive	600	4	
19/08/2016	409449	6451437	Marri	Alive	70	4	
19/08/2016	409390	6451437	Jarrah	Alive	600	5	
19/08/2016	409370	6451448	Marri	Alive	500	2	
19/08/2016	409343	6451469	Jarrah	Alive	600	4	
19/08/2016	409336	6451474	Jarrah	Alive	500	5	
19/08/2016	409350	6451476	Jarrah	Alive	500	5	
19/08/2016	409383	6451482	Jarrah	Alive	110	3	
19/08/2016	409336	6451483	Jarrah	Alive	600	4	
19/08/2016	409381	6451492	Jarrah	Alive	50	4	
19/08/2016	409375	6451493	Marri	Alive	90	3	
19/08/2016	409362	6451507	Marri	Alive	80	4	
19/08/2016	409316	6451508	Jarrah	Alive	600	3	
19/08/2016	409360	6451512	Jarrah	Alive	50	4	
19/08/2016	409349	6451515	Jarrah	Alive	50	5	
19/08/2016	409294	6451547	Jarrah	Alive	800	3	
19/08/2016	409303	6451554	Jarrah	Alive	600	3	
19/08/2016	409254	6451565	Jarrah	Alive	600	3	
19/08/2016	409256	6451567	Jarrah	Alive	500	5	
19/08/2016	409277	6451567	Jarrah	Alive	700	5	
19/08/2016	409268	6451568	Jarrah	Alive	800	3	
19/08/2016	409251	6451577	Jarrah	Alive	900	3	
19/08/2016	409988	6450904	Marri	Dead	500	5	
19/08/2016	409924	6450965	Jarrah	Dead	500	5	
19/08/2016	409887	6451163	Marri	Dead	80	3	
19/08/2016	409672	6451176	Jarrah	Dead	110	3	
19/08/2016	409673	6451176	Jarrah	Dead	1000	3	
19/08/2016	409560	6451183	Jarrah	Dead	500	3	
19/08/2016	409960	6451204	Marri	Dead	600	4	
19/08/2016	409493	6451205	Jarrah	Dead	500	5	
19/08/2016	409565	6451232	Jarrah	Dead	1100	3	
28/06/2017	409139	6451472	Marri	Alive	500	5	
28/06/2017	409124	6451473	Jarrah	Alive	500	5	

Date	Easting	Northing	Species	Live or dead	DBH	BCE score	Notes
28/06/2017	409152	6451515	Jarrah	Alive	700	5	
28/06/2017	409123	6451526	Jarrah	Alive	600	5	
28/06/2017	409109	6451556	Jarrah	Dead	700	3	
28/06/2017	409086	6451539	Jarrah	Alive	500	5	
28/06/2017	409067	6451541	Jarrah	Alive	600	3	
28/06/2017	409062	6451541	Jarrah	Dead	600	4	
28/06/2017	409062	6451535	Jarrah	Dead	500	5	
28/06/2017	409054	6451543	Jarrah	Dead	500	3	
28/06/2017	409045	6451543	Jarrah	Dead	500	3	
28/06/2017	409045	6451541	Jarrah	Dead	600	5	
28/06/2017	409031	6451552	Jarrah	Alive	800	5	
28/06/2017	409057	6451569	Wandoo	Alive	600	5	
28/06/2017	409038	6451574	Wandoo	Alive	500	5	
28/06/2017	409041	6451582	Wandoo	Alive	500	5	
28/06/2017	409042	6451590	Wandoo	Alive	400	5	
28/06/2017	409017	6451579	Wandoo	Alive	600	5	
28/06/2017	409017	6451577	Wandoo	Alive	500	5	
28/06/2017	409008	6451568	Wandoo	Alive	500	5	
28/06/2017	409007	6451594	Wandoo	Alive	400	5	Echidna diggings around many of the tree bases
28/06/2017	409007	6451600	Wandoo	Alive	500	5	
28/06/2017	409001	6451602	Wandoo	Alive	300	5	
28/06/2017	409000	6451601	Wandoo	Alive	500	5	
28/06/2017	408990	6451597	Wandoo	Alive	400	5	
28/06/2017	408993	6451605	Wandoo	Alive	500	5	1 FRTBC flying S to N
28/06/2017	408999	6451612	Wandoo	Dead	800	3	
28/06/2017	409008	6451622	Wandoo	Alive	500	5	
28/06/2017	408995	6451638	Wandoo	Alive	700	3	
28/06/2017	408993	6451640	Wandoo	Alive	600	5	