

ALCOA
Wagerup Residue Storage Area Expansion
Fauna Assessment



View over the site. Photo: Google.

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Executive Summary

Bamford Consulting Ecologists (BCE) was commissioned by Alcoa to conduct a Basic (sensu EPA 2020) fauna assessment (desktop review and site inspection) of the proposed residue storage area expansion in Wagerup. The purposes of this report are to provide information on the fauna values of the project area, an overview of the ecological function of the site within the local and regional context, and to provide discussion on the interaction of proposed development on the site with these fauna values and functions. The focus of this assessment is on terrestrial fauna with a separate aquatic fauna assessment being carried out. BCE uses a 'values and impacts' assessment process with the following components:

- The identification of **fauna values**:
 - Assemblage characteristics: uniqueness, completeness and richness;
 - Species of conservation significance;
 - Recognition of ecotypes or vegetation/substrate associations (VSAs) that provide habitat for fauna, particularly those that are rare, unusual and/or support significant fauna;
 - Patterns of biodiversity across the landscape; and
 - Ecological processes upon which the fauna depend.
- The review of **impacting processes** such as:
 - Habitat loss leading to population decline;
 - Habitat loss leading to population fragmentation;
 - Degradation of habitat due to weed invasion leading to population decline;
 - Ongoing mortality from operations;
 - Species interactions including feral and overabundant native species;
 - Hydrological change;
 - Altered fire regimes; and
 - Disturbance (dust, light, noise).
- The **recommendation** of actions to mitigate impacts (if requested).

Description of project area

The proposed location ('project area') for the residue storage area expansion surrounds existing residue storage within Alcoa Wagerup land holdings, in the outskirts of Wagerup, approximately 12 km south of Waroona. The project area is c. 585 ha, of which c. 564 ha has been cleared for agriculture. The area includes very extensive paddocks used mainly for cattle grazing, wetlands (drains, seasonally-flooded paddocks and Black Tom Brook in the north, which links to drains), planted tree belts (mostly eucalypts from eastern Australia) and a narrow belt of degraded native woodland along road verges in the north.

The project area is within the Swan Coastal Plain 2 (SWA02) subregion of the Swan Coastal Plain bioregion and falls within the Dardanup, Guildford and Serpentine River Complexes of Heddle *et al.* (1980) and Webb *et al.* (2016). There are no Bush Forever sites in the local area with several sensitive areas close to but not within the survey area. The project area also sits within the 'Northern Swan Coastal Plain' Key Biodiversity Area. There are no known Ramsar Sites or Important Wetlands within the project area.

Key fauna values

The desktop study identified 259 vertebrate fauna species as potentially occurring in the project area: nine fish, 11 frogs, 33 reptiles, 179 birds and 27 mammals. Many of these, however, are expected only as irregular visitors or vagrants. The presence of at least 35 species (one frog, 28 birds and six mammals) was confirmed during the 2022 site inspection, while long-term monitoring in the region, including at sites within a few kilometres of the project area has confirmed the presence of 178 species.

Fauna assemblage. The fauna assemblage is composed of elements from the eastern Swan Coastal Plain and the adjacent escarpment, and is likely to be depauperate due to the broad scale habitat modification (conversion to pasture) within and around the project area.

Species of conservation significance. The majority of the 67 conservation significant species expected in the project area are likely to be irregular visitors or vagrants; just eight are expected to be residents and 18 to be regular visitors. A large proportion (30 species) are of local significance but are not listed under legislation or as Priority. This reflects the highly cleared nature of the project area and its surrounds, with the result that otherwise common species are locally significant. Significant species that rely on habitats in the project area include birds listed as CS3 (locally significant only), the Quenda and Brush-tailed Phascogale. Three black-cockatoo taxa are present but habitat for them is very limited. There is a possibility that the Peregrine Falcon breeds in the project area. The only significant invertebrate known from the general area that might be present is Carter's Freshwater Mussel (in Black Tom Brook).

Vegetation and Substrate Associations (VSAs). The project area encompasses four VSAs: Cleared (VSA 1), native eucalypt woodland (VSA 2), non-native eucalypt woodland (VSA 3), and wetlands, creeks and drains (VSA 4). VSA 3 is very limited in extent.

Patterns of biodiversity. VSA 2 is likely to be richest in species and to be important for significant species, with VSA 3 important for fewer species but having a connectivity function. Drains and associated thick vegetation may also have a connectivity function for small numbers of species. Seasonal wetlands on paddocks may be intermittently and locally important for waterbirds.

Key ecological processes. The ecological processes that currently have major effects upon the fauna assemblage include landscape permeability, hydrology, fire, and the presence of feral species. The remnant woodland along road verges in the north is likely to be a significant corridor for fauna movement through the landscape. Drains may also support some fauna movement. The belt of planted eucalypts in the south is also likely to be an important corridor for fauna movement.

Potential impacts upon fauna

Threatening processes reviewed in relation to the proposed development included: habitat loss, habitat fragmentation, degradation due to weed invasion, direct mortality during construction, ongoing mortality, impacts of feral and overabundant native species, hydrological change, fire and disturbance (dust, noise and light). Potential impacts are considered to be negligible to minor largely because of the small areas involved and the generally degraded landscape. However, loss of connectivity is a concern in particular along the verge remnant woodland (VSA 2) in the north, and the tree belt (VSA 3) in the south.

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1 Introduction

Alcoa is proposing to expand operations at its residue storage area within the Wagerup operations. (see Figure 2). Bamford Consulting Ecologists (BCE) was commissioned by Alcoa to conduct a Basic (*sensu* EPA 2020) fauna assessment (desktop review and site inspection) of the proposed residue storage area expansion. The focus of this assessment is on terrestrial fauna as aquatic fauna are being assessed separately. This report presents the results of that fauna desktop review and site inspection.

1.1 General approach to fauna impact assessment

The purpose of impact assessment is to provide government agencies with the information they need to decide upon the significance of impacts of a proposed development, and to provide information to proponents to help them to develop appropriate strategies for avoiding and minimising impacts of their activities. This relies on information on the fauna assemblage and its environment, and BCE uses an approach with the following components:

- The identification of **fauna values**:
 - Assemblage characteristics: uniqueness, completeness and richness;
 - Species of conservation significance;
 - Recognition of ecotypes or vegetation/substrate associations (VSAs) that provide habitat for fauna, particularly those that are rare, unusual and/or support significant fauna;
 - Patterns of biodiversity across the landscape; and
 - Ecological processes upon which the fauna depend.
- The review of **impacting processes** such as:
 - Habitat loss leading to population decline;
 - Habitat loss leading to population fragmentation;
 - Degradation of habitat due to weed invasion leading to population decline;
 - Ongoing mortality from operations;
 - Species interactions including feral and overabundant native species;
 - Hydrological change;
 - Altered fire regimes; and
 - Disturbance (dust, light, noise).
- The **recommendation** of actions to mitigate impacts (if requested).

Based on the impact assessment process above, the objectives of the study are therefore to:

1. Conduct a literature review and searches of Commonwealth and State fauna databases;
2. Review the list of fauna expected to occur on the site in the light of fauna habitats present, with a focus on investigating the likelihood of significant species being present;
3. Identify significant or fragile fauna habitats within the project area;
4. Identify any ecological processes in the project area upon which fauna may depend;
5. Identify general patterns of biodiversity within or adjacent to the project area, and
6. Identify potential impacts upon fauna and propose recommendations to minimise impacts.

Descriptions and background information on these values and processes can be found in Appendices 1 to 4. Based on this impact assessment process, the objectives of investigations are to: identify fauna

values; review impacting processes with respect to these values and the proposed development; and provide recommendations to mitigate these impacts.

1.2 Description of project area and background environmental information

1.2.1 Project area

For spatial terminology (i.e. definitions of project, survey and study areas) see Section 2.1.1 below.

The proposed location ('project area') for the residue storage area expansion surrounds existing residue storage within Alcoa Wagerup land holdings, in the outskirts of Wagerup, approximately 12 km south of Waroona. The project area is c. c. 585 ha, of which at c. 564 ha has been cleared for agriculture.

The field investigations in this environmental impact assessment were conducted within the project area only and, therefore, the 'survey area' and project area are treated as synonymous from hereon.

1.2.2 Interim Biogeographic Regionalisation of Australia (IBRA) and landscape characteristics

The Interim Biogeographic Regionalisation of Australia (IBRA) has identified 26 bioregions in Western Australia which are further divided into subregions (DAWE 2021b). 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 2016c). The project area is within the Swan Coastal Plain 2 (SWA02) subregion of the Swan Coastal Plain bioregion, as mapped in Figure 3. This bioregion falls within the Bioregion Group 1 (South-West Botanical Province) classification of EPA (2016c) where native vegetation is "extensively cleared for agriculture".

The Swan Coastal Plain 2 subregion was described by Mitchell *et al.* (2003) and a summary of their work follows here. The Swan Coastal Plain is a low lying coastal plain, mainly covered with woodlands. It is dominated by Banksia or Tuart on sandy soils, *Casuarina obesa* on outwash plains, and paperbark in swampy areas. In the east, the plain rises to duricrusted Mesozoic sediments dominated by Jarrah woodland. The climate is Warm Mediterranean. Three phases of marine sand dune development provide relief. The outwash plains, once dominated by *C. obesa*-Marri woodlands and Melaleuca shrublands, are extensive only in the south. The Perth subregion is composed of colluvial and aeolian sands, alluvial river flats, coastal limestone. Heath and/or Tuart woodlands on limestone, Banksia and Jarrah-Banksia woodlands on Quaternary marine dunes of various ages, Marri on colluvial and alluvials. Includes a complex series of seasonal wetlands and also includes Rottneest, Carnac and Garden Islands etc. Rainfall ranges between 600 and 1000 mm annually and the climate is Mediterranean.

1.2.3 Land systems and vegetation complexes

Hedde *et al.* (1980) and Webb *et al.* (2016) have defined and described broad vegetation complexes for the Swan Coastal Plain and the mapping of these is provided by DBCA (2021j). The project area is located wholly within three of these:

- Dardanup Complex – Found in the northern part of the survey area. Mosaic of vegetation types characteristic of adjacent vegetation complexes such as Serpentine River, Southern River and Guildford.
- Guildford Complex – Found in the central and southern part of the survey area. A mixture of open forest to tall open forest of *E. calophylla*, *E. wandoo*, *E. marginata* and woodland of *E. wandoo* (with rare occurrences of *E. lane-poolei*). Minor components include *E. rudis* - *M. raphiophylla*.
- Serpentine River Complex – Found in the western part of the survey area. Closed scrub of *Melaleuca spp.* and fringing woodland of *E. rudis* and *M. raphiophylla* along streams.

Hedde vegetation complexes in the vicinity of the project area are mapped in Figure 4 (data provided by DBCA 2021j).

1.2.4 Land use and tenure

The dominant land uses within the Swan Coastal Plain 2 (SWA02) subregion are cultivation (dry land and irrigated agriculture, grazing), conservation, UCL and Crown reserves, urban, rural residential, plantations, roads and other easements and infrastructure, with smaller areas of mining and defence lands (Mitchell *et al.* 2003). The project area lies in the southern sector of the subregion. At the local scale, the project area is surrounded by areas of agriculture, plantations and mining.

1.2.5 Recognised sensitive sites

There are no Bush Forever Sites in the local area, and several sensitive areas close to but not within the survey area, as shown in Figure 5 (data provided by DPLH 2021). There are no known Ramsar Sites (DBCA 2021f) or Important Wetlands (DBCA 2021c), within the project area.

1.2.6 Climate information

The project area falls within the Köppen climate classification of ‘Hot-summer Mediterranean climate (Csa)’, which is characterised by dry summers and mild, wet winters. They usually occur on the western sides of continents between the latitudes of 30° and 45°. Hot-summer Mediterranean climates are in the polar front region in winter, and thus have moderate temperatures and changeable, rainy weather. Summers are hot and dry, due to the domination of the subtropical high pressure systems, except in the immediate coastal areas, where summers are milder due to the nearby presence of cold ocean currents that may bring fog but prevent rain (Anon. 2021; BOM 2021a).

For the Swan Coastal Plain 2 (SWA02) subregion, climate is “Warm Mediterranean” (Mitchell *et al.* 2003).

Climate averages (temperate, rainfall, sunshine) for the project area, as provided by BOM (2022b), are presented in Table 1.

Table 1. Climate averages for the project area.

Data from BOM (2022a) for:

Site name = WOKALUP

Site number = 009642

| Statistics | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual | Years | Plot | Map |
|------------------------------------|------|------|------|------|-------|-------|-------|-------|------|------|------|------|--------|-------|--------------|-----|
| Temperature | | | | | | | | | | | | | | | | |
| Mean maximum temperature (°C) | 31.0 | 30.8 | 28.3 | 24.2 | 20.2 | 17.5 | 16.7 | 17.1 | 18.7 | 21.1 | 24.0 | 28.1 | 23.1 | 38 | 1951 2000 | |
| Mean minimum temperature (°C) | 15.5 | 16.1 | 14.8 | 12.7 | 10.6 | 9.0 | 8.0 | 7.9 | 8.5 | 9.4 | 11.4 | 13.7 | 11.5 | 38 | 1951 2000 | |
| Rainfall | | | | | | | | | | | | | | | | |
| Mean rainfall (mm) | 13.9 | 15.6 | 21.1 | 51.1 | 132.3 | 178.5 | 183.1 | 132.2 | 94.9 | 57.8 | 35.6 | 14.6 | 955.0 | 55 | 1951 2022 | |
| Decile 5 (median) rainfall (mm) | 3.4 | 4.8 | 12.8 | 44.5 | 128.2 | 176.5 | 178.0 | 133.0 | 91.8 | 53.0 | 29.7 | 9.4 | 955.8 | 69 | 1951 2022 | |
| Mean number of days of rain ≥ 1 mm | 1.6 | 1.7 | 2.8 | 5.7 | 10.4 | 13.5 | 14.6 | 12.9 | 10.5 | 7.5 | 5.1 | 2.4 | 88.7 | 69 | 1951 2022 | |

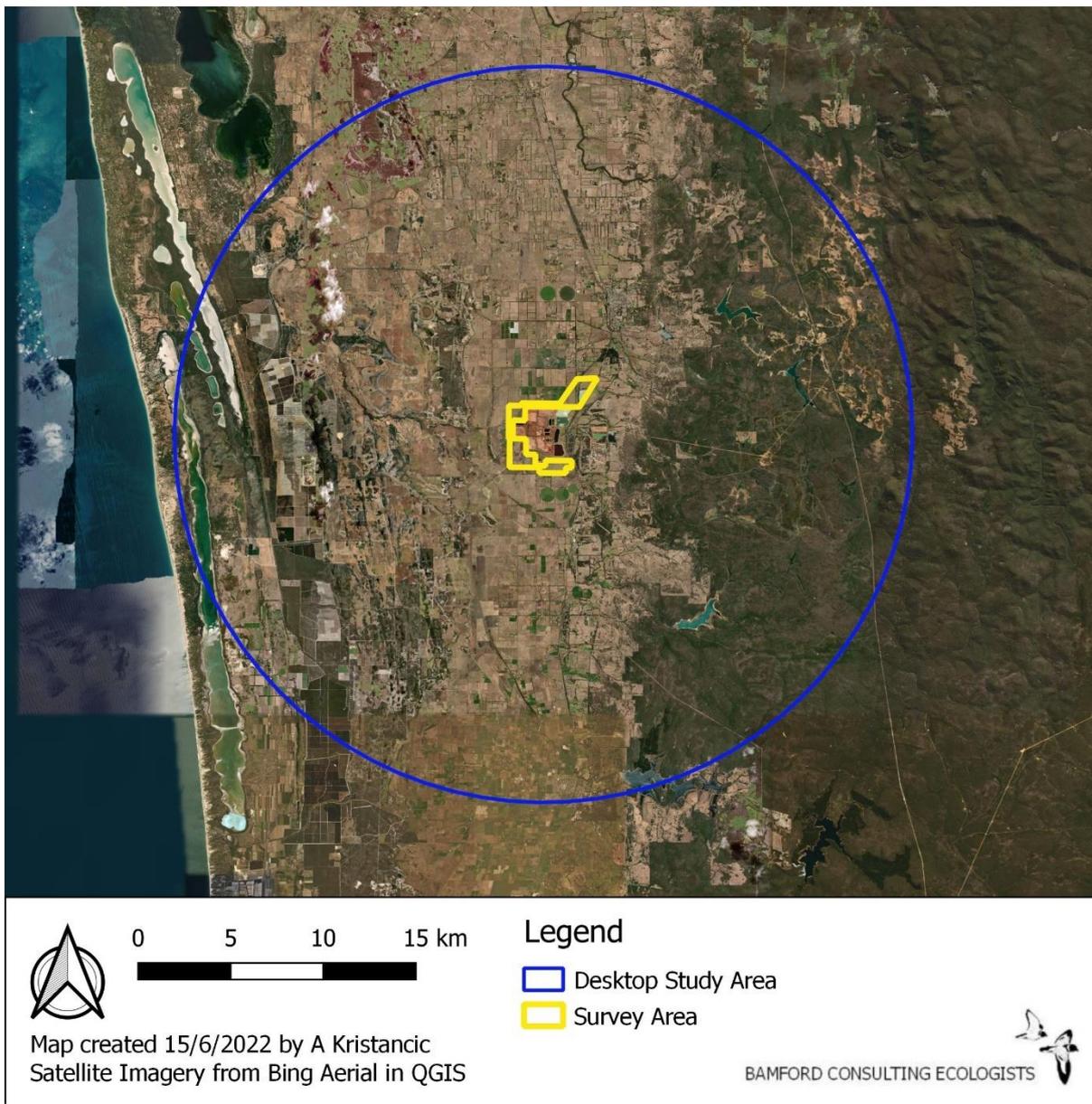


Figure 1. The project or survey area (yellow polygon) with 20km radius denoting the desktop study area.

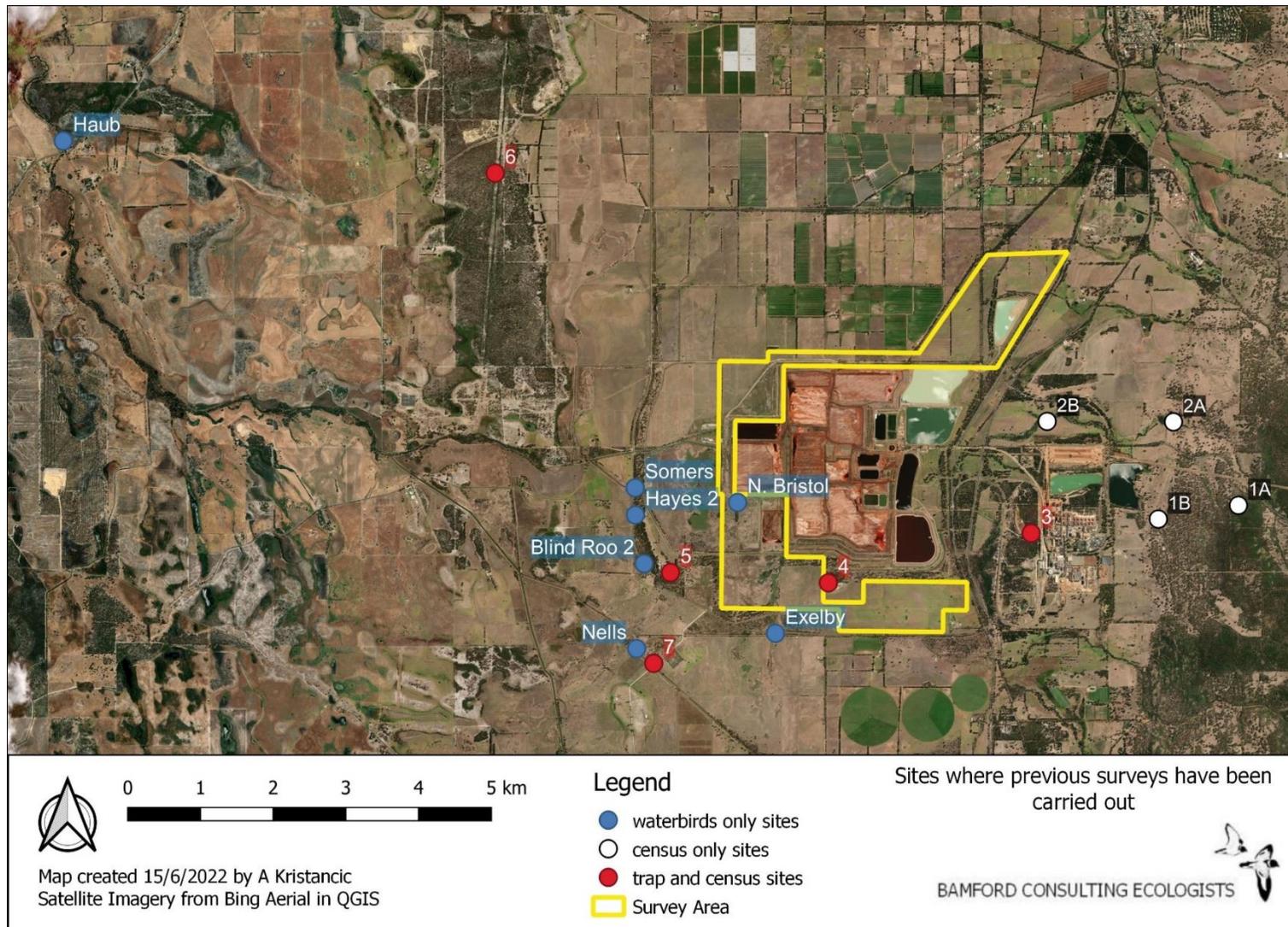


Figure 2. The project area, indicating locations of previous sampling sites (Bamford and Chuk 2020).

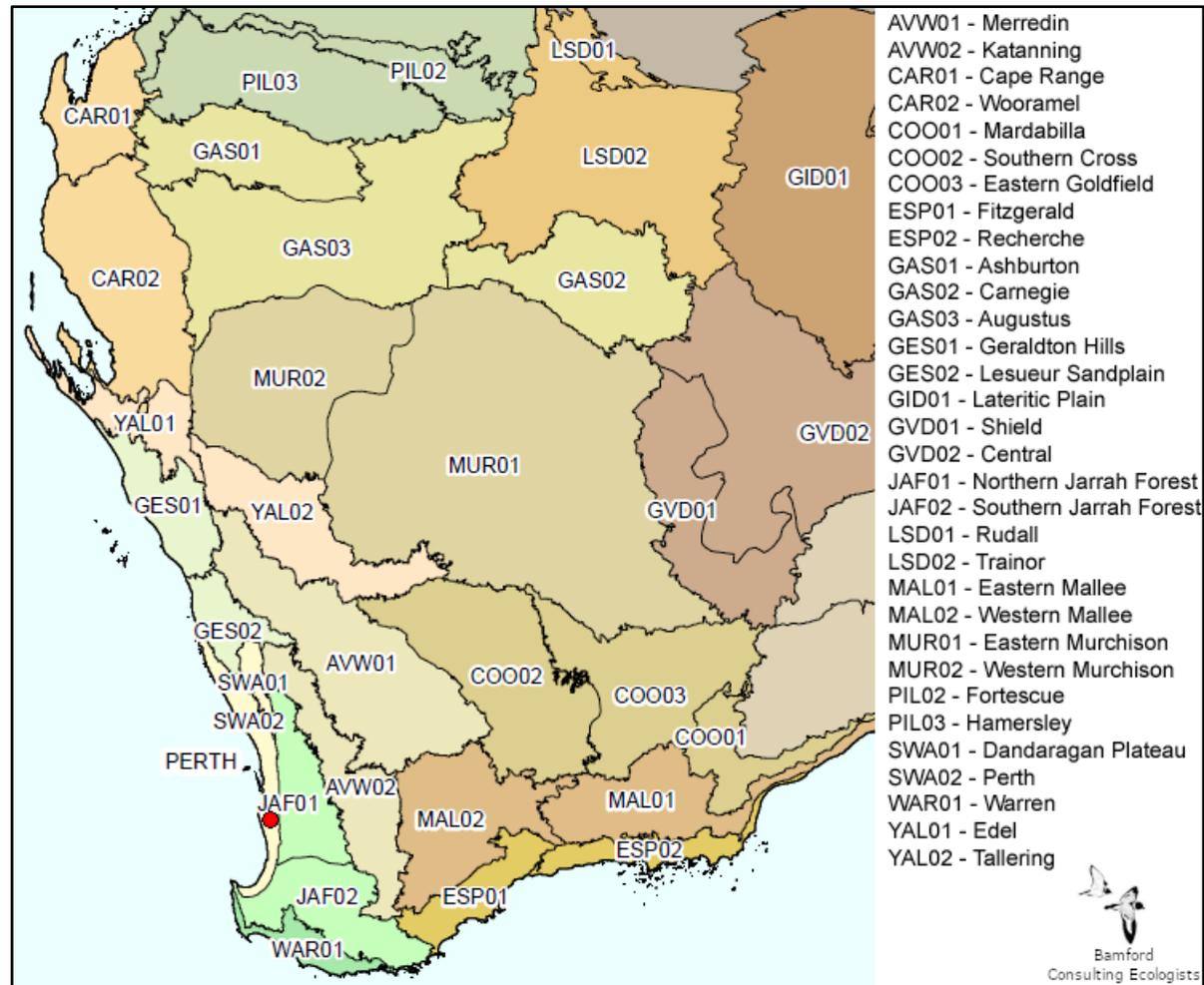


Figure 3. Project location within the Interim Biogeographic Regionalisation of Australia (IBRA).

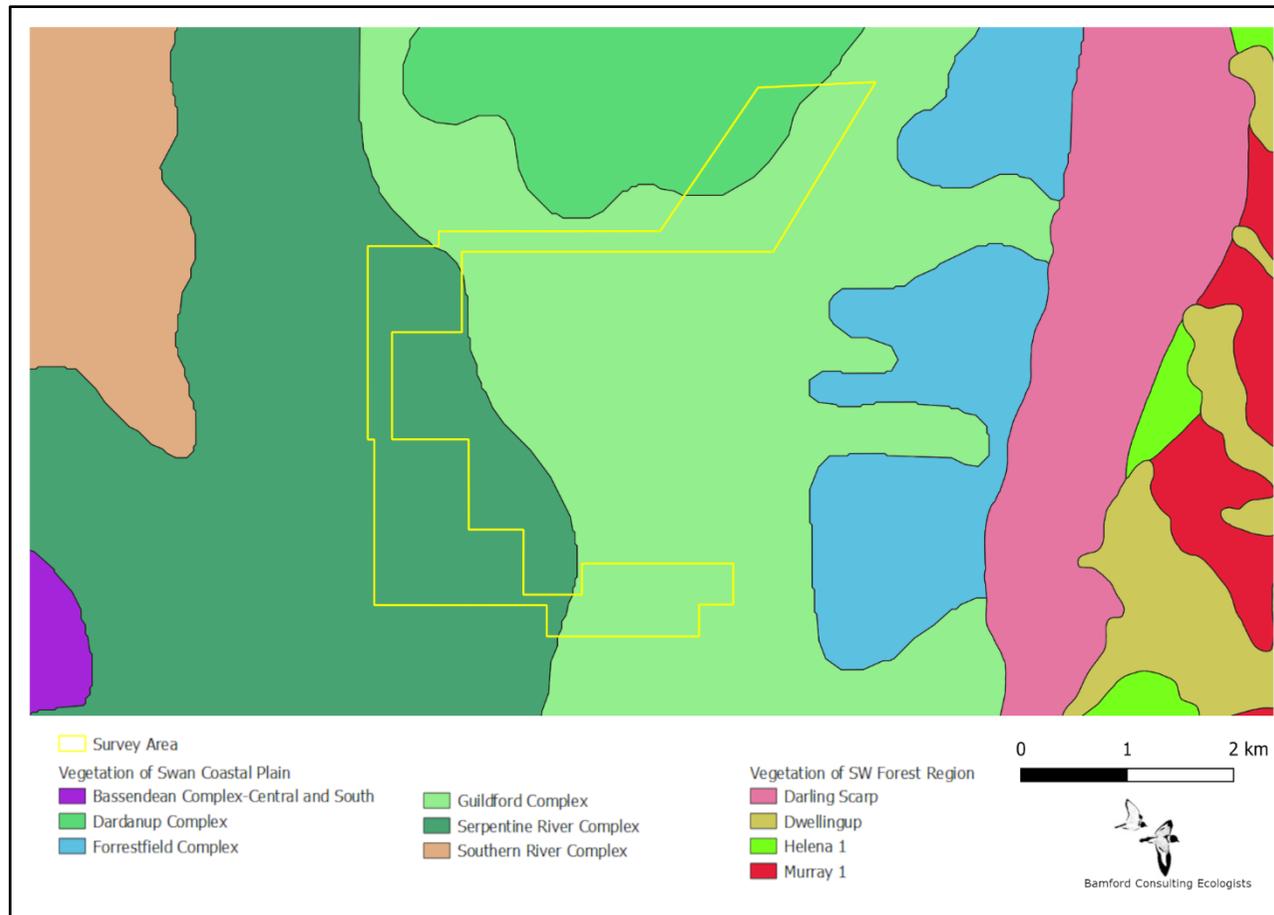


Figure 4. Vegetation Complexes (Hedde *et al.* 1980) in the vicinity of the Project.

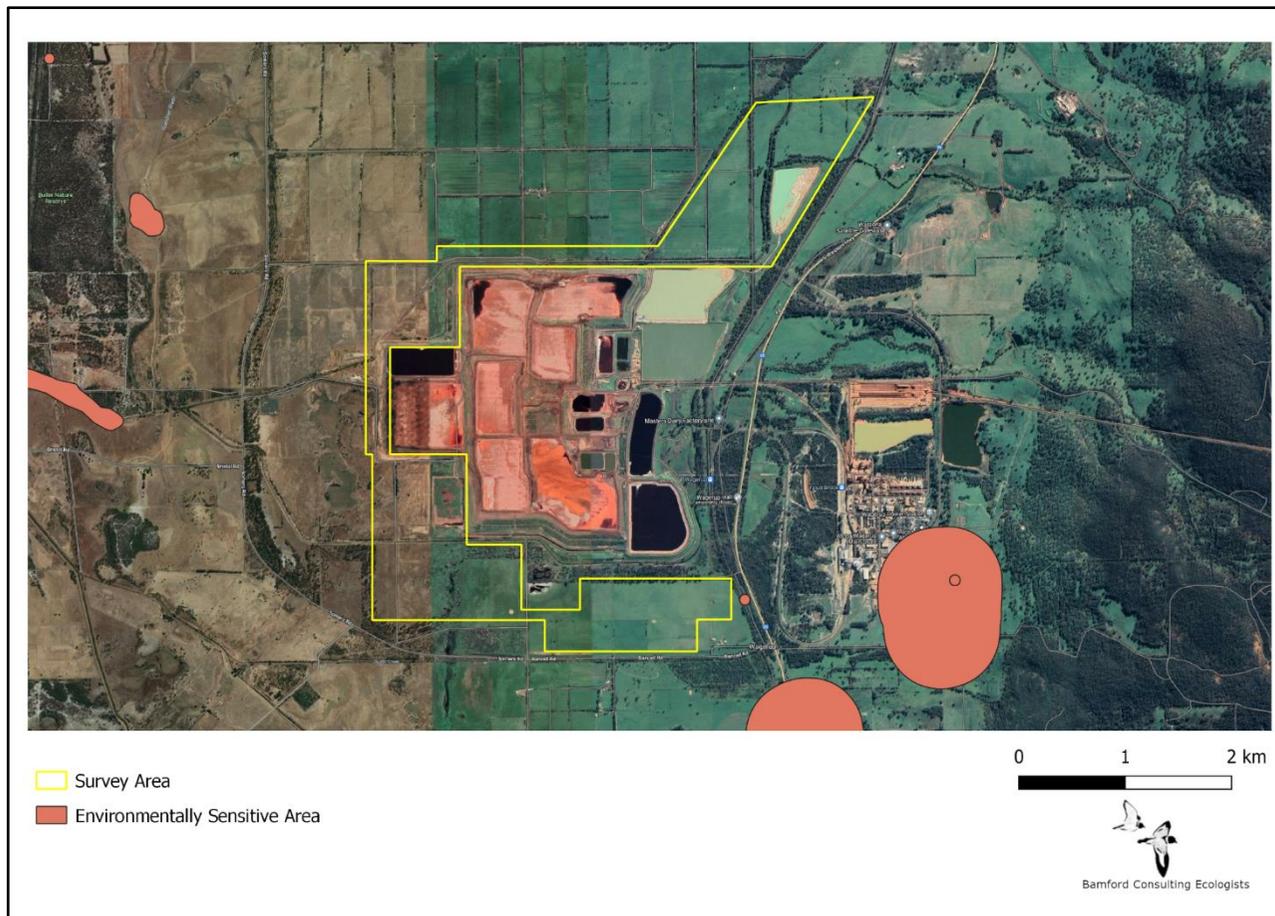


Figure 5. Environmentally Sensitive Areas (DWER 2021a, b) in the vicinity of the Project.

2 Methods

2.1 Overview

This approach to fauna impact assessment has been developed with reference to guidelines and recommendations set out by the Western Australian Environmental Protection Authority (EPA) on fauna surveys and environmental protection (EPA 2002, 2016c, b, 2020), and Commonwealth biodiversity legislation (DotE 2013; DSEWPaC 2013a). The EPA (2020) recommends three levels of investigation that differ in their approach for field investigations:

- Basic – a low-intensity survey, conducted at the local scale to gather broad fauna and habitat information (formerly referred to as ‘Level 1’). The primary objectives are to verify the overall adequacy of the desktop study, and to map and describe habitats. A basic survey can also be used to identify future survey site locations and determine site logistics and access. The results from the basic survey are used to determine whether a detailed and/or targeted survey is required. During a basic survey, opportunistic fauna observations should be made and low-intensity sampling can be used to gather data on the general faunal assemblages present. While referred to as ‘basic’, this level of survey is involved and powerful, and should be considered the primary level of assessment. Other levels of assessment (where deemed necessary) add information to inform this primary level.
- Detailed – a detailed survey to gather quantitative data on species, assemblages and habitats in an area (formerly referred to as ‘Level 2’). A detailed survey requires comprehensive survey design and should include at least two survey phases appropriate to the biogeographic region (bioregion). Surveys should be undertaken during the seasons of maximum activity of the relevant fauna and techniques should be selected to maximise the likelihood that the survey will detect most of the species that occur, and to provide data to enable some community analyses to be carried out.
- Targeted – to gather information on significant fauna and/or habitats, or to collect data where a desktop study or field survey has identified knowledge gaps. Because impacts must be placed into context, targeted surveys are not necessarily confined to potential impact areas. A targeted survey usually requires one or more site visits to detect and record significant fauna and habitats. For areas with multiple significant species there may not be a single time of year suitable to detect all species. In these cases, multiple visits, each targeting different species or groups, should be conducted.

The level of assessment recommended by the EPA (2020) is determined by geographic position, with a generic statement that detailed surveys are expected across all of the state except the south-west, but also recommending that site and project characteristics be considered, such as the survey objectives, existing available data, information required, the scale and nature of the potential impacts of the proposal and the sensitivity of the surrounding environment in which the disturbance is planned. These aspects should be considered in the context of the information acquired by the desktop study. When determining the type of survey required, the EPA (2020) suggested that the following be considered:

- level of existing regional knowledge
- type and comprehensiveness of recent local surveys
- degree of existing disturbance or fragmentation at the regional scale
- extent, distribution and significance of habitats

- significance of species likely to be present
- sensitivity of the environment to the proposed activities
- scale and nature of impact.

Guidance for field investigations methods is provided by the EPA (2016c, 2020) and by Bamford *et al.* (2013).

A 'basic' level survey (desktop review, fauna habitat identification and a site inspection) is considered appropriate for the current project. This is based upon the level of existing knowledge (see Section 2.3 below), the extent, distribution and significance of habitats (widespread) and the significance of species likely to be present (generally a limited assemblage of significant species).

The approach and methods utilised in this report are divided into three groupings that relate to the stages and the objectives of impact assessment:

- **Desktop assessment.** The purpose of the desktop review is to produce a species list that can be considered to represent the vertebrate fauna assemblage of the project area based on unpublished and published data using a precautionary approach.
- **Field investigations.** The purpose of the field investigations carried out for a Basic assessment is to gather information on the vegetation and soil associations ('habitats') that support the fauna assemblage and place the list generated by the desktop review into the context of the environment of the project area. The brief field investigations that form part of a Basic assessment also allow for some fauna observations to be made and assist the consultant to develop an understanding of the ecological processes that may be operating in the project area.
- **Impact assessment.** Determine how the fauna assemblage may be affected by the proposed development based on the interaction of the project with a suite of ecological and threatening processes.

2.1.1 Spatial terminology

A range of terms are used through the report to refer to the spatial environment around the proposed project, and these are defined below:

- Study area – the outermost boundary of the desktop assessment that is almost always a specified buffer distance (Figure 1; see also Section 2.3.1 below) around the *survey area*. The study area thus encompasses the *survey area* but includes the area from which databases are sourced. Also referred to more generally as the region.
- Survey area – the *survey area* is the area to which the results of the desktop analysis are directed and/or the area within which field investigations are conducted. Note that while the term '*survey area*' is used throughout the guidance provided by EPA (2020), it does not appear to be explicitly defined and, therefore, the above definition has been developed with interpretation of both the guidance and BCE report structure.
- Project area – this may be equivalent to the *survey area* but is strictly the land over which the proponent has tenure or some control and within which on-site impacts may occur.
- Development footprint – the expected extent of land clearing and/or development.

Where available, these spatial boundaries are mapped in Figure 2.

2.2 Identification of vegetation and substrate associations (VSAs)

Vegetation and substrate associations (VSAs) combine 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.

BCE deliberately makes the distinction between 'habitat' (a species-specific term that may encompass the whole or part of one or more VSAs and is the physical subset of an ecosystem that a given species, or species group, utilises) and 'VSA' (a general, discrete and mutually exclusive spatial division of a target area, based on soil, vegetation and topography). It is recognised, however, that, within the broader EIA literature/guidance, the former term is used more or less synonymously to indicate the latter (e.g. 'habitat assessment' used by EPA 2020). Further discussion is provided in Appendix 1 and by Bamford and Calver (2014).

For the current assessment, VSAs were identified based on the consultant's previous experience in the area and on observations made during the field investigations.

2.3 Desktop assessment of expected species

2.3.1 Sources of information

As per the recommendations of EPA (2020), information on the fauna assemblage of the project area was drawn from a range of sources including databases (as listed in Table 2) and reports from other fauna surveys in the region. Information from these sources was supplemented with species expected in the area based on general patterns of distribution. Sources of information used for these general patterns are listed in Table 3.

2.3.2 Previous fauna surveys

Alcoa's Wagerup project has had fauna monitoring surveys approximately every three years since 1995; Bamford Consulting Ecologists has undertaken these surveys since 2013 (Bamford and Chuk 2020). These indicate the local experience of the Bamford Consulting team in the region. Fauna records from almost all these investigations would have been added to naturemap, and naturemap will also contain records from other consultants who have worked in the region. Locations of sampling sites from the Bamford and Chuk (2020) study are indicated on Figure 2.

The previous studies included pitfall and funnel sampling for small vertebrates (five sites), bird censusing (nine sites), waterbird counts (seven sites) and use of motion-sensitive cameras (up to 10 site/year but variable). Cage and Elliott trap used in some years. The previous studies are part of a monitoring programme that occurs approximately every three years, with surveys in 1995, 2002, 2005, 2008, 2013/14, 2016/17 and 2020. Sample methods and effort have varied over this period, for example with motion-sensitive cameras replacing cage and Elliott traps from 2013/14. Typical sampling effort is summarised in

Table 4. Two of the trapping and land bird census sites (site 4; Knapping and Site 5; Blind Roo) are very close to the current project area, as are two of the waterbird count sites (New Bristol and Exelby).

Table 2. Databases searched for the desktop review; accessed April 2022.

| Database | Type of records held in database | Area searched |
|--|--|---|
| BCE Database | Fauna recorded by BCE in the vicinity of the project area. | 20 km buffer around the centroid of the project area (32.905° S, 115.888° E). |
| Atlas of Living Australia (ALA 2022) | Fauna records from Australian museums and conservation/research bodies, including records from BirdLife Australia's Atlas (Birdata) Database. | 20 km buffer around the centroid of the project area (32.905° S, 115.888° E). |
| NatureMap (DBCA 2022) | Records from the Western Australian Museum (WAM) and Department of Biodiversity, Conservation and Attractions (DBCA) databases, including historical data and Threatened and Priority species in WA. | 20 km buffer around the centroid of the project area (32.905° S, 115.888° E). |
| EPBC Protected Matters Search Tool (DAWE 2022) | Records on MNES protected under the EPBC Act. | 20 km buffer around the centroid of the project area (32.905° S, 115.888° E). |

Table 3. Sources of information used for general patterns of fauna distribution.

| Taxa | Sources |
|----------|---|
| Fish | Morgan <i>et al.</i> (1998), Allen <i>et al.</i> (2003), Morgan <i>et al.</i> (2014), DoF (2020). |
| Frogs | Tyler and Doughty (2009), Anstis (2017). |
| Reptiles | Storr <i>et al.</i> (1983, 1990, 1999, 2002), Bush and Maryan (2011), Wilson and Swan (2021). |
| Birds | Johnstone and Storr (1998, 2005), Menkhorst <i>et al.</i> (2017). |
| Mammals | Van Dyck and Strahan (2008), Churchill (2009), Menkhorst and Knight (2011). |

Table 4. Sampling effort in 2020 as part of Wagerup fauna monitoring project.

| Sampling method | Effort |
|--------------------------|--|
| Pitfall traps | 510 trapnights |
| Funnel traps | 220 trapnights |
| Landbird censussing | Three times at each of nine sites in May and November |
| Waterbird counts | Twice (May and November) at seven sites |
| Motion-sensitive cameras | 226 camera nights across eight sites (1334 camera-nights in 2013/2014) |

2.3.3 Nomenclature and taxonomy

As per the recommendations of the EPA (2020), the nomenclature and taxonomic order presented in this report are generally based on the Western Australian Museum's (WAM) Checklist of the Fauna of Western Australia 2020. The authorities used for each vertebrate group were: fish (Morgan *et al.* 2014), frogs (Doughty 2021a), reptiles (Doughty 2021b), birds (BirdLife Australia 2019; Gill *et al.* 2021), and mammals (Travouillon 2021). 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, and the International Ornithological Congress' 'World Bird List'). Similarly, the group name 'black-cockatoo' is consistently used for all three taxa in the South-West. English common names of species, where available, are used throughout the text; Latin names are presented with corresponding English names in tables in the appendices. The use of subspecies is limited to situations where there is an important (and relevant) geographically distinct population, or where the taxonomic distinction has direct relevance to the conservation status or listing of a taxon.

2.3.4 Interpretation of species lists

2.3.4.1 Expected occurrence

Species lists generated from the review of sources of information are generous as they include records drawn from a large region (the study area, see Figure 2) and possibly from environments not represented in the project area. Therefore, some species that were returned by one or more of the database and literature searches have been excluded because their ecology, or the environment within the project area, determine 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 the databases and not excluded on the basis of ecology or environment are therefore considered potentially present or expected to be present in the project area at least occasionally, whether or not they were recorded during field surveys, and whether or not the project area is likely to be important for them. This list of expected species is therefore subject to interpretation by assigning each a predicted status, the expected occurrence, in the project area. The status categories used are:

- **Resident:** species with a population permanently present in the project area;
- **Regular migrant or visitor:** species that occur within the project area regularly in at least moderate numbers, such as part of an annual cycle;
- **Irregular Visitor:** species that occur within the project 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 project area in at least moderate numbers and for some time;
- **Vagrant:** species that occur within the project area unpredictably, in small numbers and/or for very brief periods. Therefore, the project 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 project area.

These status categories make it possible to distinguish between vagrant species, which may be recorded at any time but for which the site is not important in a conservation sense, and species which use the 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 based on the precautionary principle. 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. It must be stressed that these status categories are predictions only and that often very intensive sampling would be required to confirm a species' status.

The results of the database searches were reviewed and interpreted, and obvious errors and out of date taxonomic names were deleted.

2.3.4.2 Conservation significance

All expected species were assessed for conservation significance as detailed in Appendix 1. Three broad levels of conservation significance are used in this report:

- Conservation Significance 1 (CS1) – species listed under State or Commonwealth Acts such as the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the *Western Australian Biodiversity Conservation Act 2016* (BC Act);
- Conservation Significance 2 (CS2) – species listed as Priority by DBCA but not listed under State or Commonwealth Acts; and
- Conservation Significance 3 (CS3) – species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution.

See Appendix 1 for an expanded discussion of these categories and Appendix 2 for a description of the categories used in the legislation (EPBC and BC Acts) and by the DBCA.

2.4 Field investigations

2.4.1 Overview

A site inspection was conducted to familiarise the consultants with the project area. This involved looking around as much of the project area as possible; including walking through areas that did not have direct vehicle access. This enabled:

- identification of VSAs (that provide habitat for fauna);
- targeted searches for significant fauna and an assessment of their likelihood of occurrence based on VSAs present;
- Setting of cameras and an Autonomous Recoding Unit (ARU) to detect bats;
- continuous recording of bird species encountered; and
- opportunistic fauna observations.

2.4.2 Dates

The project area was visited on the 30th May and 6th June 2022 by Dr Mike Bamford (B.Sc. Hons. Ph.D.).

2.4.3 Cameras and bat detector

Nine motion sensitive cameras were set across the project area from 30th May to 6th June 2022 (Figure 6; Table 5). Universal bait (peanut paste, sardines and oats with some tuna oil) was left in front of the cameras to attract fauna. The bait was placed into tubes to restrict access and prolong the period of attraction. The cameras were placed either close to a drain to target species such as the Rakali and Quenda, or in woodland to target Brushtail Possum and Brushtail Phascogale. The bat detector (an Anabat Swift) was set amongst large trees on the edge of a paddock.

Camera results were recorded as events to give a measure of the abundance of each species. An event is one or more images of an animal judged to be taken as part of one visit to the camera. For example, there might be 10 photographs taken of a Brush Wallaby taken over a period of five minutes. A separate event (i.e. visit) is considered to occur if a period of more than c. five minutes elapses before the next photograph is taken. The survey effort was 63 camera-nights and seven bat detector nights. Bat detector analysis was carried out by Brendan Metcalf

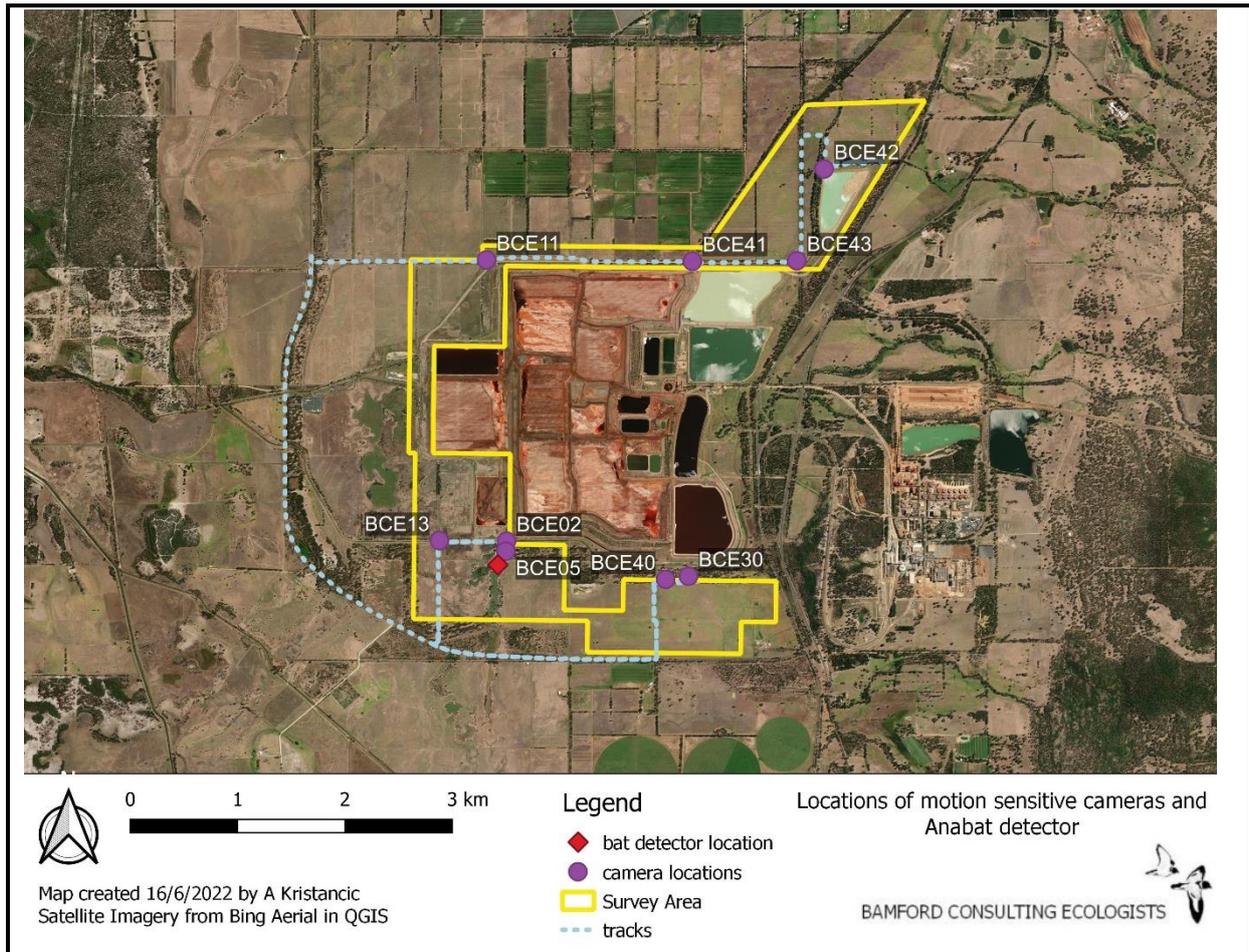


Figure 6. Locations of motion-sensitive cameras and bat detectors.

Table 5. Locations of motion-sensitive cameras and a bat detector, 30th May to 6th June 2022.

| Easting | Northing | Device code | Device type |
|----------|----------|-------------|-------------|
| 393914.5 | 6357285 | BCE13 | Camera |
| 394539.5 | 6357287 | BCE02 | Camera |
| 394533.9 | 6357193 | BCE05 | Camera |
| 394462.3 | 6357065 | Bat | ARU bat |
| 396026.9 | 6356946 | BCE40 | Camera |
| 396239.4 | 6356978 | BCE30 | Camera |
| 394326 | 6359909 | BCE11 | Camera |
| 396245.1 | 6359917 | BCE41 | Camera |
| 397218.5 | 6359931 | BCE43 | Camera |
| 397464.4 | 6360791 | BCE42 | Camera |

2.4.4 *Black-cockatoo habitat analysis*

2.4.4.1 *Guidelines*

The Commonwealth Department of Agriculture, Water and the Environment (DAWE) provides guidelines for the referral of actions that may result in impact to black-cockatoos (for assessment under the EPBC Act). The survey and analysis reported here have been conducted with strong reference to both the existing guidelines (DSEWPaC 2012) as well as the recently revised draft guidelines (DEE 2017). This includes application of the foraging habitat scoring tool in DEE (2017). In addition, survey methodology followed the recommendations listed on the DAWE's Species Profile and Threats Database (DAWE 2021c, d, e). Ecological values for black-cockatoos within the site were based on the definitions of breeding, foraging and roosting habitat as per the EPBC Act referral guidelines for black-cockatoos (DSEWPaC 2012).

The DBCA has also indicated that the methodology developed and applied previously by BCE (e.g. Bancroft and Bamford 2021), and as described below, to score nesting value and foraging habitat is an acceptable approach.

2.4.4.2 *Breeding*

The aim of the breeding surveys was to record all potential hollow-bearing trees (suitable for black-cockatoo nesting) within the project area. The entire project area (see Figure 2), was examined for the presence of these trees. The following information was recorded for every suitable tree¹ with a diameter at breast height (DBH) equal to or greater than 500 mm:

- tree location;
- tree species;
- life status;
- DBH; and
- nest-tree rank: trees were assessed (from the ground) for the potential presence/quality of nest-hollows and allocated a nesting rank (developed by BCE) as described in Table 6.

The BirdLife Australia database of black-cockatoo breeding surveys was also searched for relevant local records (see Peck 2019).

¹ the draft revised EPBC Act study guidelines (DEE 2017) stress that any tree species may provide suitable hollows. Note that trees where the DBH criterion is >300mm do not occur at Lowlands.

Table 6. Ranking system for the assessment of potential nest-trees for black-cockatoos (revised 08/01/2021).

As per DAWE (2021c, d, e) guidance, a potential nest-tree is any tree with a diameter at breast height >500 mm (or >300 mm for *Eucalyptus salmonophloia* and *E. wandoo*). Note that black-cockatoos favour vertical hollows for the nest chamber, but the hollow entrance may be vertical (a chimney hollow), have a side entrance or have a horizontal spout entrance.

| Rank | Description of tree and hollows/activity |
|------|---|
| 1 | Activity at hollow observed; adult (or immature) bird seen entering or emerging from hollow. Can also be used for a known nest tree active in the previous 12 months (although this should be noted in the description). Note that activity at a hollow does not absolutely mean that breeding is occurring unless a young bird in hollow is observed. |
| 2 | Hollow of suitable size visible with chew marks around entrance. Record if chew-marks are recent or old. |
| 3 | Potentially suitable hollow visible but no chew marks present at entrance; or potentially suitable hollow suspected to be present - as suggested by structure of tree, such as large, vertical trunk broken off at a height of >8m; but note that hollow height is contextual. Carnaby's Black-Cockatoo will nest in hollows <5m so in a Wheatbelt breeding site a lower criterion may be more appropriate. |
| 4 | Tree with large hollows or broken branches that might contain large hollows, but hollows or potential hollows (nest chamber) 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. Trees with low but otherwise suitable hollows can also be assigned a rank or 4, depending on the species of black-cockatoo likely to be present. |
| 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. |

2.4.4.3 Foraging

The foraging value of the study area was assessed by calculating a foraging score for areas of similar vegetation type/condition (see Appendix 5). The foraging score provides a numerical value that reflects the significance of vegetation as foraging habitat for black-cockatoos, and this numerical value is designed to provide the sort of information needed by DAWE, Department of Water and Environmental Regulation (DWER) and the Environmental Protection Authority (EPA) to assess impact significance and offset requirements. The foraging value of the vegetation depends upon the type, density and condition of trees and shrubs in an area, and can be influenced by the context such as the availability of foraging habitat nearby. The BCE scoring system for value of foraging habitat has three components as detailed in Appendix 5. These three components are drawn from the DAWE offset calculator but with the scoring approach developed by BCE:

- A score out of six for the vegetation composition, condition and structure.
- A score out of three for the context of the site.
- A score out of one for species density.

Foraging value can thus be assigned a score out of six, based upon site vegetation characteristics, or a score out of 10 if context and species density are also considered. A higher score represents better foraging value. A score out of 10 is presented for the purposes of aiding offset calculations. The approach to assigning scores for vegetation, context and species density are outlined in Appendix 5. Foraging value scores are calculated differently for the three black-cockatoo species (Appendix 5) depending upon the vegetation present; thus a separated score is given for each VSA for each species.

Black-cockatoo foraging signs were also recorded in conjunction with the breeding tree surveys (see Section 2.4.4.2) and general site inspections. When observed, the location, tree species and approximate age of the foraging evidence were recorded. Black-cockatoo foraging evidence may persist for some months or years after the foraging event. There is currently no published evidence documenting the deterioration process of forage. Factors that help to establish the time since foraging include: the colour of nuts/foilage, the degree of weathering or decay of debris, the presence of small fragments of nut debris, the position/compression of the foraging debris relative to surrounding vegetation and leaf litter, and the strength of the eucalypt smell emitted. Despite the absence of empirical data, four categories of foraging activity were recognised, based on the time since foraging:

- (i) Active – where birds were observed in the act of foraging;
- (ii) Recent – foraging signs (e.g. chewed nuts or vegetation) were ‘fresh’ (i.e. foraging was likely to have occurred within days to weeks). Recent foraging signs were typically green and/or with very little sign of weathering. Approximately less than four weeks old;
- (iii) Intermediate – foraging was likely to have occurred within weeks to months previously. Approximately one to six months old; and
- (iv) Old – foraging was likely to have occurred months to years previously. Approximately more than six months old.

As an indication, Appendix 6 shows examples of Forest Red-tailed Black-Cockatoo foraging signs across the range of these categories (note that it is uncertain as to the exact time frame for each stage).

2.4.4.4 *Roosting*

As the breeding and foraging surveys were conducted, areas likely to be used as roosting sites (e.g. sites adjacent to watercourses with large trees) or areas that had cockatoo activity in the late-afternoon were noted.

The BirdLife Australia Great Cocky Count (GCC) database of roost sites was also searched for relevant local records (see Peck *et al.* 2019).

2.5 Personnel

Personnel involved in the field investigations and report preparation (including desktop review) are listed in Table 7.

Table 7. Personnel involved in the field investigations and report preparation.

| Personnel | EIA Experience | Field Investigations | Report Preparation |
|--|----------------|----------------------|----------------------------|
| Dr Mike Bamford BSc (Biology), Hons (Biology), PhD (Biology) | 40 years | + | + |
| Katherine Chuk BSc (Zoology), Hons (Zoology) | 10 years | | + |
| Brendan Metcalf BSc (Biology), Hons (Biology) | 30 years | | + (bat recording analysis) |

2.6 Survey limitations

The EPA Guidance Statement 56 (EPA 2004) and the EPA (2020) outline a number of limitations that may arise during field investigations for Environmental Impact Assessment. These survey limitations are discussed in the context of the BCE investigation of the project area in Table 8. No limitations were identified.

The lack of detailed survey (i.e. intensive sampling of the fauna assemblage) is not considered a limitation as this assemblage is well-understood in the area due to multiple previous field investigations. Furthermore, EPA guidance does not consider limitations related to the effectiveness of field sampling for fauna but appears to assume that the purpose of such sampling is to confirm the fauna assemblage. This is implicit in the EPA (2020) technical guidance that does provide suggestions for sampling techniques, but the level of field investigations suggested cannot confirm the presence of an entire assemblage, or confirm the absence of a species. This requires far more work than is possible (or recommended) for studies contributing to the EIA process because fauna assemblages vary seasonally and annually, and often have high levels of variation even over short distances (Beta diversity). For example, in an intensive trapping study, How and Dell (1990) recorded in any one year only about 70% of the vertebrate species found over three years. In a study spanning over two decades, Bamford *et al.* (2010) found that the vertebrate assemblage varies over time and space, meaning that even complete sampling at a set of sites only defines the assemblage of those sites at the time of sampling. The limited effectiveness of short periods of fauna sampling is not a limitation for impact assessment *per se*, as long as database information is interpreted effectively and field investigations are targeted appropriately. That is the approach taken by BCE.

Table 8. Survey limitations as outlined by EPA (2020).

| EPA Survey Limitations | BCE Comment |
|---|---|
| Availability of data and information | Sufficient information from databases and previous studies (see Section 2.3.1). Not a limitation. |
| Competency/experience of the survey team, including experience in the bioregion surveyed | The ecologists have had extensive experience in conducting desktop reviews and reconnaissance surveys for environmental impact assessment fauna studies, and have undertaken a number of studies within the region. Not a limitation. |
| Scope of the survey (e.g. were faunal groups were excluded from the survey) | The survey focused on terrestrial vertebrate fauna and fauna values. Some information on threatened invertebrates was available from databases. Not a limitation. |
| Timing, weather and season | Timing is not of great importance for Basic level field investigations in this region. Not a limitation. |
| Disturbance that may have affected results | None. Not a limitation. |
| The proportion of fauna identified, recorded or collected | All fauna observed were identified. Not a limitation. |
| Adequacy of the survey intensity and proportion of survey achieved (e.g. the extent to which the area was surveyed) | The site was adequately surveyed to the level appropriate for a Basic level assessment. Fauna database searches covered a 20 km radius beyond the centroid of the project area. The Basic level assessment was completed. Not a limitation. |
| Access problems | There were no access problems encountered. Not a limitation. |
| Problems with data and analysis, including sampling biases | There were no data problems. Not a limitation. |

2.7 Presentation of results for Impact Assessment

While some impacts are unavoidable during a development, of concern are long-term, deleterious impacts upon biodiversity. This is reflected in documents such as the Significant Impact Guidelines provided by DSEWPaC (2012), as summarised in Appendix 4. Significant impacts may occur if:

- There is direct impact upon a VSA and the VSA is rare, a large proportion of the VSA is affected and/or the VSA supports significant fauna.
- There is direct impact upon conservation significant fauna.
- Ecological processes are altered and this affects large numbers of species or large proportions of populations, including significant species.

The impact assessment process therefore involves reviewing the fauna values identified through the desktop assessment and field investigations with respect to the project and impacting processes. The severity of impacts on the fauna assemblage and conservation significant fauna can then be quantified on the basis of predicted population change.

The presentation of this assessment follows the general approach to impact assessment as given in Section 1.1, but modified to suit the characteristics of the site. Key components to the general approach to impact assessment are addressed as follows:

Fauna values

This section presents the results of the desktop and field investigations in terms of key fauna values (described in detail in Appendix 1) and includes:

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

Impact assessment

This section reviews impacting processes (as described in detail in Appendix 3) with respect to the proposed development and examines the potential effect these impacts may have on the faunal biodiversity of the project area. It thus expands upon Section 1.1 and discusses the contribution of the project to impacting processes, and the consequences of this with respect to biodiversity. A major component of impact assessment is consideration of threats to species of conservation significance as these are a major and sensitive element of biodiversity. Therefore, the impact assessment section includes the following:

- Review of impacting processes; will the proposal result in:
 - Habitat loss leading to population decline, especially for significant species;
 - Habitat loss leading to population fragmentation, especially for significant species;
 - Weed invasion that leads to habitat degradation;
 - Ongoing mortality;
 - Species interactions that adversely affect native fauna, particularly significant species;
 - Hydrological change;
 - Altered fire regimes; or
 - Disturbance (dust, light, noise)?
- Summary of impacts upon significant species, and other fauna values.

The impact assessment concludes with recommendations for impact mitigation, based upon predicted impacts. Note that the terms direct and indirect impacts are not used in this report; for further explanation see Appendix 3.

2.7.1 Criteria for impact assessment

Impact assessment criteria are based on the severity of impacts on the fauna assemblage and conservation significant fauna, and quantified on the basis of predicted population change (Table 9). Population change can be the result of direct habitat loss and/or impacts upon ecological processes.

The significance of population change is contextual. The EPA (2016c) suggested that the availability of fauna habitats within a radius of 15 km can be used as a basis to predict low, moderate or high impacts. In this case, a high impact is where the impacted environment and its component fauna are

rare (less than 5% of the landscape within a 15 km radius or within the Bioregion), whereas a low impact is where the environment is widespread (e.g. >10% of the local landscape). Under the Ramsar Convention, a wetland that regularly supports 1% of a population of a waterbird species is considered to be significant. These provide some guidance for impact assessment criteria. In the following criteria (Table 9), the significance of impacts is based upon percentage population decline within a 15 km radius (effectively local impact) and upon the effect of the decline upon the conservation status of a recognised taxon (recognisably discrete genetic population, sub-species or species). Note that percentage declines can usually only be estimated on the basis of the distribution of a species derived from the extent of available habitat while for a few species, such as the Black-Cockatoos, there is guidance for the assessment of impact significance.

The impact assessment concludes with recommendations based upon predicted impacts and designed to mitigate these.

Table 9. Assessment criteria for impacts upon fauna.

| Impact Category | Observed Impact |
|------------------------|---|
| Negligible | Effectively no population decline; at most few individuals impacted and any decline in population size within the normal range of annual variability. |
| Minor | Population decline temporary (recovery after end of project such as through rehabilitation) or permanent, but < 1% within 15 km radius of centre-point of impact area (or within bioregion if this is smaller). No change in viability or conservation status of taxon. |
| Moderate | Permanent population decline 1-10% within 15 km radius. No change in viability or conservation status of taxon. |
| Major | Permanent population decline 10-50% within 15 km radius. No change in viability or conservation status of taxon. |
| Critical | Taxon decline > 50% (including local extinction) within 15 km and/or change in viability or conservation status of taxon. |

3 Fauna values

3.1 Vegetation and substrate associations (VSAs) ['Habitat assessment']

Vegetation and substrate associations within the project area are relatively simple due to the highly degraded nature of the landscape. From observations made during the field investigations here, four major vegetation and substrate associations (VSAs) were identified in relation to fauna in the project area:

VSA 1. Cleared (cover photograph and Figure 9). Dominated by introduced grasses and weeds with occasional shrubs or trees, generally degraded by cattle; makes up the majority of the survey area. Soils are mostly peaty-loams to sandy loams.

VSA 2. Remnant native woodland (Figure 7). Native eucalypts (Marri *Corymbia calophylla* and Flooded Gum *Eucalyptus rudis*) over a degraded understory. This is largely restricted to the north and forms narrow corridors along roads and drains, including Black Tom Brook. Soils are sandy loam to clays; Black Tom Brook is deeply incised and provides a cross-section through the surface soils, revealing some areas of sand and sandy loams over deeper red-brown loams and clayey-loams. This is typical of the eastern edge of the coastal plain where there are outwash soils from the nearby escarpment.

VSA 3. Eucalypt woodland (introduced) (Figure 8). Tree belts of non-local (eastern Australian) eucalypts over exotic grasses. The main example is in the south but there are also some examples near Black Tom Brook in the north. Soils are mostly peaty-loams to sandy loams.

VSA 4. Wetland/drainage. Wetlands, creeks and drains. Includes a permanent dam in the north (the Northern Clay Borrow Pit), the Runoff Collection Pond 1 in the west (collects runoff from the existing retention ponds), a network of creeks and drains throughout the project area, and areas of seasonally flooded pasture. A large area of seasonally flooded pasture in the west that lies mostly outside the project area is named New Bristol, a waterbird count site included in the study by Bamford and Chuk (2020). Drains are generally thickly covered with Bulrush *Typha* sp. (Figure 9), but some drains and creeks support fringing trees (Figure 10; Figure 11). Includes some small areas of paperbark *Melaleuca* sp. over weeds in paddocks; these are the remnants of original extensive seasonal wooded wetlands (Figure 12). The two dams are largely sterile bodies of water. Black Tom Brook in the north is notable as the only more or less natural waterway in the project area, but is badly degraded by cattle and deeply incised, and thus supports little fringing vegetation. Soils are mostly loams and clayey-loams.

The extent of the VSAs in the project area is mapped in Figure 13.



Figure 7. VSA 2. Remnant Eucalypt Woodland along Fawcett road near Black Tom Brook.



Figure 8. VSA 3. Tree belt of planted (eastern Australian) eucalypts on southern edge of existing residue ponds.



Figure 9. VSA 4. Drain in south of project area with paddocks (VSA 1) on the right.

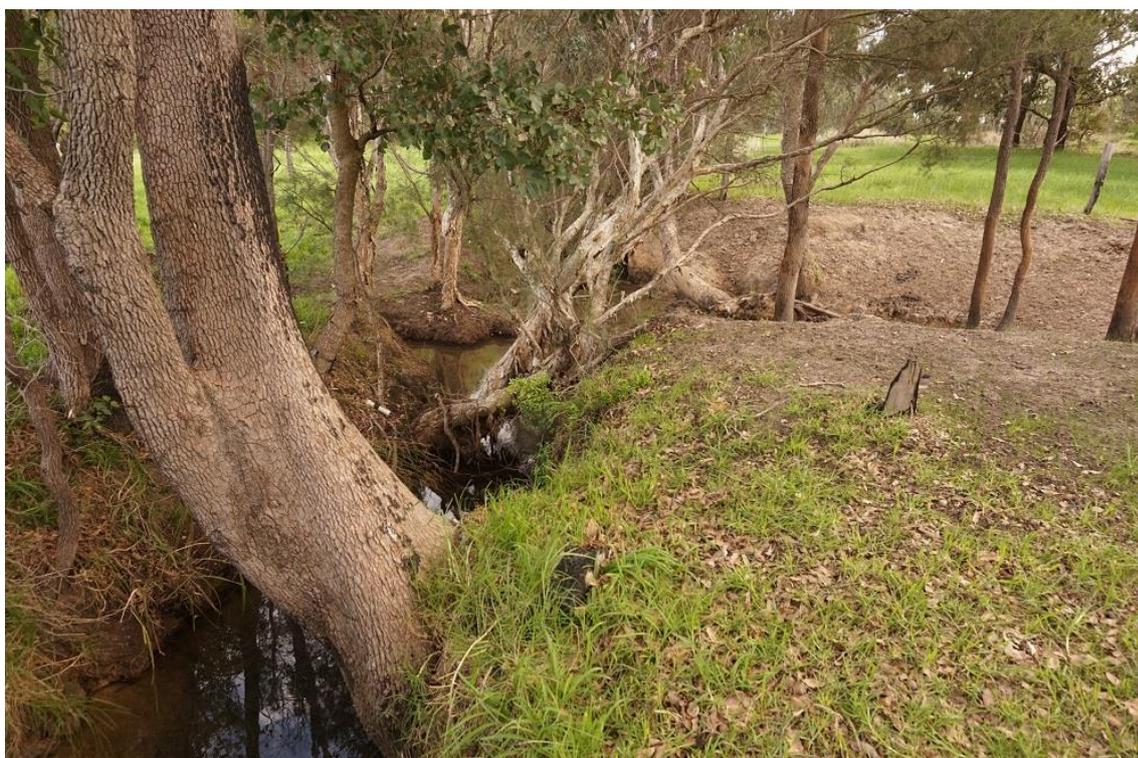


Figure 10. VSA 4. Black Tom Brook with fringing trees.



Figure 11. VSA 4. Drain in north with fringing trees and an understorey composed mostly of exotic grasses.



Figure 12. VSA 4. Paperbark thicket over grasses in seasonally flooded paddock.

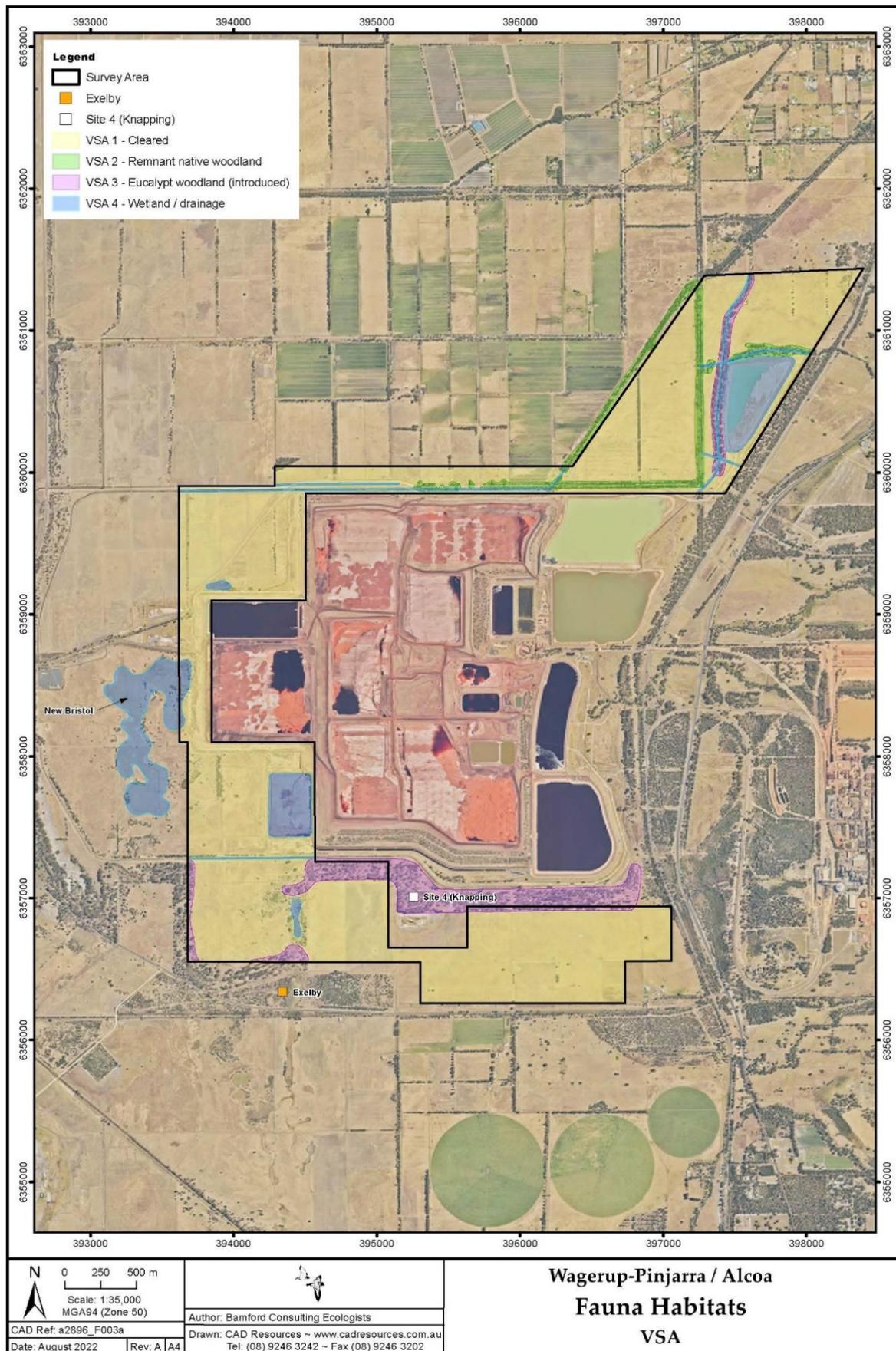


Figure 13. The distribution of VSAs in the project area.

3.1.1 *Regional development*

The project area is located within a highly fragmented natural landscape that has been largely cleared for housing, agriculture or plantations. Figure 1 illustrates the existing extent of development around the project area. Within a 15km radius of the project area, existing developments (c. 61,134 ha) impact c. 63.24% of the total land area within this buffer (c. 96,676 ha), but disproportionately affects the coastal plain compared with the escarpment; about 75% of the coastal plain is cleared. The survey site has a total area of c. 585 ha, of which at c. 564 ha has been historically cleared. Therefore, up to an additional 21 ha may be impacted. This represents 0.06% of remaining native vegetation within a 15km radius, and takes the total developments in the region to c. 63.26% of the area. Within the coastal plain, the additional clearing accounts for about 0.25% of remaining native vegetation within a 15km radius. It should be noted that the development footprint (see Section 2.1.1) of the residue storage area expansion within the project area may be less than this figure.

3.2 **Fauna assemblage**

3.2.1 *Overview of vertebrate fauna assemblage*

The desktop study identified 259 vertebrate fauna species as potentially occurring in the project area: 9 fish, 11 frogs, 33 reptiles, 179 birds and 27 mammals. These species are listed in Appendix 7. The presence of at least 37 species (two fish, one frog, 28 birds and six mammals) was confirmed during the 2022 site inspection, while larger numbers of species have been recorded in the immediate region by Bamford and Chuk (2020). (Table 10 and Appendix 7). Ninety-six species (11 fish, 4 frogs, 21 reptiles, 50 birds and 9 mammals) that were returned by the database searches and/or literature review have been omitted from the expected species list because of habitat or range limitations, or because they are considered to be locally extinct in the project area. These species are listed in

Appendix 8. The composition of the vertebrate fauna is summarised discussed below. Significant species are discussed in Section 3.2.3.

Table 10. Composition of vertebrate fauna assemblage of the project area.

The number of non-native species is shown in parentheses.

The number of species expected excludes those considered locally extinct.

| Taxon | Number of species Expected | Number of species Recorded | | Number of species in each status category | | | | |
|--------------|----------------------------|----------------------------|-----------------------|---|----------------------------|-------------------|-----------|-----------------|
| | | 2022 | Bamford and Chuk 2020 | Resident | Migrant or regular visitor | Irregular visitor | Vagrant | Locally extinct |
| Fish | 9 (4) | 2 | 2 | 2 | 1 | 6 | 0 | 1 |
| Frogs | 11 | 1 | 9 | 9 | 0 | 2 | 0 | 0 |
| Reptiles | 33 | 0 | 21 | 32 | 0 | 1 | 0 | 0 |
| Birds | 179 (5) | 28 | 124 (4) | 31 | 68 | 60 | 20 | 2 |
| Mammals | 27 (9) | 6 | 22 (9) | 9 | 15 | 1 | 2 | 7 |
| Total | 259 | 37 | 178 | 83 | 84 | 70 | 22 | 10 |

There is limited information on invertebrate fauna in the area; this fauna is discussed in Section 3.2.3.

3.2.2 Expected vertebrate fauna

Fish

Aquatic Fauna have not been considered in detail during this scope of work. It is understood that a separate Aquatic Fauna survey is being completed in the survey area. There is some suitable habitat (VSA 4) for fish within the project area. Two species may be residents, one may be a regular visitor and six species may only visit irregularly. The assemblage includes four introduced species of fish, one of which is resident. The fish will be present in drains and creeks and may occasionally disperse into flooded paddocks. During the site visit, the Mosquitofish (introduced) was observed in several drains, and the Western Minnow was present in Black Tom Brook. Both these species, but no others, have been observed previously (Bamford and Chuk 2020). The one locally extinct species, the Black-striped Minnow, may have been present in seasonal paperbark swamps in the area; it formerly occurred nearby, in the north of the Kemerton region, but that population may have died out recently (M. Bamford pers. obs. 2022).

Frogs

The eleven frog species include nine that are considered to be residents within the project area, with all of these recorded by Bamford and Chuk (2020) in previous surveys. The remaining two species are expected to be irregular visitors to the site; passing through when suitable conditions prevail and/or in very low numbers. Some of these species spend much of their life cycle away from wetlands/damplands and may occur in the woodlands, while some would be more wetland dependant and would mostly be found in VSA 4, including flooded paddocks. Only one frog species, the

Squelching Froglet, was recorded during the site inspection, but on 6th May 2022, four frog species were calling from a wetland in Waroona: Slender Tree-Frog, Clicking Frog, Western False Froglet and Lea's Frog. Bamford and Chuk (2020) have recorded six frog species at Blind Roo and Knapping, and these are the species most likely to occur in wetlands within the project area: Clicking Frog, Squelching Froglet, Moaning Frog, Banjo Frog, Slender Tree-Frog and Motorbike Frog. These are all widespread species.

Reptiles

The 33 reptile species are all considered to be residents with the exception of the Carpet Python which may occur as an irregular visitor. However, there is very limited habitat and assigning most of the reptiles a status of 'resident' is precautionary. Some of the species are also more closely allied with the forests and lateritic soils of the nearby escarpment than the sandy and loamy soils of the eastern Coastal Plain, but they could be present. Even across the multiple surveys carried out by Bamford and Chuk (2020), only 21 of the expected reptile assemblage have been recorded, while in the nearest two monitoring sites to the project area, (Blind Roo (site 5) and Knapping (site 4); Bamford and Chuk 2020) only nine reptile species have been recorded. However, comparison with the project area is not entirely legitimate, as these two sites are rehabilitated areas, whereas at least VSA2 in the project area is remnant native vegetation. It is the small area of this VSA in the north of the project area that may be richest in reptile species, with few species occurring in pasture, along fencelines and in rehabilitated areas. There are no introduced species of reptiles expected.

Birds

The bird assemblage of 179 species appears rich, but includes 80 species expected only as irregular visitors or vagrants, and just 31 species expected as residents. The long-term surveys carried out by Bamford and Chuk (2020) have confirmed only 124 species, reflecting the high proportion of irregular visitors and vagrants that are hard to detect. Many of these are waterbirds and are thus only present when wetland conditions are suitable. Flooded paddocks are particularly attractive to waterbirds, and two of the waterbird sites included in the surveys by Bamford and Chuk (2020) are close to the project area: New Bristol and Exelby (Figure 2). A summary of waterbird counts is presented in

Table 11 and demonstrates that at least occasionally, the flooded paddocks can support moderate numbers of waterbirds. This included breeding by Black Swans in some years.

There were also two monitoring sites (Bamford and Chuk 2020) close to the project area where bird censusing has been carried out: Blind Roo (site 5) and Knapping (site 4). Both sites have a seasonal wetland, areas of VSA3 (non-native trees) and Blind Roo has a small area of Marri with no understorey (VSA2). Blind Roo also had a small area of planted native shrubs. These areas regularly supported a moderately rich bird assemblage (up to 33 species on some surveys) that include honeyeaters and some of the species considered to be locally significant such as fairy-wrens and scrubwrens. These two sites demonstrate that plantings in the otherwise agricultural landscape do support birds.

Some bird observations were made in the project area during the site inspection, with 27 bird species recorded. These observations are summarised in Appendix 9. The drains are usually densely-vegetated which excludes most waterbirds, but does provide habitat for some of the more cryptic species such as Spotless Crake and Buff-banded Rail, with both recorded during the current survey, including a photograph of the latter on a drain in the north (Figure 14). This was the first record of the Buff-banded Rail in the area despite the regular surveys conducted by Bamford and Chuk (2020). The Buff-banded Rail is not rare or of conservation significance, but it is cryptic and probably not present at all times. Most other wetlands were dry, but the dam in the north supported a small number of ducks and cormorants. Almost all the remaining bird observations were of species that favour paddocks or cleared areas with scattered trees, but a party of White-browed Scrubwrens was observed in dense Bulrush along a drain near one of the cameras (BCE02).

A few bird species are probably locally extinct and many others have declined in abundance due to loss of habitat.

Table 11. Maximum waterbird counts from Exelby and New Bristol (from Bamford and Chuk 2020).

| Species | Exelby (2013/2014) | New Bristol (2016/2017) |
|-----------------------|--------------------|-------------------------|
| Chestnut Teal | | |
| Grey Teal | 41 | 42 |
| Pacific Black Duck | 61 | 56 |
| Hardhead | 25 | 200 |
| Black Swan | - | 5 |
| Pink-eared Duck | 8 | - |
| Australasian Shoveler | 1 | - |
| Australian Shelduck | - | 30 |
| Hoary-headed Grebe | 2 | 7 |
| Australasian Grebe | 2 | - |
| White-necked Heron | 1 | - |
| White-faced Heron | - | 52 |
| Australian White Ibis | - | 8 |
| Straw-necked Ibis | - | 5 |
| Little Pied Cormorant | 1 | 1 |

Mammals

The mammal assemblage is depauperate with at least seven species locally extinct (

Appendix 8), while of the 27 species expected to be present, nine are introduced. Only three of the native species are expected to be residents (Western Grey Kangaroo, Brushtail Possum and Quenda), but with a further nine expected to be regular visitors. This reflects the location close to extensive native vegetation of the escarpment, with some of the species expected as regular visitors being associated with the tall eucalypt forests of the escarpment (eg. Mardo, Chuditch, Western False Pipistrelle (Appendix 7). The Western Grey Kangaroo and Brushtail Possum were recorded during the site inspection, with the possum record of particular interest as it was of a female and large young on a camera (BCE30; see Figure 15) in a woodland on non-native eucalypts (VSA 3). Other mammals recorded on cameras were introduced species including one, the Brown Rat, that had not been recorded by Bamford and Chuk (2020). Camera results are summarised in Table 12. Three bat species were recorded on the Anabat Swift: low quality calls of Gould's Wattled Bat and one of the long-eared bats (calls of long-eared bats are often not species-specific), and a high quality call of the Southern Forest Bat; this last at 9pm on 2nd June 2022. Calls recorded several hours after sunset are indicative of individuals passing through rather than there being a nearby roost, while the low number of recording events suggests low abundance of bats.

Surveys by Bamford and Chuk (2020) have confirmed a number of mammal species of interest. At Blind Roo (site 5), the Brushtail Possum, Brushtail Phascogale and Quenda appear to be resident, indicating that all three have the potential to occur in VSAs 2 and 3 in the project area (with the Brushtail Possum confirmed). The Brushtail Phascogale and Quenda are of conservation significance and are discussed further below. The Rakali (Water-Rat) has been recorded consistently along a large drainage line to the west (Haub; see Figure 2), and is therefore considered likely to occur at least occasionally along drains throughout the area.



Figure 14. Buff-banded Rail on camera BCE11, along a drain in the north of the project area.**Figure 15. Adult and juvenile Brushtail Possum on camera BCE30 in tree belt on non-local eucalypts (VSA 3) in south of project area.****Table 12. Number of events on each camera. 30/05 to 4/06 22. Five nights. No photos of animals on BCE05, BCE40 or BCE43.**

| Species | Camera code | | | | | | | | |
|------------------------|-------------|-------|-------|-------|---------------|-------|-------|-------|-------|
| | BCE13 | BCE02 | BCE05 | BCE40 | BCE30 | BCE11 | BCE41 | BCE42 | BCE43 |
| Common Bronzewing | | | | | | | 1 | | |
| White-faced Heron | 1 | | | | | | 5 | | |
| Buff-banded Rail | | | | | | 2 | | | |
| White-browed Scrubwren | | 1 | | | | | | | |
| Willie Wagtail | | 1 | | | | 1 | | | |
| Magpie-lark | | | | | | 2 | | | |
| Grey Kangaroo | 1 | | | | 1 | | | | |
| Brushtail Possum | | | | | 1 (F + 1 yng) | | | | |
| Black Rat | | | | | 4 | | 8 | 3 | |
| Brown Rat | | | | | | | 4 | | |
| House Mouse | 1 | 12 | | | | | 1 | | |

| | | | | | | | | | |
|-----|--|--|--|--|--|--|--|----|--|
| Cow | | | | | | | | 20 | |
|-----|--|--|--|--|--|--|--|----|--|

Overview of vertebrate fauna assemblage

The vertebrate fauna assemblage occurs in a highly modified landscape with broad scale loss of forests and woodlands, replaced by extensive grasslands. Key features of the fauna assemblage expected in the project area are:

- **Uniqueness:** The fauna assemblage is probably typical of the southern coastal plain but potentially has some elements of fauna from the adjacent escarpment. A major component of the assemblage is species favoured by farmland and seasonal flooded paddocks. This is in particular a feature of the bird assemblage. This assemblage is well-represented in the region.
- **Completeness:** The assemblage is likely to be substantially incomplete; while only a few species are confidently predicted to be locally extinct, it is likely that many more species of the original assemblage have either gone or declined to the status of vagrants/irregular visitors. This is related to broad scale habitat loss.
- **Richness:** The assemblage is likely to be moderately poor, with some species loss and a high level of species decline in abundance. There is a lack of the large areas of contiguous native vegetation needed to maintain species richness, but records of a few species such as the Brushtail Phascogale suggest that there is enough such habitat left, or being created, to maintain at least low numbers of some species that might otherwise have disappeared.

3.2.3 *Invertebrate fauna of conservation significance*

There are no records of threatened invertebrate fauna within the project area. Three species have been recorded from within the regional (20 km) buffer:

- Neopasiphae simplicior* (a short-tongued native bee; Critically Endangered (EPBC) and Schedule 2 (Endangered – WABC) Known from only a few locations in ‘shrublands on claypans’ from Forrestdale, Armadale and Cannington (ALA 2021). Two records of this species were made near Wheeler Airstrip in the Shire of Waroona in 2010. Due to the absence of shrublands on claypans and the degraded understorey in the survey area it is unlikely that this species is present.
- Idiosoma sigillatum* (Swan Coastal Plain Shield-backed Trapdoor Spider; Priority 3). There are two records of this species within 20 km of the project area. Rix *et al.* (2017) noted that this species has a “relatively widespread although strictly ... substrate-specific distribution along the Swan Coastal Plain of south-western Western Australia, from Dalyellup north to at least Ledge Point (including Rottneest Island and Garden Island)”. While much of its previous range has been developed (as part of the greater Perth Metropolitan area) it persists in areas of remnant bushland with “Banksia woodland and heathland on sandy soils”. There is no Banksia Woodland in the project area and the soils are alluvial loams, reflecting its position in the east on the Coastal Plain. It is therefore very unlikely that the Swan Coastal Plain Shield-backed Trapdoor Spider is present.
- Westralunio carteri* (Carter’s Freshwater Mussel; Vulnerable (EPBC) and Schedule 3 (Vulnerable – WABC). This species has been recorded within 20 km of the project area and is present in permanent and near-permanent freshwater stream in the region, particularly along the Darling Escarpment. It favours slow flowing water courses with soft sediment for

burrowing. Black Tom Brook may provide suitable habitat and thus this species may be present in the project area. The Brook was checked for the species, as were some of the drains where there was clear, open water, but it was not seen. It can be readily detected by trails in soft sediment and by shells discarded by predators. It therefore seems unlikely the species is present, although the larvae are mobile and their vector (freshwater fish) are present. As a result, the mussel may occasionally colonise Black Tom Brook if the species occurs upstream.

Therefore, of the three species recorded in the desktop search, Carter's Freshwater Mussel is the only one that might be present in the survey area, although this seems unlikely. The aquatic survey may provide more insight into the status of this species in the survey area.

It should be noted that the ecology and distribution of short-range endemic invertebrates is often poorly understood or documented, and the project area occurs in a region that is likely to be poorly-surveyed for these groups. Thus there may be undetected SRE species present, although given the degraded nature of almost all the project area, it seems unlikely any would be abundant. The aquatic survey may provide additional information on SRE invertebrates.

3.2.4 Vertebrate fauna of conservation significance

Of the 259 species of vertebrate fauna that are expected to occur in the project area (Section 3.2.1 above), 63 are considered to be of conservation significance (23 CS1, 11 CS2 and 30 CS3; see Appendix 1 for descriptions of these CS (conservation significance) levels). A summary of the numbers in each vertebrate class is presented in

Table 13. Nearly half the species are of local significant (ie no formal listing) which reflects the importance of otherwise common species that persist in degraded landscapes. Species of conservation significance are indicated in the complete species list (Appendix 7) but are also listed with details of their conservation significance in

Table 14. Only eight of the conservation significant species are expected to be residents, and seven of these have been recorded by Bamford and Chuk (2020). Similarly, of the 18 species expected as regular visitors, 17 have been recorded. The remaining species are either irregular visitors (26; 9 recorded) or vagrants (11; none recorded). Information on the conservation status, distribution and habitat, salient ecology and expected occurrence within the project area is provided for species (in some cases groups of species) considered to be at least irregular visitors below in Section 3.2.5 (and, for invertebrates, in Section 3.2.3 above). Vagrants are not discussed on the basis that they are very unlikely to occur and, if they did, their presence would not be significant for the species.

Significant species of most interest in the project area, being species that are present or very likely to be present regularly, and that rely on habitats in the project area to persist, are the birds listed as CS3, and the Quenda and Brush-tailed Phascogale. Three black-cockatoo taxa are present but habitat for them is very limited. There is a possibility that the Peregrine Falcon breeds in the project area.

Table 13. The number of conservation significant species in each vertebrate class.

See Appendix 1 for full explanation of Conservation Significance (CS) levels: CS1 = listed under WA State and/or Commonwealth legislation; CS2 = listed as Priority by DBCA; CS3 = considered locally significant.

| CLASS | CONSERVATION SIGNIFICANCE | | | |
|--------------|---------------------------|-----------|-----------|-----------|
| | CS1 | CS2 | CS3 | Total |
| Fish | 0 | 1 | 0 | 0 |
| Frogs | 0 | 0 | 0 | 0 |
| Reptiles | 0 | 1 | 1 | 2 |
| Birds | 21 | 5 | 29 | 55 |
| Mammals | 2 | 4 | 0 | 6 |
| Total | 23 | 12 | 30 | 63 |

Table 14. Conservation significant fauna species expected to occur within the project area.

Species are listed in taxonomic order.

CS1, CS2, CS3 = (summary) levels of conservation significance. See Appendix 1 for full explanation.

EPBC Act listings: C = Critically Endangered, E = Endangered, V = Vulnerable, M = Migratory (see Appendix 2).

WA Biodiversity Conservation Act 2016 (BC Act) listings: S1 to S7 = Schedules 1 to 7 (see Appendix 2).

DBCA Priority species: P1 to P4 = Priority 1 to 4 (see Appendix 2).

Bush Forever (Dell and Banyard 2000) status: HS = habitat specialists with a reduced distribution on the Swan Coastal Plain, WR = wide ranging species with reduced populations on the Swan Coastal Plain.

LS = considered by BCE to be of local significance (see Appendix 1).

Species recorded by Bamford and Chuk (2020) and/or the current survey are indicated in bold.

| SPECIES | | STATUS | EXPECTED OCCURRENCE |
|----------------------------------|-------------------------------------|------------------|--------------------------|
| Pouched Lamprey | <i>Geotria australis</i> | CS2 (P3) | Irregular visitor |
| Coastal Plains Skink | <i>Ctenotus ora</i> | CS2 (P3) | Resident |
| Carpet Python (southwest) | <i>Morelia spilota imbricata</i> | CS3 (LS) | Irregular visitor |
| Australasian Bittern | <i>Botaurus poiciloptilus</i> | CS1 (E,S2) | Vagrant |
| Carnaby's Black-Cockatoo | <i>Calyptorhynchus latirostris</i> | CS1 (E,S2) | Regular visitor |
| Baudin's Black-Cockatoo | <i>Calyptorhynchus baudinii</i> | CS1 (V,S2) | Regular visitor |
| Forest Red-tailed Black-Cockatoo | <i>Calyptorhynchus banksii naso</i> | CS1 (V,S2) | Regular visitor |
| Pacific Golden Plover | <i>Pluvialis fulva</i> | CS1 (M,S5) | Irregular visitor |
| Australian Painted-snipe | <i>Rostratula australis</i> | CS1 (E,,S2) | Vagrant |
| Curlew Sandpiper | <i>Calidris ferruginea</i> | CS1 (C,M, S3,S5) | Irregular visitor |
| Common Sandpiper | <i>Actitis hypoleucos</i> | CS1 (M,S5) | Irregular visitor |

| SPECIES | | STATUS | EXPECTED OCCURRENCE |
|-------------------------|----------------------------------|-------------|--------------------------|
| Sharp-tailed Sandpiper | <i>Calidris acuminata</i> | CS1 (M, S5) | Irregular visitor |
| Pectoral Sandpiper | <i>Calidris melanotos</i> | CS1 (M,S5) | Vagrant |
| Red-necked Stint | <i>Calidris ruficollis</i> | CS1 (M, S5) | Irregular visitor |
| Long-toed Stint | <i>Calidris subminuta</i> | CS1 (M,S5) | Vagrant |
| Bar-tailed Godwit | <i>Limosa lapponica</i> | CS1 (M,S5) | Vagrant |
| Black-tailed Godwit | <i>Limosa limosa</i> | CS1 (M,S5) | Vagrant |
| Wood Sandpiper | <i>Tringa glareola</i> | CS1 (M,S5) | Irregular visitor |
| Common Greenshank | <i>Tringa nebularia</i> | CS1 (M,S5) | Irregular visitor |
| Marsh Sandpiper | <i>Tringa stagnatilis</i> | CS1 (M,S5) | Irregular visitor |
| Fork-tailed Swift | <i>Apus pacificus</i> | CS1 (M,S5) | Irregular visitor |
| Glossy Ibis | <i>Plegadis falcinellus</i> | CS1 (M,S5) | Vagrant |
| Eastern Osprey | <i>Pandion cristatus</i> | CS1 (M,S5) | Irregular visitor |
| Peregrine Falcon | <i>Falco peregrinus</i> | CS1 (S7) | Resident |
| Hooded Plover | <i>Thinornis cucullatus</i> | CS2 (P4) | Irregular visitor |
| Black Bittern | <i>Ixobrychus flavicollis</i> | CS2 (P2) | Irregular visitor |
| Masked Owl | <i>Tyto novaehollandiae</i> | CS2 (P3) | Vagrant |
| Blue-billed Duck | <i>Oxyura australis</i> | CS2 (P4) | Irregular visitor |
| Letter-winged Kite | <i>Elanus scriptus</i> | CS2 (P4) | Vagrant |
| Common Bronzewing | <i>Phaps chalcoptera</i> | CS3 (HS) | Resident |
| Brush Bronzewing | <i>Phaps elegans</i> | CS3 (HS) | Irregular visitor |
| Red-winged Fairy-wren | <i>Malurus elegans</i> | CS3 (HS) | Regular visitor |
| Splendid Fairy-wren | <i>Malurus splendens</i> | CS3 (HS) | Resident |
| Southern Emu-wren | <i>Stipiturus malachurus</i> | CS3 (HS) | Irregular visitor |
| Inland Thornbill | <i>Acanthiza apicalis</i> | CS3 (HS) | Resident |
| Yellow-rumped Thornbill | <i>Acanthiza chrysorrhoa</i> | CS3 (HS) | Resident |
| Western Thornbill | <i>Acanthiza inornata</i> | CS3 (HS) | Irregular visitor |
| White-browed Scrubwren | <i>Sericornis frontalis</i> | CS3 (HS) | Resident |
| Weebill | <i>Smicronis brevirostris</i> | CS3 (HS) | Resident |
| Varied Sittella | <i>Daphoenositta chrysoptera</i> | CS3 (HS) | Irregular visitor |
| Grey Shrike-thrush | <i>Colluricincla harmonica</i> | CS3 (HS) | Irregular visitor |
| Scarlet Robin | <i>Petroica boodang</i> | CS3 (HS) | Regular visitor |

| SPECIES | | STATUS | EXPECTED OCCURRENCE |
|---------------------------|-------------------------------------|------------|--------------------------|
| White-breasted Robin | <i>Quoyornis georgianus</i> | CS3 (HS) | Irregular visitor |
| Emu | <i>Dromaius novaehollandiae</i> | CS3 (WR) | Irregular visitor |
| Painted Button-quail | <i>Turnix varius</i> | CS3 (WR) | Regular visitor |
| Collared Sparrowhawk | <i>Accipiter cirrocephalus</i> | CS3 (WR) | Regular visitor |
| Brown Goshawk | <i>Accipiter fasciatus</i> | CS3 (WR) | Regular visitor |
| Wedge-tailed Eagle | <i>Aquila audax</i> | CS3 (WR) | Regular visitor |
| Whistling Kite | <i>Haliastur sphenurus</i> | CS3 (WR) | Regular visitor |
| Little Eagle | <i>Hieraaetus morphnoides</i> | CS3 (WR) | Regular visitor |
| Square-tailed Kite | <i>Lophoictinia isura</i> | CS3 (WR) | Regular visitor |
| Western Wattlebird | <i>Anthochaera lunulata</i> | CS3 (WR) | Regular visitor |
| Tawny-crowned Honeyeater | <i>Glyciphila melanops</i> | CS3 (WR) | Irregular visitor |
| Yellow-throated Miner | <i>Manorina flavigula</i> | CS3 (WR) | Irregular visitor |
| White-cheeked Honeyeater | <i>Phylidonyris niger</i> | CS3 (WR) | Regular visitor |
| New Holland Honeyeater | <i>Phylidonyris novaehollandiae</i> | CS3 (WR) | Regular visitor |
| Dusky Woodswallow | <i>Artamus cyanopterus</i> | CS3 (WR) | Regular visitor |
| Grey Currawong | <i>Strepera versicolor</i> | CS3 (WR) | Irregular visitor |
| Brush-tailed Phascogale | <i>Phascogale tapoatafa</i> | CS1 (S6) | Regular visitor |
| Chuditch | <i>Dasyurus geoffroii</i> | CS1 (V,S3) | Vagrant |
| Quenda | <i>Isodon fusciventer</i> | CS2 (P4) | Resident |
| Brush Wallaby | <i>Notamacropus irma</i> | CS2 (P4) | Irregular visitor |
| Water-rat, Rakali | <i>Hydromys chrysogaster</i> | CS2 (P4) | Regular visitor |
| Western False Pipistrelle | <i>Falsistrellus mackenziei</i> | CS2(P4) | Vagrant |

3.2.5 Conservation significant species accounts

3.2.5.1 Conservation Significance 1

Fork-tailed Swift (*Apus pacificus*)

CS1 (M,S5)

| | |
|---------------------------|--|
| Conservation status: | Migratory under the EPBC Act and Schedule 5 under the BC Act. |
| Distribution and habitat: | The swift is a largely aerial species of unpredictable occurrence in Western Australia. There are scattered records from the south coast, widespread in coastal and subcoastal areas between Augusta and Carnarvon, scattered along the coast from south-west Pilbara to the north and east Kimberley region. Sparsely scattered inland records, especially in the Wheatbelt, but more common in the north and north-west Gascoyne Region, north through much of the Pilbara Region, and the south and east Kimberley (Higgins 1999; DAWE 2022). Aerial, usually flying from as low as one metre to in excess of 300 m above the ground. |
| Ecology: | A diurnal, aerial insectivore, this species often forages along the edge of low pressure systems in flocks of ten to 1000 birds (Higgins 1999; DAWE 2021a). Breeds in Siberia (April to July) and spends the non-breeding season (October to mid-April) in Australia. Being aerial, it is effectively independent of terrestrial ecosystems when in Australia. |
| Expected occurrence: | Irregular visitor. Likely to occur unpredictably within the region and to pass over the project area on an occasional basis. Not recorded. |

Peregrine Falcon (*Falco peregrinus*)

CS1 (S7)

| | |
|---------------------------|--|
| Conservation status: | Schedule 7 under the BC Act. |
| Distribution and habitat: | More or less cosmopolitan throughout Australia (Menkhorst <i>et al.</i> 2017). This species occurs in a variety of habitats but is usually reliant on cliff faces or tall trees for nesting; in tall trees it will occupy the nests of other birds of prey, and of corvids (Debus 2019). |
| Ecology: | A highly adept aerial predator that predominantly forages on birds, although will also occasionally take invertebrates, fish, reptiles and mammals (Debus 2019). Mostly diurnal or crepuscular. |

Expected occurrence: Resident. A pair was observed on several occasions in 2016 (bear BCE02; see Figure 6), and a single bird was seen in the north of the project area (near BCE11; see Figure 6) on 30th May 2022. It was perched in a large tree. It is possible these observations represent a resident pair which may breed in the general area. They could nest anywhere, but most likely in a very tall tree, and most likely by taking over the nest of another species. Where the bird was observed in May 2022, there was a pair of Black-shouldered Kites nest-building.

Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*)

CS1 (V,S3)

Conservation status: Vulnerable under the EBPC Act and Schedule 3 under the BC Act.

Distribution and habitat: Endemic to the deeper south-west of Western Australia, from around Gingin in the north, east to Mount Helena, North Bannister and Mount Saddleback, and south to around Albany (Johnstone and Storr 1998). 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. Generally restricted to areas of Jarrah-Marri forest, farmlands with remnant trees and urban landscapes. Forest Red-tailed Black-Cockatoos are currently considered not to undergo regular migration (DAWE 2021c). Two other sub-species occur in Western Australia: *C. b. escondidus* in the western mid-west and Pilbara, and *C. b. macrorhynchus* in the Kimberley (Johnstone and Storr 1998). Neither of these is a conservation significant taxon.

Ecology: Diurnal granivore, feeding predominantly on the seeds of Jarrah and Marri (Johnstone and Kirkby 1999; Johnstone *et al.* 2013b) but is also adapting to foraging on urban (introduced) plant species. Reliant on large tree-hollows in eucalypts (especially Marri) for breeding (Johnstone *et al.* 2013a; DAWE 2021c). Threatened by habitat loss, habitat degradation, nest hollow shortage, and competition for available nest hollows from other parrots and feral Honeybees (DAWE 2021c).

Expected occurrence: Regular visitor. The project area supports little suitable foraging or breeding habitat but this species is regularly seen in the local area, with pairs and small flocks around the Wagerup refinery and in nearby paddock trees on most visits to the general area. Foraging and nesting habitat for black-cockatoos is discussed below (section 3.3).

Baudin's Black-Cockatoo (*Calyptorhynchus baudinii*)

CS1 (V,S2)

- Conservation status: Vulnerable under the EBPC Act and Schedule 2 under the BC Act.
- Distribution and habitat: Endemic to the south-west of Western Australia, from around Perth to around Albany. 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. Generally restricted to areas of Jarrah-Marri forest and farmlands with remnant trees or pine plantations.
- Ecology: Diurnal granivore, feeding predominantly on the seeds of Jarrah and Marri (Johnstone and Kirkby 1999; Johnstone *et al.* 2013b) but is also adapting to foraging on urban (introduced) plant species. Reliant on large tree-hollows in eucalypts (especially Marri) for breeding (Johnstone *et al.* 2013a; DAWE 2021c). Threatened by habitat loss, habitat degradation, nest hollow shortage, and competition for available nest hollows from other parrots and feral Honeybees (DAWE 2021c).
- Expected occurrence: Regular visitor. The project area supports little suitable foraging or breeding habitat but this species is regularly seen in the local area. For example a flock of about 20 birds was feeding almost daily in a grove of Marri trees near Hamel in 2020. Foraging and nesting habitat for black-cockatoos is discussed below (Section 3.3).

Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*)

CS1 (E,S2)

- Conservation status: Endangered under the EPBC Act and Schedule 2 under the BC Act.
- Distribution and habitat: Endemic to south-western Western Australia, from Kalbarri in the north, east to Merredin and Ravensthorpe, and then further east along the south coast to the Esperance area (Johnstone and Storr 1998; DAWE 2021e). Breeds (July to December) predominantly in the east of its range with a migration to coastal areas in the non-breeding period. In recent years, however, the species has expanded its breeding range westward and south into the Jarrah-Marri forests of the Darling Scarp and into the Tuart forests of the Swan Coastal Plain (DAWE 2021e). Heavily reliant on areas of Banksia woodland and proteaceous shrubland/heath for foraging (Johnstone and Storr 1998; DAWE 2021e).

Ecology: Diurnal granivore, feeding predominantly on the seeds of the Proteaceae (especially banksias) but also known to feed on a very wide variety of plants, including non-native ornamentals and plantation species such as pine (Valentine and Stock 2008; Groom 2011; DPaW 2013; Johnston *et al.* 2016; DAWE 2021e). Reliant on large tree-hollows in eucalypts (especially smooth-barked species such as Wandoo and Salmon Gum) for breeding (Saunders 1974; Johnstone and Storr 1998; DAWE 2021e). Threatened by habitat loss, habitat degradation, nest hollow shortage, and competition for available nest hollows from other parrots and feral Honeybees, illegal shooting and illegal trade (Burbidge 2004; DAWE 2021e).

Expected occurrence: Regular visitor. Known to occur within the local area and seen more often to the west (around Buller Nature Reserve) than closer to the escarpment. Foraging and nesting values of the project area for the species are assessed in section 0.

Chuditch (*Dasyurus geoffroii*)

CS1 (V,S3)

Conservation status: Vulnerable under the EBPC Act and Schedule 3 under the BC Act.

Distribution and habitat: The Chuditch is a wide-ranging resident in Marri-Jarrah forest of the south-west of Western Australia and also in heaths and eucalypt woodlands of the eastern wheatbelt and goldfields (Van Dyck and Strahan 2008). This species was formerly distributed throughout much of western and inland Australia but its range has contracted to the region approximately south-west of a line between Shark Bay and Esperance (Burbidge 2004; Van Dyck and Strahan 2008; DAWE 2021f).

Ecology: The Chuditch is a nocturnal, terrestrial carnivore, feeding mainly on smaller vertebrates (e.g. reptiles, birds and mammals) and large invertebrates (Burbidge 2004; Van Dyck and Strahan 2008). During the day Chuditch shelter in dens; predominantly hollow logs and earth burrows (Van Dyck and Strahan 2008). Chuditch have a large home range, with females in the deeper south-west occupying 55-120 ha and males ranging over 400 ha or more (Van Dyck and Strahan 2008). Further east, Rayner *et al.* (2012) found that Chuditch in the Forrestania area occurred at an average density of 0.039 individuals/km², with home ranges as small as 189 ha (a female) and as large as 2,125 ha (a male).

Expected occurrence: Vagrant. Present in the nearby forests of the escarpment and rerecorded in the period 1995-2008 (Bamford and Chuk 2020), but there is limited habitat in the project area.

Eastern Osprey (*Pandion cristatus*)

CS1 (M, S5)

- Conservation status: Migratory under the EPBC Act and Schedule 5 under the BC Act.
- Distribution and habitat: Found in coastal areas throughout mainland Australia, ventures inland in northern Australia. Found in coastal, wetland and riverine habitats.
- Ecology: Hunts for fish by diving into the water feet-first.
- Expected occurrence: Irregular visitor. Likely to pass over the project area on an occasional basis, however the wetlands are generally too seasonal, shallow and lack large fish to provide regular hunting habitat.

Migratory waders (18 species; see Table 10)

CS1 (M, S5)

- Conservation status: Migratory under the EPBC Act and Schedule 5 under the BC Act.
- Distribution and habitat: Widespread particularly in coastal areas, arrive in spring and early summer and migrate north in autumn.
- Ecology: Forages in shallow water and still pools.
- Expected occurrence: Irregular visitors and vagrant. Likely to be regular migrants within the broader region but to visit wetlands within the survey area on only an occasional basis in small numbers. A few individuals of the Common Sandpiper, Red-necked Stint and Marsh Sandpiper have been recorded (Bamford and Chuk 2020).

Brush-tailed Phascogale (*Phascogale tapoatafa wambenger*)

CS1 (S6)

- Conservation status: Schedule 6 under the BC Act.
- Distribution and habitat: The Brush-tailed Phascogale is a wide-ranging but low density resident in sclerophyll forests of the south-west of Western Australia.
- Ecology: The Brush-tailed Phascogale is a nocturnal, arboreal carnivore, feeding mainly on smaller vertebrates (e.g. reptiles, birds and mammals) and large invertebrates.
- Expected occurrence: Regular visitor. The Brush-tailed Phascogale has been recorded regularly by Bamford and Chuk (2020) at Blind Roo (site 5) as part of the fauna monitoring programme. This lies less than 1km west of the project area, and the animals are recorded in a small patch of VSA2 and VSA3. This makes it very likely that individuals will at least move through the project area in suitable habitat on a fairly regular basis. The most likely areas would be the tree belt (VSA3) on the southern edge of the existing residue ponds, and the remnant Marri Woodland (VSA 2) in the north.

3.2.5.2 Conservation Significance 2

Pouched Lamprey (*Geotria australis*) **CS2 (P3)**

Conservation status: Listed as Priority 3 by DBCA. Adversely affected by declining water quality, declining rainfall and barriers across drainage systems.

Distribution and habitat: Occurs in south-eastern and south-western Australia, but the south-western population is confined to rivers and creeks from south of Perth to around Albany, and is declining (Morgan *et al.* 1998). Observed in the Brunswick River system (M. Bamford pers. obs).

Ecology: Adult lampreys are marine but enter rivers and swim upstream to breed. The larvae live in sediment and filter-feed until they metamorphose into a juvenile that then swims downstream to enter the ocean.

Expected occurrence: Irregular visitor. The network of drains links to the Harvey River system which is highly likely to support the species. Therefore, dispersing adults and juveniles may occasionally move through the project area. Further information on this species may become available upon completion of the aquatic fauna survey.

Coastal Plains skink (*Ctenotus ora*) **CS2 (P3)**

Conservation status: Listed as Priority 3 by DBCA.

Distribution and habitat: Restricted to coastal sandplains from near Dunsborough to Mandurah.

Ecology: Preys upon invertebrates in loose sandy habitats of Banksia Woodland (Wilson and Swan 2021). Also found amongst dense sedges in sandy soil on the margins of the Peel Inlet (M. Bamford pers. obs.).

Expected occurrence: Resident (if present). This is not a well-known species and has been included as resident on a pre-cautionary basis. It has not been recorded and there is effectively no sand in the project area (but there are sandy soils nearby). If present, it would be likely only in the Remnant Marri Woodland (VSA 2) along the road reserve in the north of the project area.

Blue-billed Duck (*Oxyura australis*)

CS2 (P4)

- Conservation status: Listed as Priority 4 by DBCA.
- Distribution and habitat: The western population is found in wetlands across the south-west and wheatbelt.
- Ecology: Prefers deep freshwater wetlands; feeds on aquatic invertebrates and vegetation.
- Expected occurrence: Irregular visitor. There is limited deep water in the project area, but individuals could occasionally visit the dam in the north.

Quenda (*Isoodon fusciventer*)

CS2 (P4)

- Conservation status: Listed as Priority 4 by DBCA.
- Distribution and habitat: The Quenda formerly occurred across the south-west of Western Australia from Geraldton to east of Esperance, including the wheatbelt, but it now has a much-reduced range, with few records north of Yanchep/Muchea on the coastal plain, and it is more or less extinct across the Wheatbelt (Van Dyck and Strahan 2008; Travouillon and Phillips 2018). It persists around Perth, particularly in areas of dense vegetation around wetlands, and it remains locally common in suitable environments (Howard *et al.* 2014).
- Ecology: Omnivorous and cathemeral (active throughout the day and night), Quenda feed on invertebrates, plant material and fungi (Van Dyck and Strahan 2008). It is one of the few native, terrestrial mammals to persist in semi-urban landscapes in the south-west. Populations of this species have declined due to ongoing threats from feral predators and land-clearing (Van Dyck and Strahan 2008; Howard *et al.* 2014).
- Expected occurrence: Resident. The Quenda has been recorded regularly by Bamford and Chuk (2020) at Blind Roo (site 5) as part of the fauna monitoring programme, and a roadkill was recorded near Exelby in 2017. These locations lie <1km west and south of the project area (Figure 2). This makes it very likely that individuals will at least move through the project area in suitable habitat on a fairly regular basis, and it is likely that some are resident along drains and where thick, low vegetation is present.

Brush Wallaby (*Notamacropus irma*)

CS2 (P4)

- Conservation status: Listed as Priority 4 by DBCA.
- Distribution and habitat: Endemic to the South-West more or less south of line from Geraldton to Esperance, although it has disappeared from much of the Wheatbelt due to clearing. Occurs in a wide range of vegetation types from Eucalypt Woodland to Banksia Woodland, Shrublands and Kwongan.
- Ecology: Based on detailed radio-tracking study in Banksia Woodland in Whiteman Park (Bamford and Bamford 1999), a largely solitary species that browses on shrubs and bushes; rarely on grass. Rarely drinks free-standing water and rarely ventures from dense vegetation. Individuals occupy home ranges of up to c. 10ha; larger in males than females and those of females overlap.
- Expected occurrence: Irregular visitor. Unlikely to reside in the project area with the nearest records in Buller Nature Reserve to the west (Site 6; see Figure 2), and in forests of the escarpment to the east. However, individuals may disperse through the project area occasionally, most likely from the east as forests and woodland are nearby.

Rakali or Water Rat (*Hydromys chrysogaster*)

CS2 (P4)

- Conservation status: Listed as Priority 4 by DBCA.
- Distribution and habitat: The Rakali occurs across most of eastern Australia, along the north coast and in the south-west. It is generally found in coastal, wetland or riverine habitats.
- Ecology: The Rakali feeds on fish, invertebrates and small vertebrates. They are most active at dusk.
- Expected occurrence: Regular visitor. The Rakali has been regularly recorded to the west (site Haub; see Figure 2), with an old record (before 2008; Bamford and Chuk 2020) from a drain near Somers. It is therefore likely to occur regularly along the network of drains through and around the project area. Black Tom Brook in the north appeared very suitable, with overhung banks and stream-side trees.

3.2.5.3 Conservation Significance 3

Carpet Python (southwest) (*Morelia spilota imbricata*)

CS3 (LS)

| | |
|---------------------------|--|
| Conservation status: | This subspecies was formerly listed under the Western Australian <i>Wildlife Conservation Act 1950</i> as 'other specially protected fauna' but that status has, more recently, been removed in the <i>WA Biodiversity Conservation Act 2016</i> (DBCA 2021g). It is likely to remain uncommon or at risk in the proximity of development. |
| Distribution and habitat: | Patchily distributed through south-west Western Australia in a wide range of habitats including woodlands, heaths and rock outcrops (Bush <i>et al.</i> 2010; Wilson and Swan 2021). It is particularly common in areas of exposed limestone in the west of the Coastal Plain, including offshore islands (Bush <i>et al.</i> 2010). |
| Ecology: | Predominantly a nocturnal carnivore, the Carpet Python preys mainly on birds and mammals, although reptiles are occasionally taken (Bush <i>et al.</i> 2010). |
| Expected occurrence: | Irregular visitor. Unlikely to reside in the survey area due to the degraded understorey, but likely to be present along the escarpment and individuals may visit occasionally. |

Habitat specialist or wide-ranging bird species with reduced populations on the Swan Coastal Plain (29 species; see

CS3 (LS)

Table 14)

| | |
|---------------------------|---|
| Conservation status: | These species have all been noted by Dell and Banyard (2000) as either habitat specialists or wide ranging species with a reduced population on the Swan Coastal Plain. While their assessment was based upon the greater Perth region, the same effects of broad-scale habitat loss apply in agricultural areas and thus these species can be considered locally significant. |
| Distribution and habitat: | Generally species that require larger areas of intact native remnants to persist. |
| Ecology: | There is a wide range of foraging strategies in this group but the majority of the species are small insectivores. Also includes ground-foraging granivores (e.g. Emu, bronzewings, button-quail) and nectarivores (honeyeaters). |
| Expected occurrence: | Most species are expected to be regular or irregular visitors, although a number are expected as residents (see Table 14). Many have been recorded by Bamford and Chuk (2020) and they tend to be restricted to areas of native or planted understorey vegetation. In the 2022 site inspection, the White-browed Scrubwren was present in dense sedges and rushes along some drains, while the Yellow-rumped Thornbill was present in remnant VCA 2 in the north. |

3.3 Black-cockatoo habitat analysis

3.3.1 *Black-cockatoo presence*

Although no Black-Cockatoos were recorded on the site during the site inspection, all three expected species have been previously recorded on a regular basis in the local area during fauna monitoring (Bamford and Chuk 2020). Given these previous records, presence of foraging habitat (see Section 3.3.3 below), roosting data (see Section 3.3.4 below) and the literature review (including current species distributions), it is considered that all three taxa (Carnaby's, Forest Red-tailed and Baudin's Black-Cockatoos, are regular but probably non-breeding visitors to the project area.

3.3.2 *Black-cockatoo breeding habitat*

Twenty-seven trees that met the potential nest-tree criteria of DAWE (2021c, d, e) and DEE (2017) were recorded within the project area (**Figure 16**). Of these, 25 had a rank of 5 (no large hollows) and two had a rank of 4 (possible but probably unsuitable hollows). The trees were concentrated in the north and noticeably along Black Tom Brook. However, the tree belt in the south (VSA3) was not fully surveyed as the boundary of the project area was only just into the belt of trees. Furthermore, while some of the trees do meet the basic criterion of having a DBH >500mm, they are all young (estimated 40 years) and therefore lack hollows of anywhere near suitable size.

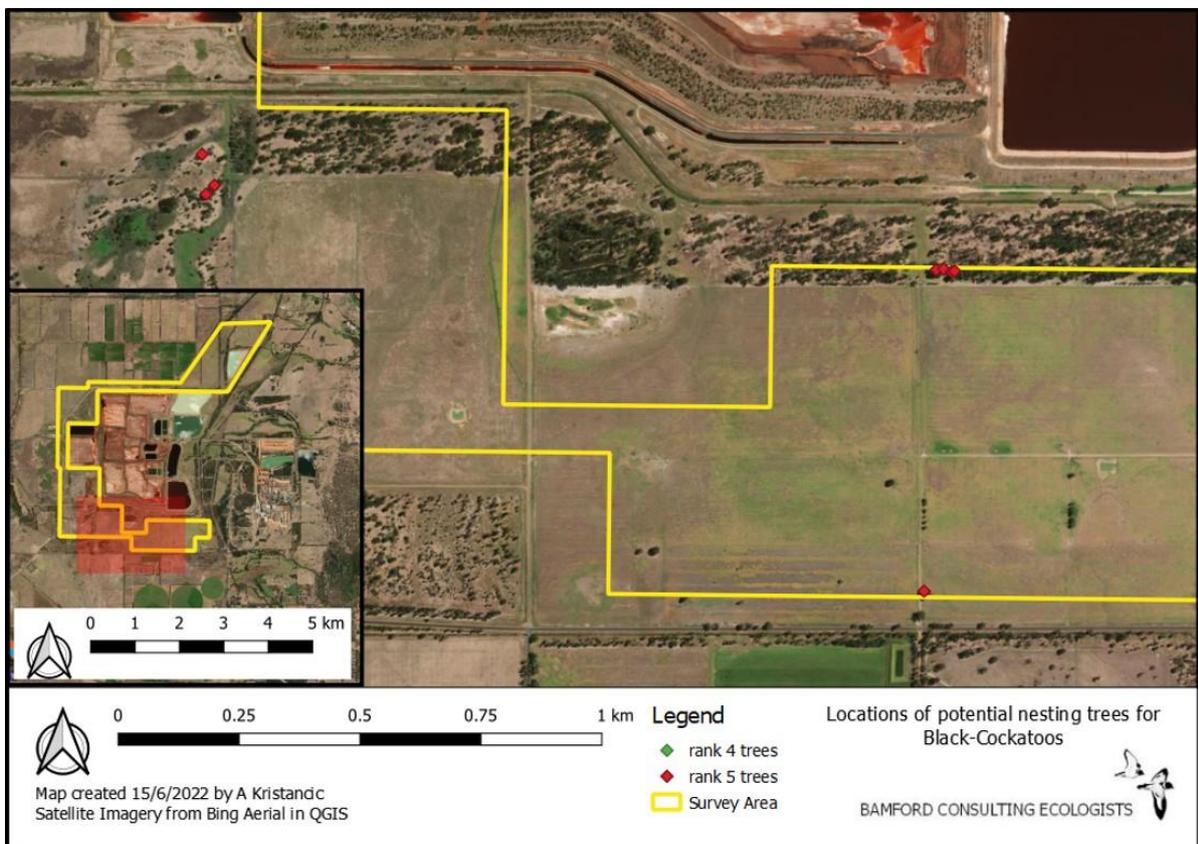
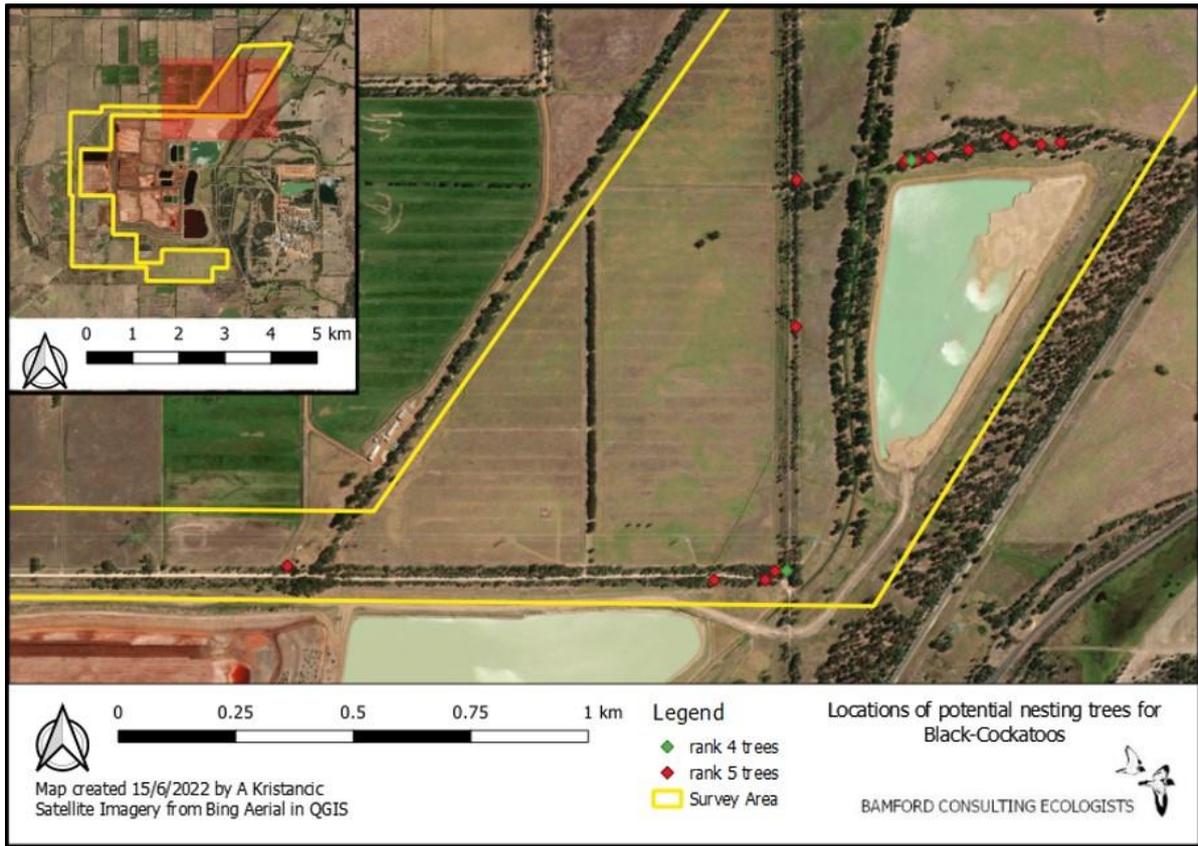


Figure 16. Distribution of potential breeding trees for black-cockatoos in the project area.

3.3.3 Black-cockatoo foraging habitat

Foraging habitat for Black-Cockatoos is limited in the project area. All three taxa will forage occasionally in paddocks, and will occasionally visit eastern Australian eucalypts, but the only key food plant available is the Marri. This is present in VSA 2 with scattered individual trees in VSA 3 and even across paddocks (VSA 1). Based upon guidance on the assessment of foraging values of vegetation (Appendix 5), VSA2 was assigned a vegetation score of 4 out of 6 for all three species. This reflects the presence and density of Marri, and also the lack of other foraging habitat immediately nearby. In contrast, VSA 3 gets a score of 2 out of 6, and paddocks get a score of 1 out of 6 (most paddock very heavily grazed and thus lack the edible plants such as *Erodium* sp. that black-cockatoos will forage on). Wetlands (VSA 4) effectively have no foraging value.

The total foraging habitat quality score (out of 10) includes an assessment based on context and species presence, as outlined in section 2.4.4.3. Context and species presence scores are usually assigned only to a vegetation or VSA type that has a score of 3 or more out of 6 based on vegetation characteristics. Lower value vegetation is only considered for a context and species presence score if it is effectively the only foraging habitat left in an area. This is not the case in the current project area, where there is extensive foraging habitat to the east (escarpment) and moderately extensive foraging habitat to the west (Buller Nature Reserve). Therefore, only VSA 2 is considered for context and species presence scores. Even then, the area of VSA 2 is very small (about 20ha), and there is very extensive foraging habitat of similar value to the east within 15km (Figure 1). Based upon the guidance in Appendix 5, and with about 35,000ha of native forest within 15km of the project area (Section 3.1.1), the small area of VSA 2 qualifies for a context score of 0. All three species are present, however, so a species presence score of 1 can be assigned. The total foraging habitat quality score is summarised in XX.

Table 15. Black-Cockatoo foraging scores calculated for each VSA type.

| VSA type | Vegetation condition score (/6) | Context score (/3) | Species presence (/1) | Total score (/10) |
|-----------------------------|---------------------------------|--------------------|-----------------------|-------------------|
| VSA 1 (farmland) | 1 | 0 | 0 | 1 |
| VSA 2 (native woodland) | 3 | 0 | 1 | 4 |
| VSA 3 (non-native woodland) | 2 | 0 | 0 | 2 |
| VSA 4 (wetlands) | 0 | 0 | 0 | 0 |

3.3.4 *Black-cockatoo roosting habitat*

The region around the project area is known to support black-cockatoo roosting, however there are no records of roost sites within the project area itself. Known roost locations (provided by DBCA (2021a) and that reflect data collected in BirdLife Australia's Great Cocky Counts) near the project area are mapped in Figure 17. The nearest of these known roosts are within c. 5 km of the project area boundary.

The absence of known roosts within the project area is reasonable as there is little suitable roosting habitat. Black-cockatoos favour locally tall trees for roosting, particularly if these are close to foraging habitat and water. While there are tall trees present, such as in VSA 3 where some of the eastern Australian eucalypts have reached a great height, there is very little foraging habitat and water sources are widespread across the surrounding landscape. It is therefore unlikely that Black-Cockatoos are dependent on the project area for roosting habitat.



Figure 17. Known black-cockatoo roost locations near the project area.

3.4 Patterns of biodiversity

Investigating patterns of biodiversity can be complex and are often beyond the scope even of detailed or targeted investigations (see Section 2.1 above), but it is possible to draw some general conclusions based upon the different landscapes in the project area. This is particularly the case in a landscape with broad scale clearing and only small areas of degraded native and rehabilitated vegetation. VSA 1 (farmland) is likely to support few and very widespread species, while VSA 2 (native woodland) is likely to be richest in native fauna as it represents the only more or less intact natural habitat remaining in the project area. It is also likely to be where the black-cockatoos forage. This is limited to small areas in the north, and a patch of woodland near Blind Roo/site 5 in the south. VSA 3 (woodland of non-native eucalypts over weeds) may have a moderate species richness, such as where it includes understorey plantings (indicated by census results from Blind Roo/Site 5. Most of VSA 3 in the project area, consists solely of large trees over weeds. Wetlands are limited in extent and degraded, but broad areas of seasonal flooding across paddocks were found to support moderately large numbers of waterbirds occasionally (Bamford and Chuk 2020), with New Bristol, just west of the project area, notable in this regard. Drains support some cryptic waterbirds and even some other species where cover is dense. Black Tom Brook is degraded but has a corridor of VSA 2 along it, and may have some value for aquatic species.

3.5 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 1 for descriptions and other ecological processes). These include the aspects discussed below.

Connectivity and landscape permeability. The project area consists largely of cleared land and is also largely surrounded by cleared land; the only extensive areas of intact native vegetation can be found on the escarpment c. 3km to the east, in Buller Nature Reserve c. 3km to the west, and in Yalgorup National Park c. 14km to the west. There is limited connectivity to the west but some, albeit fragmented, connectivity to the east. The terrestrial fauna, and birds that rely on adequate cover, are thus very limited in their ability to move across the landscape. The layout of VSA 2 and VSA 3, and the linear nature of the drains, means that these do provide some connectivity through the project area. The tree belt of VSA 3 in the south may be of particular importance for birds, and species such as the Brushtail Possum and Brush-tailed Phascogale, to move across the landscape.

Local hydrology. The project area contains seasonal wetlands and watercourses, additionally elements of the native vegetation are likely to have some reliance on groundwater. Seasonal flooding of paddocks creates waterbird habitat that is at least locally important.

Fire. Native vegetation throughout the project area is subject to fire and is likely to be burnt on a regular basis. While appropriate fire regimes can benefit biodiversity, inappropriate regimes can lead to a loss of biodiversity. Most of the local area was burnt in 2016. The small areas of VSA 2 and VSA 3 make fauna vulnerable to single fires.

Feral species and interactions with over-abundant native species. Feral species occur throughout Western Australia and are a considerable component of the current mammal fauna of the project area (see Section 3.2.1). They have contributed to local extinctions (see

Appendix 8) and may be affecting populations of extant species. Feral Cats and Foxes, are likely to be placing considerable pressure on the native fauna in the region, while the effect of Black and Brown Rats upon the native Rakali is unknown, but both the introduced species appear to be common along drains in the project area.

3.6 Summary of fauna values

The desktop study identified 259 vertebrate fauna species as potentially occurring in the project area: nine fish, 11 frogs, 33 reptiles, 179 birds and 27 mammals. The presence of at least 35 species (one frog, 28 birds and six mammals) was confirmed during the 2022 site inspection, with many more confirmed in ongoing fauna monitoring in the region.

Fauna assemblage. The fauna assemblage occurs in a highly modified landscape with broad scale loss of forests and woodlands, replaced by extensive grasslands. It has elements of both the escarpment and the Swan Coastal Plain, and has experienced substantial species loss and declines in abundance in many cases, but with grassland-dependent species abundant. The assemblage is not rich, but it is notable for species that are persisting in small numbers in the remnant of native vegetation and in some areas of rehabilitation.

Species of conservation significance. The majority of the 67 conservation significant species (two reptiles, 55 birds, six mammals and three invertebrates) are predicted to be only vagrants or irregular visitors in small numbers, and just eight of the significant species are expected to be residents; 18 are expected to be regular visitors. Significant species that rely on habitats in the project area include birds listed as CS3 (locally significant only), the Quenda and Brush-tailed Phascogale. Three black-cockatoo taxa are present but habitat for them is very limited. There is a possibility that the Peregrine Falcon breeds in the project area.

Vegetation and Substrate Associations (VSAs). The project area encompasses four VSAs which reflect landscape position and soil type: Cleared (VSA 1), native eucalypt woodland (VSA 2), non-native Eucalypt Woodland (VSA 3) and Wetland/drainage (VSA 4). VSA 2 is the only original VSA and is limited in extent to small areas totalling about 21ha in the north.

Patterns of biodiversity. VSA 2 is likely to be richest in species and to be important for significant species, with VSA 3 important for fewer species but having a connectivity function. Drains and associated thick vegetation may also have a connectivity function for small numbers of species. Seasonal wetlands on paddocks may be intermittently and locally important for waterbirds.

Key ecological processes. The ecological processes that currently have major effects upon the fauna assemblage include landscape permeability, hydrology, fire, and the presence of feral species.

4 Impact assessment

Threatening processes have to be considered in the context of fauna values, the surrounding landscape and the nature of the proposed action, and are examined below. Landscape context is important, as the project area contains areas of cleared or disturbed lands and is in a local, and regional, landscape that is extensively cleared. Impact categories are defined in Table 9.

Habitat loss leading to population decline

Negligible to Minor

The development footprint has not been defined but is likely to lie mostly within existing farmland. The main concern with habitat loss would be if the small areas of VSA 2 were cleared.

Habitat loss leading to population fragmentation.

Minor

The project area is largely surrounded by cleared land, larger areas of intact native vegetation can be found in the hills c. 3km to the east, Buller Nature Reserve c. 3km to the west and Yalgorup National Park c. 14km to the west. Only a few incomplete corridors provide east-west connectivity across the coastal plain, including several strips of vegetation along roads and watercourses in the project area. The development footprint has not been defined but loss of VSA 2 and VSA 3, and disruption along drainage lines, could adversely affect connectivity for fauna across the project area.

Degradation of habitat due to weed invasion.

Minor

The level of weed invasion is already high in the native vegetation. Weed control measures may benefit any retained native vegetation in the area.

Mortality during construction.

Negligible to Minor

This is a concern mostly on animal welfare grounds, as the survey area is largely cleared already. Animals will inevitably be killed during clearing but there are standard practices for reducing fauna mortality during such activities. The main concern would be if large trees were to be removed as these may shelter Brushtail Possums, Brush-tailed Phascogales, and potentially nesting birds. There is a possibility that a pair of Peregrine Falcons nests in a large tree in the project area.

Ongoing mortality.

Negligible

This results mainly from roadkill due to vehicle movements close to native vegetation, fauna striking infrastructure and effects of lighting. The numbers of animals affected are likely to be very small given the low abundance of fauna across much of the project area. It is not known if the residue ponds pose a threat to waterbirds which do occasionally occur in moderately large numbers in the area.

Species interactions.

Negligible to Minor

Feral species are already present on the site, but feral species may be attracted to work-sites and increase in abundance. Impacts to native fauna can be kept to Negligible/Minor through standard practices such as not feeding wildlife, managing waste and even implementing some feral species control. Local populations of the Quenda, Brushtail Possum and Brush-tailed Phascogale are likely to be small and thus vulnerable to an even slight increase in predation.

Hydrological change.

Negligible

It is not known if the proposed development will affect local hydrology, such as the persistence of drains and the frequency and duration of flooding across nearby, low-lying paddocks. Black Tom Brook may have some local significance for fauna but it is not known if it will be impacted. A separate aquatic fauna survey will provide more information on hydrological impacts. Assuming no impact any effect will be negligible.

Altered fire regimes.

Negligible

The vegetation of the project area is tolerant of and to some extent dependent on fire, but the fire regime is important. There have been recent fires that are likely to have affected the fauna, and any increase in fire frequency is likely to have adverse impacts. The proposed development has the potential to lead to increased fire frequency, but given the small areas of native vegetation involved this risk should be readily managed.

Disturbance (dust, noise, light).

Minor

The level of dust, noise and light during development and operation has the potential to result in some impacts, but there are standard management procedures to minimise these. There is also existing activity so these forms of disturbance will not be new to the location. As noted above, impacts of additional lighting upon invertebrates is largely unknown.

5 References

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6 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 and 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.

VSA assessment was made with reference to the key attributes provided by (EPA 2020):

- soil type and characteristics
- extent and type of ground surfaces and landforms
- height, cover and dominant flora within each vegetation stratum
- presence of specific flora or vegetation of known importance to fauna
- evidence of fire history including, where possible, estimates of time since fire
- evidence and degree of other disturbance or threats, e.g. feral species
- presence of microhabitats and significant habitat features, such as coarse woody debris, rocky
- outcrops, tree hollows, water sources and caves
- evidence of potential to support significant fauna
- function of the habitat as a fauna refuge or part of an ecological linkage.

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 Commonwealth and State Acts such as the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the *Western Australian Biodiversity Conservation Act 2016* (BC Act). In addition, the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA) 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 2.

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 2012), 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 1950* uses a series of seven Schedules to classify conservation status that largely reflect the IUCN categories (IUCN 2012).

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

In Western Australia, DBCA has produced a supplementary list of Priority Fauna, being species that are not considered threatened under the *Wildlife Conservation Act 1950* but for which DBCA feels there is cause for concern.

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 DBCA, used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of the Perth Bushplan (Dell and Banyard 2000).

Marine-listed species

Some conservation significant species may also be listed as 'Marine' under the EPBC Act. This listing protects these species in 'Commonwealth areas' which include "marine areas beyond the coastal waters of each State and the Northern Territory, and includes all of Australia's Exclusive Economic Zone (EEZ)" (DAWE 2020b). The EEZ extends to 200 nautical miles (approximately 350 kilometres) from the coast (DAWE 2020b). This may mean that the 'Marine' listing does not apply to the project/survey area (depending on its location). Therefore, when a species is otherwise protected (under the EPBC Act or BC Act) or priority-listed (by the DBCA) then the Marine listing is also noted but it does not have site-specific relevance. In cases where a species is solely Marine-listed (for a list see DAWE 2020a) and a project/survey area is not within a Commonwealth area then it is treated like all other fauna.

Invertebrates

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 area may be affected and effectively determined by processes such as:

- fire regime.
- landscape patterns (such as fragmentation and/or linkage).
- the presence of feral species.
- hydrology.

Some of the threatening processes as outlined in Appendix 3 are effectively the ecological processes that can be altered to result in impacts upon fauna.

Appendix 2. Categories used in the assessment of conservation status.

IUCN (International Union for the Conservation of Nature) categories, as outlined by IUCN (2012), and as used for the *Environment Protection and Biodiversity Conservation Act 1999* and the *Western Australian Biodiversity Conservation Act 2016*.

| | |
|---------------------------------------|--|
| Extinct | Taxa not definitely located in the wild during the past 50 years. |
| Extinct in the Wild (Ex) | Taxa known to survive only in captivity. |
| Critically Endangered (CR) | Taxa facing an extremely high risk of extinction in the wild in the immediate future. |
| Endangered (E) | Taxa facing a very high risk of extinction in the wild in the near future. |
| Vulnerable (V) | 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 Biodiversity Conservation Act 2016*

| | |
|-----------------|---|
| 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 DBCA Priority species (species not listed under the *WA Biodiversity Conservation Act 2016*, but for which there is some concern).

| | |
|------------------|--|
| Priority 1 (P1) | Taxa with few, poorly known populations on threatened lands. |
| Priority 2 (P2) | Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands. |
| Priority 3 (P3) | Taxa with several, poorly known populations, some on conservation lands. |
| Priority 4. (P4) | 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 (P5) | 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 3. Explanation of threatening processes.

Potential impacts of proposed developments upon fauna values can be related to threatening processes. This is recognised in the literature and under the EPBC Act, in which threatening processes are listed (see Appendix 4). Processes that may impact fauna values are discussed below. Rather than being independent of one another, processes are complex and often interrelated. They are the mechanisms by which fauna can be affected by development. Impacts may be significant if large numbers of species or large proportions of populations are affected.

Note that the terms direct and indirect impacts are used by the DoE (2013), DSEWPaC (2013c) and EPA (2016a), but there is some inconsistency in how these are defined. The federal guidance does not define direct impact but has a very broad definition of indirect, and makes the statement (DoE 2013) *‘Consideration should be given to all adverse impacts that could reasonably be predicted to follow from the action, whether these impacts are within the control of the person proposing to take the action or not. Indirect impacts will be relevant where they are sufficiently close to the proposed action to be said to be a consequence of the action, and they can reasonably be imputed to be within the contemplation of the person proposing to take the action.’* Indirect impacts therefore can even include what the DoE (2013) calls facilitated impacts, which are the result of third party actions triggered by the primary action. In contrast, the EPA (2016a) defines direct impacts to *‘include the removal, fragmentation or modification of habitat, and mortality or displacement of individuals or populations.’* This document then lists as indirect impacts what in many cases are the consequences of the removal, fragmentation or modification of habitat. For example, *‘disruption of the dispersal of individuals required to colonise new areas inhibiting maintenance of genetic diversity between populations’* is a consequence of habitat fragmentation. Impacts of light, noise and even roadkill are defined as indirect but they are clearly the result of the action and in control of the person taking the action. Roadkill is as direct a form of mortality as can be observed, but it is considered as an indirect impact in the context of a development presumably because it is not directly linked to land clearing. The EPA (2016a) makes a strong distinction between removal of vegetation (direct impact) and the consequences of such clearing and other aspects of a development (indirect impacts). It is not obvious how this distinction between direct and indirect impacts is helpful in the EIA process, as the key aim is to ensure that all impacts that result from a project are addressed in this assessment process. Interestingly, Gleeson and Gleeson (2012), in a major review of impacts of development on wildlife, do not use the terms direct or indirect. In the following outlines of threatening processes that can cause impacts, the emphasis is upon interpreting how a threatening process will cause an impact. For example, loss of habitat (threatening process) can lead to population decline and to population fragmentation, which are two distinct impacts, with population decline considered a direct impact and fragmentation an indirect impact by the EPA (2016a).

Loss of habitat affecting population survival

Clearing for a development can lead to habitat loss for a species with a consequent decline in population size. This may be significant if the smaller population has reduced viability. Conservation significant species or species that already occur at low densities may be particularly sensitive to habitat loss affecting population survival.

Loss of habitat leading to population fragmentation

Loss of habitat can affect population movements by limiting movement of individuals throughout the landscape as a result of fragmentation (Soule *et al.* 2004; Gleeson and Gleeson 2012). Obstructions associated with the development, such as roads, pipes and drainage channels, may also affect movement of small, terrestrial species. Fragmented populations may not be sustainable and may be sensitive to effects such as reduced gene flow.

Degradation of habitat due to weed invasion leading to population decline

Weed invasion, such as through introduction by human boots or vehicle tyres, can occur as a result of development and if this alters habitat quality, can lead to effects similar to habitat loss.

Increased mortality

Increased mortality can occur during project operations; for example from roadkill, animals striking infrastructure and entrapment in trenches. Roadkill as a cause of population decline has been documented for several medium-sized mammals in eastern Australia (Dufty 1989; Jones 2000). Increased mortality due to roadkill is often more prevalent in habitats that have been fragmented (Scheick and Jones 1999; Clevenger and Waltho 2000; Jackson and Griffin 2000).

Increased mortality of common species during development is unavoidable and may not be significant for a population. However, the cumulative impacts of increased mortality of conservation significant species or species that already occur at low densities may have a significant impact on the population.

Species interactions, including predation and competition

Changes in species interactions often occur with development. Introduced species, including the feral Cat, Red Fox and Rabbit may have adverse impacts upon native species and development can alter their abundance. In particular, some mammal species are very sensitive to introduced predators and the decline of many mammals in Australia has been linked to predation by the Red Fox, and to a lesser extent the feral Cat (Burbidge and McKenzie 1989). Introduced grazing species, such as the Rabbit, Goat, Camel and domestic livestock, can also degrade habitats and deplete vegetation that may be a food source for other species.

Changes in the abundance of some native species at the expense of others, due to the provision of fresh watering points, can also be a concern. Harrington (2002) found the presence of artificial fresh waterpoints in the semi-arid mallee rangelands to influence the abundance and distribution of certain bird species. Common, water-dependent birds were found to out-compete some less common, water-independent species. Similarly, Read *et al.* (2015) found a decline in some bird species but an increase in others in the vicinity of active mines and concluded this was due to the mine attracting large and aggressive species that displaced other species. Over-abundant native herbivores, such as kangaroos, can also adversely affect less abundant native species through competition and displacement.

Hydroecology

Interruptions of hydroecological processes can have major effects because they underpin primary production in ecosystems and there are specific, generally rare habitats that are hydrology-dependent. Fauna may be impacted by potential changes to groundwater level and chemistry and

altered flow regime. These changes may alter vegetation across large areas and may lead to habitat degradation or loss. Impacts upon fauna can be widespread and major.

Changes to flow regime across the landscape may alter vegetation and may lead to habitat degradation or loss, affecting fauna. For example, Mulga has a shallow root system and relies on surface sheet flow during flood events. If surface sheet flow is impeded, Mulga can die (Kofoed 1998), which may impact on a range of fauna associated with this vegetation type.

Fire

The role of fire in the Australian environment and its importance to vertebrate fauna has been widely acknowledged (Gill *et al.* 1981; Fox 1982; Letnic *et al.* 2004). It is also one of the factors that has contributed to the decline and local extinction of some mammal and bird species (Burbidge and McKenzie 1989). Fire is a natural feature of the environment but frequent, extensive fires may adversely impact some fauna, particularly mammals and short-range endemic species. Changes in fire regime, whether to more frequent or less frequent fires, may be significant to some fauna. Impacts of severe fire may be devastating to species already occurring at low densities or to species requiring long unburnt habitats to survive. In terms of conservation management, it is not fire *per se* but the fire regime that is important, with evidence that infrequent, extensive and intense fires adversely affect biodiversity, whereas frequent fires that cover small areas and are variable in both season and intensity can enhance biodiversity. Fire management may be considered the responsibility of managers of large tracts of land, including managers of mining tenements.

Dust, light, noise and vibration

Impacts of dust, light, noise and vibration upon fauna are difficult to predict. Some studies have demonstrated the impact of artificial night lighting on fauna, with lighting affecting fauna behaviour more than noise (Rich and Longcore 2006). Effects can include impacts on predator-prey interactions, changes to mating and nesting behaviour, and increased competition and predation within and between invertebrates, frogs, birds and mammals.

The death of very large numbers of insects has been observed around some remote mine sites and attracts other fauna, notably native and introduced predators (M. Bamford pers. obs). The abundance of some insects can decline due to mortality around lights, although this has previously been recorded in fragmented landscapes where populations are already under stress (Rich and Longcore 2006). Artificial night lighting may also lead to disorientation of migratory birds. Aquatic habitats and open habitats such as grasslands and dunes may be vulnerable to light spill.

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 2014b):

- 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 km² (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, the federal Department of Agriculture, Water and the Environment (DAWE) 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. Scoring system for the assessment of foraging value of vegetation for Black-Cockatoos.

Bamford Consulting Ecologists

Revised 4th April 2021

Introduction

Application of the Offset Assessment Guide (offsets guide) developed by the federal environment department for assessing Black-Cockatoo foraging habitat requires the calculation of a score out of 10. The following system has been developed by Bamford Consulting Ecologists (BCE) with assistance from Quessentia Consulting to provide an objective scoring system that is practical and can be used by trained field zoologists with experience in the environments frequented by the species.

The foraging value score provides a numerical value that reflects the significance of vegetation as foraging habitat for Black-Cockatoos, and this numerical value is designed to provide the information needed by the Federal Department of Agriculture, Water and the Environment (DAWE) to assess impact significance and offset requirements. The foraging value of the vegetation depends upon the type, density and condition of trees and shrubs in an area and can be influenced by the context such as the availability of foraging habitat nearby. The BCE scoring system for value of foraging habitat has three components as detailed above. These three components are drawn from the DAWE offsets guide but the scoring approach was developed by BCE and includes a fourth (moderation) component. Note that the scoring system can only be applied within the range of the species or at least where the species could reasonably be expected to occur based upon existing information.

Calculating the total score (out of 10) requires the following steps:

- A. Site condition. Determining a score out of six for the vegetation composition, condition and structure; plus
- B. Site context. Determining a score out of three for the context of the site; plus
- C. Species stocking rate. Determining a score out of one for species density.
- D. Determining the total score out of 10, which may require moderation for context and species density with respect to the site condition (vegetation) score. Moderation also includes consideration of pine plantations as a special case for foraging value.

The BCE scoring system places the greatest weight on site condition (scale of 0 to 6) because this has the highest influence on the foraging values of a site, which in turn is the fundamental driver in meeting ecological requirements for continued survival.

Site context has a lower weight (scale of 0 to 3) in recognition of the mobility of the species, which means they can access good foraging habitat even in fragmented landscapes, but allowing for recognition of the extent of available habitat in a region and context in relation to activity (such as breeding and roosting). The application of scoring site context is further discussed below.

Species stocking rate is given a low weight (0 to 1) as it is a means only of recognising that a species may or may not be abundant at a site, but that abundance is dependent upon site condition and context and is thus not an independent variable. The abundance of a species is also sensitive to

sampling effort, and to seasonal and annual variation, and is therefore an unreliable indicator of actual importance of a site to a species.

Calculation of scores and the moderation process are described in detail below.

A. Site condition. Vegetation composition, condition and structure scoring

| Site Score | Description of Vegetation Values | | |
|------------|---|---|---|
| | Carnaby's Black-Cockatoo | Baudin's Black-Cockatoo | Forest Red-tailed Black-Cockatoo |
| 0 | <p>No foraging value. No Proteaceae, eucalypts or other potential sources of food. Examples:</p> <ul style="list-style-type: none"> Water bodies (e.g. salt lakes, dams, rivers); Bare ground; Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits) or with vegetation of no food value, such as some suburban landscapes. Mown grass | <p>No foraging value. No eucalypts or other potential sources of food. Examples:</p> <ul style="list-style-type: none"> Water bodies (e.g. dams, rivers); Bare ground; Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits). | <p>No foraging value. No eucalypts or other potential sources of food. Examples:</p> <ul style="list-style-type: none"> Water bodies (e.g. dams, rivers); Bare ground; Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits). |
| 1 | <p>Negligible to low foraging value. Examples:</p> <ul style="list-style-type: none"> Scattered specimens of known food plants but projected foliage cover of these is < 2%. This could include urban areas with scattered foraging trees; Paddocks that are lightly vegetated with melons or other known food-source weeds (e.g. <i>Erodium</i> spp.) that represent a short-term and/or seasonal food source; Blue Gum plantations (foraging by Carnaby's Black-Cockatoos has been reported but appears to be unusual). | <p>Negligible to low foraging value. Scattered specimens of known food plants but projected foliage cover of these < 1%. This could include urban areas with scattered foraging trees.</p> | <p>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.</p> |

| Site Score | Description of Vegetation Values | | |
|------------|---|--|---|
| | Carnaby's Black-Cockatoo | Baudin's Black-Cockatoo | Forest Red-tailed Black-Cockatoo |
| 2 | <p>Low foraging value. Examples:</p> <ul style="list-style-type: none"> • Shrubland in which species of foraging value, such as shrubby banksias, have < 10% projected foliage cover; • Woodland with tree banksias 2-5% projected foliage cover; • Woodland with tree banksias (of key species <i>B. attenuata</i> and <i>B. menziesii</i>) with <10% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Open eucalypt woodland/mallee of small-fruited species; • Paddocks that are densely vegetated with melons or other known food-source weeds (e.g. <i>Erodium</i> spp.) that represent a short-term and/or seasonal food source. | <p>Low foraging value. Examples:</p> <ul style="list-style-type: none"> • Woodland with scattered specimens of known food plants (e.g. Marri and Jarrah) 1-5% projected foliage cover; • Marri-Jarrah Woodland with <10% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Parkland-cleared Eucalypt Woodland/Forest with known food plants <10% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants <10% projected foliage cover (establishing food sources with good long-term viability); • Urban areas with scattered foraging trees. | <p>Low foraging value. Examples:</p> <ul style="list-style-type: none"> • Woodland with scattered specimens of known food plants (e.g. Marri, Jarrah) 1-5% projected foliage cover; • Marri-Jarrah Woodland with <10% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Sheoak Woodland with <10% projected foliage cover; • Parkland-cleared Eucalypt Woodland/Forest with known food plants <10% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants <10% projected foliage cover (establishing food sources with good long-term viability); • Urban areas with scattered food plants such as Cape Lilac, <i>Eucalyptus caesia</i> and <i>E. erythrocorys</i>. |

| Site Score | Description of Vegetation Values | | |
|------------|--|---|--|
| | Carnaby's Black-Cockatoo | Baudin's Black-Cockatoo | Forest Red-tailed Black-Cockatoo |
| 3 | <p>Low to Moderate foraging value. Examples:</p> <ul style="list-style-type: none"> • Shrubland in which species of foraging value, such as shrubby banksias, have 10-20% projected foliage cover; • Woodland with tree banksias 5-20% projected foliage cover; • Woodland with tree banksias (of key species <i>B. attenuata</i> and <i>B. menziesii</i>) with 10-40% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Eucalypt Woodland/Mallee of small-fruited species; • Eucalypt Woodland with Marri < 10% projected foliage cover. | <p>Low to Moderate foraging value. Examples:</p> <ul style="list-style-type: none"> • Eucalypt Woodland with known food plants (especially Marri) 5-10% projected foliage cover; • Marri-Jarrah Woodland with 10-40% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Parkland-cleared Eucalypt Woodland/Forest with known food plants 10-40% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants 10-40% projected foliage cover (establishing food sources with good long-term viability). | <p>Low to Moderate foraging value. Examples:</p> <ul style="list-style-type: none"> • Eucalypt Woodland with known food plants (especially Marri and Jarrah) 5-20% projected foliage cover; • Marri-Jarrah Woodland with 10-40% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Sheoak Forest with 10-40% projected foliage cover; • Parkland-cleared Eucalypt Woodland/Forest with known food plants 10-40% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants 10-40% projected foliage cover (establishing food sources with good long-term viability). |

| Site Score | Description of Vegetation Values | | |
|------------|---|---|---|
| | Carnaby's Black-Cockatoo | Baudin's Black-Cockatoo | Forest Red-tailed Black-Cockatoo |
| 4 | <p>Moderate foraging value. Examples:</p> <ul style="list-style-type: none"> Woodland/low forest with tree banksias (of key species <i>B. attenuata</i> and <i>B. menziesii</i>) 20-40% projected foliage cover; Woodland/low forest with tree banksias (of key species <i>B. attenuata</i> and <i>B. menziesii</i>) with 40-60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; Kwongan/ Shrubland in which species of foraging value, such as shrubby banksias, have 20-40% projected foliage cover; Eucalypt Woodland/Forest with Marri 20-40% projected foliage cover. | <p>Moderate foraging value. Examples:</p> <ul style="list-style-type: none"> Marri-Jarra Woodland/Forest with 20-40% projected foliage cover; Marri-Jarra Forest with 40-60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; Parkland-cleared Eucalypt Woodland/Forest with known food plants 40-60% projected foliage cover (poor long-term viability without management); Younger areas of (managed) revegetation with known food plants 40-60% projected foliage cover (establishing food sources with good long-term viability); Orchards with highly desirable food sources (e.g. apples, pears, some stone fruits). | <p>Moderate foraging value. Examples:</p> <ul style="list-style-type: none"> Marri-Jarra Woodland/Forest with 20-40% projected foliage cover; Marri-Jarra Forest with 40-60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; Sheoak Forest with 40-60% projected foliage cover; Parkland-cleared Eucalypt Woodland/Forest with known food plants 40-60% projected foliage cover (poor long-term viability without management); Younger areas of (managed) revegetation with known food plants 40-60% projected foliage cover (establishing food sources with good long-term viability). |

| Site Score | Description of Vegetation Values | | |
|------------|---|--|--|
| | Carnaby's Black-Cockatoo | Baudin's Black-Cockatoo | Forest Red-tailed Black-Cockatoo |
| 5 | <p>Moderate to High foraging value. Examples:</p> <ul style="list-style-type: none"> • Banksia Low Forest (of key species <i>B. attenuata</i> and <i>B. menziesii</i>) with 40-60% projected foliage cover; • Banksia Low Forest (of key species <i>B. attenuata</i> and <i>B. menziesii</i>) with > 60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Kwongan/ Shrubland in which species of foraging value, such as shrubby banksias, have 40-60% projected foliage cover; • Marri-Jarrah Forest with 40-60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term). • Pine plantations with trees more than 10 years old (but see pine note below in moderation section). | <p>Moderate to High foraging value. Examples:</p> <ul style="list-style-type: none"> • Marri-Jarrah Forest with 40-60% projected foliage cover; • Marri-Jarrah Forest with > 60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Parkland-cleared Eucalypt Woodland/Forest with known food plants >60% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants >60% projected foliage cover (establishing food sources with good long-term viability). | <p>Moderate to High foraging value. Examples:</p> <ul style="list-style-type: none"> • Marri-Jarrah Forest with 40-60% projected foliage cover; • Marri-Jarrah Forest with > 60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Sheoak Forest with > 60% projected foliage cover; • Parkland-cleared Eucalypt Woodland/Forest with known food plants >60% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants >60% projected foliage cover (establishing food sources with good long-term viability). |

| Site Score | Description of Vegetation Values | | |
|------------|--|---|---|
| | Carnaby's Black-Cockatoo | Baudin's Black-Cockatoo | Forest Red-tailed Black-Cockatoo |
| 6 | <p>High foraging value. Example:</p> <ul style="list-style-type: none"> Banksia Low Forest (of key species <i>B. attenuata</i> and <i>B. menziesii</i>) with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term). Kwongan/ Shrubland in which species of foraging value, such as shrubby banksias, have >60% projected foliage cover; Marri-Jarra Forest with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term). | <p>High foraging value. Example:</p> <ul style="list-style-type: none"> Marri-Jarra Forest with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term). | <p>High foraging value. Example:</p> <ul style="list-style-type: none"> Marri-Jarra Forest with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term). |

Vegetation structural class terminology follows Keighery (1994).

B. Site context.

Site Context is a function of site size, availability of nearby habitat and the availability of nearby breeding areas. Site context includes consideration of connectivity, although Black-Cockatoos are very mobile and will fly across paddocks to access foraging sites. Based on BCE observations, Black-Cockatoos are unlikely to regularly go over open ground for a distance of more than a few kilometres and prefer to follow tree-lines.

The maximum score for site context is 3, and because it is effectively a function of presence/absence of nearby breeding and the distribution of foraging habitat across the landscape, the following table, developed by Bamford Consulting in conjunction with the Department of the Environment and Energy (DEE), provides a *guide* to the assignment of site context scores. Note that 'local area' is defined as within a 15 km radius of the centre point of the study site. This is greater than the maximum distance of 12km known to be flown by Carnaby's Black-Cockatoo when feeding chicks in the nest.

| Site Context Score | Percentage of the existing native vegetation within the 'local' area that the study site represents. | |
|--------------------|--|---------------------------|
| | 'Local' breeding known/likely | 'Local' breeding unlikely |
| 3 | > 5% | > 10% |
| 2 | 1 - 5% | 5 - 10% |
| 1 | 0.1 - 1% | 1 - 5% |
| 0 | < 0.1% | < 1% |

The table above provides weighting for where nearby breeding is known (or suspected) and for the proportion of foraging habitat within 15 km represented by the site being assessed. Some adjustments may be needed based on the judgement of the assessor and in relation to the likely function of the site. For example, a small area of foraging habitat (e.g. 0.5% of such habitat within 15 km) could be upgraded to a context of 2 if it formed part of a critical movement corridor. In contrast, the same sized area of habitat, of the same local proportion, could be downgraded if it were so isolated that birds could never access it.

C. Species density (stocking rate).

Species stocking rate is described as "the usage and/or density of a species at a particular site" in the offsets guide. The description also implies that a site supports a discrete population, which is unlikely in the case of very mobile black-cockatoos. Assignment of the species density score (0 or 1) is based upon the black-cockatoo species being either abundant or not abundant. A score of 1 is used where the species is seen or reported regularly and/or there is abundant foraging evidence. Regularly is when the species is seen at intervals of every few days or weeks for at least several months of the year. A score of 0 is used when the species is recorded or reported very infrequently and there is little or no foraging evidence. Where information on actual presence of birds is lacking, a species density score can be assigned by interpreting the landscape and the site context. For example, a site with a moderate condition score that is part of a network of such habitat where a black-cockatoo species is

known would get a species density score of 1 even without clear presence data, while a species density score of 0 can be assigned to a site where the level of usage can confidently be predicted to be low.

D. Moderation of scores for the calculation of a value out of 10.

The calculation out of 10 requires the vegetation characteristics (out of 6) to be combined with the scores given for context and species density. It is considered that the context and density scores are not independent of vegetation characteristics; otherwise habitat of absolutely no value for black-cockatoo foraging (such as concrete or a wetland) could get a foraging score out of 10 as high as 4 if it occurred in an area where the species breed (context score of 3) and are abundant (species density score of 1). Similarly, vegetation of negligible or low characteristics which could not support black-cockatoos could be assigned a score as high as 6 out of 10. In that case, the score of 6 would be more a reflection of nearby vegetation of high characteristics than of the foraging value of the negligible to low scoring vegetation. The Black-Cockatoos would only be present because of vegetation of high characteristics, so applying the context and species density scores to vegetation of low characteristics would not give a true reflection of their foraging value.

For this reason, the context and species density scores need to be moderated for the vegetation characteristic score to prevent vegetation of little or no foraging value receiving an excessive score out of 10. A simple approach is to assign a context and species density score of zero to sites with a Condition score of low (2), negligible (1) or none (0), on the basis that birds will not use such areas unless they are adjacent to at least low-moderate quality foraging habitat (≥ 3). The approach to calculating a score out of 10 can be summarised as follows:

| Vegetation composition, condition and structure score | Context score | Species density score |
|--|-------------------------|------------------------------|
| 3-6 (low/moderate to high value) | Assessed as per B above | Assessed as per C above |
| 0-2 (no to low value) | 0 | 0 |

Note that this moderation approach may require interpretation depending on the context. For example, vegetation with a condition score of 2 could be given a context score of 1 under special circumstances. Such as when very close to a major breeding area or if strategically located along a movement corridor.

Pine plantations

Pine plantations are an important foraging resource for Carnaby's Black-Cockatoo (only) but are not directly comparable with native vegetation. In comparing native vegetation with pine plantations for the purpose of calculating offsets, the following should be noted:

- Pine plantations are a commercial crop established with the intention of being harvested and thus have short-term availability (30-50 years), whereas native vegetation is available indefinitely if protected. Due to the temporary nature of pines as a food source, site condition and context differs between pines and native vegetation.
- Although pines provide a high abundance of food in the form of seeds, they are a limited food resource compared with native vegetation which provides seeds, insect larvae, flowers and nectar. The value of insect larvae in the diet of Carnaby's Black-Cockatoo has not been quantified, but in the vicinity of Perth, the birds forage very heavily on insect larvae in young cones of *Banksia attenuata* in winter, ignoring the seeds in these cones and seeds in older cones on the same trees (Scott and Black 1981; M. Bamford pers. obs.). This suggests that insect larvae are of high nutritional importance immediately prior to the breeding season.
- Pine plantations have very little biodiversity value other than their importance as a food source for Carnaby's Black-Cockatoos. They inhibit growth of other flora. While this is not a factor for direct consideration with respect to Carnaby's Black-Cockatoo, it is a factor in regional conservation planning of which offsets for the cockatoos are a part.

Taking the above points into consideration, it is possible to assign pine plantations a foraging value as follows:

- Site condition. The actual foraging value of pines is high. Stock *et al.* (2013) report that it takes nearly twice as many seeds of *Pinus pinaster* to meet the daily energy requirements for Carnaby's Black-Cockatoo compared with Marri, and three times as many *P. pinaster* seeds compared with Slender Banksia. However, pines are planted at a high density so the food supply per hectare can be high. Taking account of the lack of variety of food from pines, this suggests a site condition score of 4 or 5 out of 6 (5 is used in Section A above). As a source of food, pines are thus comparable to the best banksia woodland. This site condition score then needs to be adjusted to take account of the short-term nature of the food supply (for pine plantations to be harvested. Where pines are 'ornamental, such as in some urban contexts, they can be treated as with other trees in urban landscapes). The foraging value of a site after pines are harvested will effectively be 0, or possibly 1 if there is some retention. It is proposed that this should approximately halve the site condition score; young pine plantations could be redacted slightly less than old plantations on the basis that a young plantation provides a slightly longer term food supply. If a maximum site condition score of 5 is given, then a young plantation (>10 but <30 years old) could be assigned a score of 3, and an old plantation (>30 years old) could be assigned a score of 2. Plantations <10 years old and thus not producing large quantities of cones could also get a score of 2, but recognising they may increase in value.
- Site context. Although a temporary food source, pines can be very important for Carnaby's Black-Cockatoo in some contexts; they could be said to carry populations in areas where there is little native vegetation. The system for assigning a context score as outlined above (Section B) also applies to pines. Thus, a context score of 3 can be given where pines are a significant

proportion of foraging habitat (>5% if breeding occurs; >10% if no breeding), but where pines are a small part of the foraging landscape they will receive a context score of less than this.

- Species density. As outlined above (Section C), pines will receive a species density score of 1 where Carnaby's Black-Cockatoo are regular visitors. This is irrespective of an old plantation having a moderated condition score of 2.

Based on the above, pine plantations that represent a substantial part of the foraging landscape, such as in the region immediately north of Perth, would receive a total score (out of 10) of 6; young plantations in this area would receive a score of 7. In contrast, isolated and small plantations in rural landscapes could receive a score of just 2 if they are only a small proportion of foraging habitat and Carnaby's Black-Cockatoos are not regularly present.

Appendix 6. Examples of Forest Red-tailed Black-Cockatoo foraging signs across the range of age categories used in this study.

Active/Recent



Intermediate

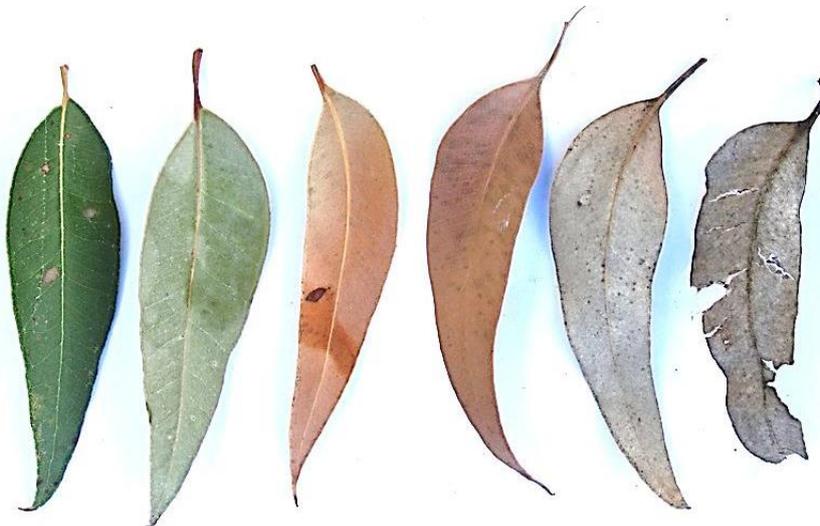


Old

Jarrah nuts



Jarrah leaves



Marri nuts



Appendix 7. Vertebrate fauna expected to occur in the project area.

Status codes:

CS1, CS2, CS3 = (summary) levels of conservation significance. See Appendix 1 for full explanation.

EPBC Act listings: E = Endangered, V = Vulnerable, M = Migratory, Mar = Marine (see Appendix 2).

Biodiversity Conservation Act 2016 listings: S1 to S7 = Schedules 1 to 7 (see Appendix 2).

DBCA Priority species: P1 to P4 = Priority 1 to 4 (see Appendix 2).

Bush Forever (Dell and Banyard 2000) status: HS = habitat specialists with a reduced distribution on the Swan Coastal Plain,

LE = locally extinct, WR = wide ranging species with reduced populations on the Swan Coastal Plain.

LS = considered to be of local significance by Bamford Consulting Ecologists (see Appendix 1).

Int = introduced species.

Expected Occurrence categories:

See Section 2.3.4 for explanation of expected occurrence categories.

Source:

1 = Atlas of Living Australia (ALA 2021), 2 = NatureMap (DBCA 2021e), 3 = Protected Matters Search Tool (DAWE 2021g),
4 = Birdlife Australia (Birdlife 2022) 5 = BCE records.

Recorded:

'X' = recorded in 2022 survey, .+ = recorded in previous surveys (Bamford and Chuk 2020)

| Species | Status | Expected Occurrence | Source | Recorded |
|--|------------------------------|---------------------|-------------------|----------|
| Geotriidae (southern lampreys) | | | | |
| Pouched Lamprey | <i>Geotria australis</i> | CS2 (P3) | Irregular visitor | 5 |
| Cyprinidae (Cyprinids) | | | | |
| European Carp | <i>Cyprinus carpio</i> | Int | Irregular visitor | 5 |
| Goldfish | <i>Carassius auratus</i> | Int | Irregular visitor | 1 |
| Percidae (Perches) | | | | |
| Redfin Perch | <i>Perca fluviatilis</i> | Int | Irregular visitor | 1 |
| Percichthyidae (Australian Perches) | | | | |
| Western Pygmy-perch | <i>Edelia vittata</i> | | Regular visitor | 5 |
| Nightfish | <i>Bostockia porosa</i> | | Irregular visitor | 1 |
| Galaxiidae (Galaxia) | | | | |
| Western Minnow | <i>Galaxias occidentalis</i> | | Resident | 1 + X |
| Poeciliidae (Livebearers) | | | | |
| Eastern Mosquitofish | <i>Gambusia holbrooki</i> | Int | Resident | 1 + X |
| Oxudercidae (Gobies) | | | | |
| Swan River Goby | <i>Pseudogobius olorum</i> | | Irregular visitor | 5 |
| Hylidae (Tree frogs) | | | | |

| Species | Status | Expected Occurrence | Source | Recorded |
|--|---|---------------------|--------|----------|
| Slender Tree Frog | <i>Litoria adelaidensis</i> | Resident | 1 5 | + |
| Motorbike Frog | <i>Litoria moorei</i> ^w | Resident | 1 5 | + |
| Limnodynastidae (Burrowing frogs) | | | | |
| Moaning Frog | <i>Heleioporus eyrei</i> | Resident | 1 5 | + |
| Sand Frog | <i>Heleioporus psammophilus</i> | Irregular visitor | 5 | |
| Western Banjo Frog | <i>Limnodynastes dorsalis</i> ^{w†} | Resident | 1 5 | + |
| Myobatrachidae (Ground frogs) | | | | |
| Quacking Frog | <i>Crinia georgiana</i> | Resident | 1 5 | + |
| Clicking Frog | <i>Crinia glauerti</i> ^{w†} | Resident | 1 5 | + |
| Squelching Froglet | <i>Crinia insignifera</i> ^{w†} | Resident | 1 5 | + X |
| False Western Froglet | <i>Crinia pseudinsignifera</i> | Irregular visitor | 1 5 | + |
| Lea's Frog | <i>Anstisia (Geocrinia) leai</i> | Resident | 1 5 | + |
| Crawling Toadlet | <i>Pseudophryne guentheri</i> | Resident | | |
| Chelidae (Side-necked tortoises) | | | | |
| Oblong Tortoise | <i>Chelodina oblonga</i> ^w | Resident | 1 5 | + |
| Diplodactylidae (Diplodactylid geckoes) | | | | |
| South-western Clawless Gecko | <i>Crenadactylus ocellatus</i> | Resident | 1 | |
| Gekkonidae (Gekkonid geckoes) | | | | |
| Marbled Gecko | <i>Christinus marmoratus</i> | Resident | 1 5 | + |
| Pygopodidae (Legless lizards) | | | | |
| Sandplain Worm-Lizard | <i>Aprasia repens</i> | Resident | 5 | + |
| Fraser's Legless-Lizard | <i>Delma fraseri</i> | Resident | 1 | |
| Burton's Legless-Lizard | <i>Lialis burtonis</i> | Resident | 1 5 | + |
| Common Scaly Foot | <i>Pygopus lepidopodus</i> | Resident | 1 | |
| Agamidae (Dragons) | | | | |
| Western Bearded Dragon | <i>Pogona minor minor</i> | Resident | 1 5 | + |
| Scincidae (Skinks) | | | | |
| | <i>Acritoscincus trilineatus</i> | Resident | 1 5 | + |

| Species | Status | Expected Occurrence | Source | Recorded |
|---|------------------------------------|---------------------|-------------------|----------|
| Fence Skink | <i>Cryptoblepharus buechananii</i> | Resident | 1 5 | + |
| | <i>Ctenotus australis</i> | Resident | 1 | |
| | <i>Ctenotus impar</i> | Resident | 1 | |
| | <i>Ctenotus labillardieri</i> | Resident | 1 | + |
| Coastal Plains Skink | <i>Ctenotus ora</i> | CS2 (P3) | 1 2 | |
| King's Skink | <i>Egernia kingii</i> | Resident | 1 5 | + |
| Salmon-bellied Skink | <i>Egernia napoleonis</i> | Resident | 1 5 | |
| | <i>Hemiergis quadrilineata</i> | Resident | 1 5 | + |
| South-western Orange-tailed Slider | <i>Lerista distinguenda</i> | Resident | 1 5 | |
| | <i>Lerista elegans</i> | Resident | 1 5 | + |
| Western Mourning Skink | <i>Lissolepis luctuosa</i> | Resident | 1 | |
| Dwarf Skink | <i>Menetia greyii</i> | Resident | 1 5 | + |
| | <i>Morethia lineocellata</i> | Resident | 1 5 | |
| | <i>Morethia obscura</i> | Resident | 1 5 | + |
| Bobtail | <i>Tiliqua rugosa</i> | Resident | 1 5 | + |
| Varanidae (Monitors and goannas) | | | | |
| Bungarra or Sand Goanna | <i>Varanus gouldii</i> | Resident | 1 5 | + |
| Heath Monitor | <i>Varanus rosenbergi</i> | Resident | 1 5 | + |
| Tree Goanna | <i>Varanus tristis</i> | Resident | 5 | + |
| Typhlopidae (Blind snakes) | | | | |
| Southern Blind Snake | <i>Anilius australis</i> | Resident | 1 5 | + |
| Pythonidae (Pythons) | | | | |
| Carpet Python (southwest) | <i>Morelia spilota imbricata</i> | CS3 (LS) | Irregular visitor | 1 |
| Elapidae (Venomous land snakes) | | | | |
| Crowned Snake | <i>Elapognathus coronatus</i> | Resident | 1 5 | + |
| Tiger Snake | <i>Notechis scutatus</i> | Resident | 1 5 | + |
| Gould's Hooded Snake | <i>Parasuta gouldii</i> | Resident | 1 | |
| Mitchell's Short-tailed Snake | <i>Parasuta nigriceps</i> | Resident | 1 5 | + |

| Species | | Status | Expected Occurrence | Source | Recorded |
|---|-------------------------------------|----------|---------------------|---------|----------|
| Dugite | <i>Pseudonaja affinis</i> | | Resident | 1 5 | + |
| Casuariidae (Emus and Cassowaries) | | | | | |
| Emu | <i>Dromaius novaehollandiae</i> | CS3 (WR) | Irregular visitor | 1 4 5 | + |
| Anatidae (Ducks, Geese and Swans) | | | | | |
| Chestnut Teal | <i>Anas castanea</i> | | Irregular visitor | 1 5 | + |
| Grey Teal | <i>Anas gracilis^w</i> | | Regular visitor | 1 4 5 | + |
| Pacific Black Duck | <i>Anas superciliosa</i> | | Regular visitor | 1 4 5 | + X |
| Hardhead | <i>Aythya australis</i> | | Regular visitor | 1 4 5 | + |
| Musk Duck | <i>Biziura lobata</i> | | Regular visitor | 1 4 5 | + |
| Australian Wood Duck | <i>Chenonetta jubata</i> | | Regular visitor | 1 4 5 | + |
| Black Swan | <i>Cygnus atratus</i> | | Regular visitor | 1 4 5 | + |
| Pink-eared Duck | <i>Malacorhynchus membranaceus</i> | | Irregular visitor | 1 4 5 | + |
| Blue-billed Duck | <i>Oxyura australis</i> | CS2 (P4) | Irregular visitor | 1 2 4 5 | + |
| Australasian Shoveler | <i>Spatula rhynchotis</i> | | Irregular visitor | 1 4 5 | + |
| Freckled Duck | <i>Stictonetta naevosa</i> | | Irregular visitor | 1 | |
| Australian Shelduck | <i>Tadorna tadornoides</i> | | Regular visitor | 1 4 5 | + X |
| Phasianidae (Pheasants and Quail) | | | | | |
| Stubble Quail | <i>Coturnix pectoralis</i> | | Resident | 1 4 5 | + |
| Brown Quail | <i>Synoicus ypsilophorus</i> | | Irregular visitor | 1 | + |
| Podicipedidae (Grebes) | | | | | |
| Great Crested Grebe | <i>Podiceps cristatus</i> | | Regular visitor | 1 5 | + |
| Hoary-headed Grebe | <i>Poliiocephalus poliocephalus</i> | | Regular visitor | 1 4 5 | + |
| Australasian Grebe | <i>Tachybaptus novaehollandiae</i> | | Regular visitor | 1 4 5 | + |
| Columbidae (Pigeons and Doves) | | | | | |
| Rock Dove/Feral Pigeon | <i>Columba livia</i> | Int | Irregular visitor | 1 4 5 | + |
| Crested Pigeon | <i>Ocyphaps lophotes</i> | | Resident | 1 4 5 | + |
| Common Bronzewing | <i>Phaps chalcoptera</i> | CS3 (HS) | Resident | 1 4 5 | + X |
| Brush Bronzewing | <i>Phaps elegans</i> | CS3 (HS) | Irregular visitor | 1 4 5 | + |

| Species | Status | Expected Occurrence | Source | Recorded |
|---|---|----------------------------|-------------------|----------------|
| Laughing Dove | <i>Spilopelia senegalensis</i> | Int | Irregular visitor | 1 4 5 + |
| Spotted Dove | <i>Streptopelia chinensis</i> | Int | Irregular visitor | 1 4 + |
| Cuculidae (Cuckoos) | | | | |
| Fan-tailed Cuckoo | <i>Cacomantis flabelliformis</i> | | Regular visitor | 1 4 5 + |
| Horsfield's Bronze-Cuckoo | <i>Chalcites basalis</i> | | Regular visitor | 1 4 5 + |
| Shining Bronze-Cuckoo | <i>Chalcites lucidus</i> | | Regular visitor | 1 4 5 + |
| Black-eared Cuckoo | <i>Chalcites osculans</i> | | Vagrant | 1 |
| Pallid Cuckoo | <i>Heteroscenes pallidus</i> | | Regular visitor | 1 4 5 + |
| Recurvirostridae (Stilts and Avocets) | | | | |
| Banded Stilt | <i>Cladorhynchus leucocephalus</i> ^w | | Irregular visitor | 1 4 5 + |
| Pied Stilt | <i>Himantopus leucocephalus</i> ^w | | Regular visitor | 1 4 5 |
| Red-necked Avocet | <i>Recurvirostra novaehollandiae</i> ^w | | Irregular visitor | 1 4 |
| Charadriidae (Plovers, Dotterel and Lapwings) | | | | |
| Red-capped Plover | <i>Charadrius ruficapillus</i> | | Irregular visitor | 1 4 |
| Black-fronted Dotterel | <i>Euseyonis melanops</i> | | Regular visitor | 1 4 5 + |
| Red-kneed Dotterel | <i>Erythrogonys cinctus</i> | | Irregular visitor | 1 4 |
| Pacific Golden Plover | <i>Pluvialis fulva</i> | CS1 (M,Mar,S5) | Irregular visitor | 3 4 |
| Hooded Plover | <i>Thinornis cucullatus</i> | CS2 (Mar,P4) | Irregular visitor | 1 2 4 |
| Banded Lapwing | <i>Vanellus tricolor</i> | | Regular visitor | 1 4 5 + |
| Scolopacidae (Snipe, Sandpipers, Godwits, Curlew, Stints and Phalaropes) | | | | |
| Common Sandpiper | <i>Actitis hypoleucos</i> | CS1 (M,Mar,S5) | Irregular visitor | 1 2 3 4 5 + |
| Sharp-tailed Sandpiper | <i>Calidris acuminata</i> | CS1 (M,Mar,S5) | Irregular visitor | 1 2 3 4 |
| Curlew Sandpiper | <i>Calidris ferruginea</i> | CS1 (C,M,Mar, S3,S5) | Irregular visitor | 1 2 3 4 |
| Pectoral Sandpiper | <i>Calidris melanotos</i> | CS1 (M,Mar,S5) | Vagrant | 3 |
| Red-necked Stint | <i>Calidris ruficollis</i> | CS1 (M,Mar,S5) | Irregular visitor | 1 2 3 4 5 + |

| Species | Status | Expected Occurrence | Source | Recorded |
|---|--|---------------------|-------------------|-----------|
| Long-toed Stint | <i>Calidris subminuta</i> | CS1 (M,Mar,S5) | Vagrant | 3 |
| Bar-tailed Godwit | <i>Limosa lapponica</i> | CS1 (M,Mar,S5) | Vagrant | 1 3 4 |
| Black-tailed Godwit | <i>Limosa limosa</i> ^w | CS1 (M,Mar,S5) | Vagrant | 1 3 |
| Wood Sandpiper | <i>Tringa glareola</i> | CS1 (M,Mar,S5) | Irregular visitor | 1 3 |
| Common Greenshank | <i>Tringa nebularia</i> | CS1 (M,Mar,S5) | Irregular visitor | 1 2 3 4 |
| Marsh Sandpiper | <i>Tringa stagnatilis</i> | CS1 (M,Mar,S5) | Irregular visitor | 1 3 5 + |
| Rostratulidae (Painted Snipe) | | | | |
| Australian Painted-snipe | <i>Rostratula australis</i> ^w | CS1 (E,Mar,S2) | Vagrant | 3 |
| Laridae (Gulls, Terns and Noddies) | | | | |
| Silver Gull | <i>Chroicocephalus novaehollandiae</i> | | Irregular visitor | 1 4 |
| Whiskered Tern | <i>Chlidonias hybrida</i> | | Irregular visitor | 1 |
| Pelecanidae (Pelicans) | | | | |
| Australian Pelican | <i>Pelecanus conspicillatus</i> | | Irregular visitor | 1 4 5 |
| Rallidae (Crakes, Rails and Swampheas) | | | | |
| Eurasian Coot | <i>Fulica atra</i> | | Regular visitor | 1 4 5 + |
| Dusky Moorhen | <i>Gallinula tenebrosa</i> | | Regular visitor | 1 4 5 + |
| Buff-banded Rail | <i>Hypotaenidia philippensis</i> | | Regular visitor | 1 X |
| Australian Spotted Crake | <i>Porzana fluminea</i> | | Irregular visitor | 1 5 |
| Purple Swampheas | <i>Porphyrio porphyrio</i> | | Regular visitor | 1 4 5 + X |
| Black-tailed Native-hen | <i>Tribonyx ventralis</i> | | Irregular visitor | 1 5 + |
| Baillon's Crake | <i>Zapornia pusilla</i> | | Irregular visitor | 1 |
| Spotless Crake | <i>Zapornia tabuensis</i> | | Regular visitor | 1 4 X |
| Turnicidae (Button-quail) | | | | |
| Painted Button-quail | <i>Turnix varius</i> | CS3 (WR) | Regular visitor | 1 4 5 + |
| Podargidae (Frogmouths) | | | | |
| Tawny Frogmouth | <i>Podargus strigoides</i> | | Resident | 1 4 5 + |

| Species | Status | Expected Occurrence | Source | Recorded |
|---|--------------------------------------|---------------------|-------------------|-----------|
| Aegothelidae (Owlet-nightjars) | | | | |
| Australian Owlet-nightjar | <i>Aegotheles cristatus</i> | | Regular visitor | 1 4 |
| Apodidae (Swifts and Swiftlets) | | | | |
| Fork-tailed Swift | <i>Apus pacificus</i> | CS1 (M,Mar,S5) | Irregular visitor | 1 3 + |
| Ardeidae (Herons, Egrets and Bitterns) | | | | |
| Great Egret | <i>Ardea alba</i> | | Regular visitor | 1 4 5 + |
| White-necked Heron | <i>Ardea pacifica</i> | | Irregular visitor | 1 4 5 + |
| Australasian Bittern | <i>Botaurus poiciloptilus</i> | CS1 (E,S2) | Vagrant | 1 3 |
| Eastern Cattle Egret | <i>Bubulcus coromandus</i> | | Irregular visitor | 4 |
| Little Egret | <i>Egretta garzetta</i> ^w | | Irregular visitor | 1 4 |
| White-faced Heron | <i>Egretta novaehollandiae</i> | | Regular visitor | 1 4 5 + X |
| Black Bittern | <i>Ixobrychus flavicollis</i> | CS2 (P2) | Irregular visitor | 1 |
| Nankeen Night-Heron | <i>Nycticorax caledonicus</i> | | Regular visitor | 1 4 5 + |
| Threskiornithidae (Ibis and Spoonbills) | | | | |
| Yellow-billed Spoonbill | <i>Platalea flavipes</i> | | Regular visitor | 1 4 5 + |
| Royal Spoonbill | <i>Platalea regia</i> ^w | | Vagrant | 1 |
| Glossy Ibis | <i>Plegadis falcinellus</i> | CS1 (M,Mar,S5) | Vagrant | 1 2 4 |
| Australian White Ibis | <i>Threskiornis moluccus</i> | | Regular visitor | 1 4 5 + |
| Straw-necked Ibis | <i>Threskiornis spinicollis</i> | | Regular visitor | 1 4 5 + |
| Phalacrocoracidae (Cormorants and Shags) | | | | |
| Little Pied Cormorant | <i>Microcarbo melanoleucos</i> | | Regular visitor | 1 4 5 + X |
| Great Cormorant | <i>Phalacrocorax carbo</i> | | Vagrant | 1 4 5 + |
| Little Black Cormorant | <i>Phalacrocorax sulcirostris</i> | | Irregular visitor | 1 4 5 + |
| Pied Cormorant | <i>Phalacrocorax varius</i> | | Irregular visitor | 1 4 5 + |
| Anhingidae (Darter) | | | | |
| Australasian Darter | <i>Anhinga novaehollandiae</i> | | Irregular visitor | 1 4 5 + X |
| Pandionidae (Osprey) | | | | |
| Eastern Osprey | <i>Pandion cristatus</i> | CS1 (M,Mar,S5) | Irregular visitor | 2 3 4 |

| Species | | Status | Expected Occurrence | Source | Recorded |
|---|---------------------------------|----------|---------------------|---------|----------|
| Accipitridae (Eagles, Kites, Goshawks) | | | | | |
| Collared Sparrowhawk | <i>Accipiter cirrocephalus</i> | CS3 (WR) | Regular visitor | 1 4 5 | + |
| Brown Goshawk | <i>Accipiter fasciatus</i> | CS3 (WR) | Regular visitor | 1 4 5 | + |
| Wedge-tailed Eagle | <i>Aquila audax</i> | CS3 (WR) | Regular visitor | 1 4 5 | + |
| Swamp Harrier | <i>Circus approximans</i> | | Regular visitor | 1 4 5 | + |
| Spotted Harrier | <i>Circus assimilis</i> | | Irregular visitor | 1 4 | |
| Black-shouldered Kite | <i>Elanus axillaris</i> | | Regular visitor | 1 4 5 | + X |
| Letter-winged Kite | <i>Elanus scriptus</i> | CS2 (P4) | Vagrant | 1 | |
| White-bellied Sea-Eagle | <i>Haliaeetus leucogaster</i> | | Irregular visitor | 1 4 | |
| Whistling Kite | <i>Haliastur sphenurus</i> | CS3 (WR) | Regular visitor | 1 4 5 | + |
| Little Eagle | <i>Hieraaetus morphnoides</i> | CS3 (WR) | Regular visitor | 1 4 5 | + |
| Square-tailed Kite | <i>Lophoictinia isura</i> | CS3 (WR) | Regular visitor | 1 4 5 | + |
| Tytonidae (Masked Owls) | | | | | |
| Barn Owl | <i>Tyto alba</i> | | Regular visitor | 1 4 5 | + |
| Masked Owl | <i>Tyto novaehollandiae</i> | CS2 (P3) | Vagrant | 2 | |
| Strigidae (Hawk-Owls) | | | | | |
| Southern Boobook | <i>Ninox novaeseelandiae</i> | | Regular visitor | 1 4 5 | + |
| Meropidae (Bee-eaters) | | | | | |
| Rainbow Bee-eater | <i>Merops ornatus</i> | | Regular migrant | 1 4 5 | + |
| Alcedinidae (Kingfishers) | | | | | |
| Laughing Kookaburra | <i>Dacelo novaeguineae</i> | Int | Resident | 1 4 5 | + |
| Red-backed Kingfisher | <i>Todiramphus pyrrhopygius</i> | | Vagrant | 1 | |
| Sacred Kingfisher | <i>Todiramphus sanctus</i> | | Regular migrant | 1 4 5 | + |
| Falconidae (Falcons) | | | | | |
| Nankeen Kestrel | <i>Falco cenchroides</i> | | Resident | 1 4 5 | + X |
| Australian Hobby | <i>Falco longipennis</i> | | Regular visitor | 1 4 5 | + |
| Brown Falcon | <i>Falco berigora</i> | | Irregular visitor | 1 4 5 | + |
| Peregrine Falcon | <i>Falco peregrinus</i> | CS1 (S7) | Resident | 1 2 4 5 | + X |
| Cacatuidae (Cockatoos and Corellas) | | | | | |

| Species | | Status | Expected Occurrence | Source | Recorded |
|--|--------------------------------------|------------|---------------------|--------------|----------|
| Western Corella | <i>Cacatua pastinator</i> | | Vagrant | 4 | |
| Little Corella | <i>Cacatua sanguinea</i> | | Regular visitor | 1 4 5 | + |
| Forest Red-tailed Black-Cockatoo | <i>Calyptorhynchus banksii naso</i> | CS1 (V,S3) | Regular visitor | 1 2 3 4 5 | + |
| Baudin's Black-Cockatoo | <i>Calyptorhynchus baudinii</i> | CS1 (V,S2) | Regular visitor | 1 2 3 4 5 | + |
| Carnaby's Black-Cockatoo | <i>Calyptorhynchus latirostris</i> | CS1 (E,S2) | Regular visitor | 1 2 3 4 5 | + |
| Galah | <i>Eolophus roseicapilla</i> | | Resident | 1 4 5 | + |
| Psittaculidae (Parrots, Lorikeets and Rosellas) | | | | | |
| Australian Ringneck | <i>Barnardius zonarius</i> | | Resident | 1 4 5 | + X |
| Purple-crowned Lorikeet | <i>Glossopsitta porphyrocephala</i> | | Irregular visitor | 1 4 5 | + |
| Elegant Parrot | <i>Neophema elegans</i> | | Resident | 1 4 5 | + X |
| Western Rosella | <i>Platycercus icterotis</i> | | Irregular visitor | 1 4 5 | + |
| Regent Parrot | <i>Polytelis anthopeplus</i> | | Regular visitor | 1 4 5 | + |
| Red-capped Parrot | <i>Purpureicephalus spurius</i> | | Resident | 1 4 5 | + X |
| Rainbow Lorikeet | <i>Trichoglossus haematodus</i> | Int | Vagrant | 1 4 | |
| Climacteridae (Treecreepers) | | | | | |
| Rufous Treecreeper | <i>Climacteris rufus</i> | | Vagrant | 1 4 | |
| Maluridae (Fairy-wrens, Emu-wrens and Grasswrens) | | | | | |
| Red-winged Fairy-wren | <i>Malurus elegans</i> | CS3 (HS) | Regular visitor | 1 4 5 | + |
| Splendid Fairy-wren | <i>Malurus splendens</i> | CS3 (HS) | Resident | 1 4 5 | + |
| Southern Emu-wren | <i>Stipiturus malachurus</i> | CS3 (HS) | Irregular visitor | 1 | |
| Meliphagidae (Honeyeaters and Chats) | | | | | |
| Western Spinebill | <i>Acanthorhynchus superciliosus</i> | | Regular visitor | 1 4 5 | + |
| Red Wattlebird | <i>Anthochaera carunculata</i> | | Regular visitor | 1 4 5 | + X |
| Western Wattlebird | <i>Anthochaera lunulata</i> | CS3 (WR) | Regular visitor | 1 4 5 | + |
| White-fronted Chat | <i>Epthianura albifrons</i> | | Irregular visitor | 1 4 5 | |
| Singing Honeyeater | <i>Gavicalis virescens</i> | | Regular visitor | 1 4 5 | + |
| Tawny-crowned Honeyeater | <i>Glyciphila melanops</i> | CS3 (WR) | Irregular visitor | 1 4 | |

| Species | Status | Expected Occurrence | Source | Recorded |
|--|-------------------------------------|---------------------|-------------------|-----------|
| Brown Honeyeater | <i>Lichmera indistincta</i> | Resident | 1 4 5 | + X |
| Yellow-throated Miner | <i>Manorina flavigula</i> | CS3 (WR) | Irregular visitor | 4 |
| Brown-headed Honeyeater | <i>Melithreptus brevirostris</i> | | Irregular visitor | 1 4 |
| Gilbert's Honeyeater | <i>Melithreptus chloropsis</i> | | Irregular visitor | 1 4 5 + |
| White-cheeked Honeyeater | <i>Phylidonyris niger</i> | CS3 (WR) | Regular visitor | 1 4 5 + |
| New Holland Honeyeater | <i>Phylidonyris novaehollandiae</i> | CS3 (WR) | Regular visitor | 1 4 5 + |
| Yellow-plumed Honeyeater | <i>Ptilotula ornata</i> | | Irregular visitor | 1 4 |
| Pardalotidae (Pardalotes) | | | | |
| Spotted Pardalote | <i>Pardalotus punctatus</i> | | Regular visitor | 1 4 5 + |
| Striated Pardalote | <i>Pardalotus striatus</i> | | Resident | 1 4 5 + |
| Acanthizidae (Thornbills and Gerygones) | | | | |
| Inland Thornbill | <i>Acanthiza apicalis</i> | CS3 (HS) | Resident | 1 4 5 + |
| Yellow-rumped Thornbill | <i>Acanthiza chrysorrhoa</i> | CS3 (HS) | Resident | 1 4 5 + X |
| Western Thornbill | <i>Acanthiza inornata</i> | CS3 (HS) | Irregular visitor | 1 4 5 + |
| Western Gerygone | <i>Gerygone fusca</i> | | Resident | 1 4 5 + |
| White-browed Scrubwren | <i>Sericornis frontalis</i> | CS3 (HS) | Resident | 1 4 5 + X |
| Weebill | <i>Smicronis brevirostris</i> | CS3 (HS) | Resident | 1 4 5 + |
| Neosittidae (Sittellas) | | | | |
| Varied Sittella | <i>Daphoenositta chrysoptera</i> | CS3 (HS) | Irregular visitor | 1 4 5 + |
| Campephagidae (Cuckoo-shrikes and Trillers) | | | | |
| Black-faced Cuckoo-shrike | <i>Coracina novaehollandiae</i> | | Regular visitor | 1 4 5 + |
| White-winged Triller | <i>Lalage tricolor</i> | | Regular visitor | 1 4 5 + |
| Pachycephalidae (Whistlers, Shrike-thrushes and allies) | | | | |
| Grey Shrike-thrush | <i>Colluricincla harmonica</i> | CS3 (HS) | Irregular visitor | 1 4 5 + |
| Western Whistler | <i>Pachycephala fuliginosa</i> | | Regular visitor | 1 4 5 + |
| Rufous Whistler | <i>Pachycephala rufiventris</i> | | Resident | 1 4 5 + |
| Artamidae (Woodswallows, Currawongs, Butcherbirds and Magpie) | | | | |
| Black-faced Woodswallow | <i>Artamus cinereus</i> | | Resident | 1 4 5 + X |

| Species | Status | Expected Occurrence | Source | Recorded |
|--|---------------------------------|---------------------|-------------------|-----------|
| Dusky Woodswallow | <i>Artamus cyanopterus</i> | CS3 (WR) | Regular visitor | 1 4 5 + |
| Grey Butcherbird | <i>Cracticus torquatus</i> | | Resident | 1 4 5 + X |
| Australian Magpie | <i>Gymnorhina tibicen</i> | | Resident | 1 4 5 + X |
| Grey Currawong | <i>Strepera versicolor</i> | CS3 (WR) | Irregular visitor | 1 4 5 + |
| Rhipiduridae (Fantails) | | | | |
| Grey Fantail | <i>Rhipidura albiscapa</i> | | Resident | 1 4 5 + X |
| Willie Wagtail | <i>Rhipidura leucophrys</i> | | Resident | 1 4 5 + X |
| Corvidae (Crows and Ravens) | | | | |
| Little Crow | <i>Corvus bennetti</i> | | Vagrant | 1 |
| Australian Raven | <i>Corvus coronoides</i> | | Resident | 1 4 5 + X |
| Monarchidae (Monarch and Flycatchers) | | | | |
| Magpie-lark | <i>Grallina cyanoleuca</i> | | Resident | 1 4 5 + X |
| Restless Flycatcher | <i>Myiagra inquieta</i> | | Vagrant | 1 4 |
| Petroicidae (Australian Robins) | | | | |
| Western Yellow Robin | <i>Eopsaltria griseogularis</i> | | Irregular visitor | 1 4 5 + |
| Hooded Robin | <i>Melanodryas cucullata</i> | | Irregular visitor | 1 4 |
| Jacky Winter | <i>Microeca fascinans</i> | | Vagrant | 1 4 |
| Scarlet Robin | <i>Petroica boodang</i> | CS3 (HS) | Regular visitor | 1 4 5 + |
| Red-capped Robin | <i>Petroica goodenovii</i> | | Irregular visitor | 1 4 |
| White-breasted Robin | <i>Quoyornis georgianus</i> | CS3 (HS) | Irregular visitor | 1 4 |
| Dicaeidae (Flowerpeckers) | | | | |
| Mistletoebird | <i>Dicaeum hirundinaceum</i> | | Regular visitor | 1 4 |
| Estrildidae (Weaver Finches) | | | | |
| Red-browed Finch | <i>Neochmia temporalis</i> | | Vagrant | 1 |
| Red-eared Firetail | <i>Stagonopleura oculata</i> | | Irregular visitor | 1 4 |
| Motacillidae (Pipits and Wagtails) | | | | |
| Australasian Pipit | <i>Anthus novaeseelandiae</i> | | Resident | 1 4 5 + X |
| Locustellidae (Grassbirds) | | | | |
| Brown Songlark | <i>Cincloramphus cruralis</i> | | Regular visitor | 1 4 |

| Species | Status | Expected Occurrence | Source | Recorded | |
|--|--------------------------------|---------------------|-------------------|----------|-----|
| Rufous Songlark | <i>Cincloramphus mathewsi</i> | Regular visitor | 1 4 5 | + | |
| Little Grassbird | <i>Poodytes gramineus</i> | Regular visitor | 1 4 | | |
| Acrocephalidae (Reed-Warblers) | | | | | |
| Australian Reed-Warbler | <i>Acrocephalus australis</i> | Regular visitor | 1 4 5 | + | |
| Hirundinidae (Swallows and Martins) | | | | | |
| Fairy Martin | <i>Petrochelidon ariel</i> | Regular visitor | 1 5 | + | |
| Tree Martin | <i>Petrochelidon nigricans</i> | Resident | 1 4 5 | + | |
| Welcome Swallow | <i>Hirundo neoxena</i> | Resident | 1 4 5 | + X | |
| Zosteropidae (White-eyes) | | | | | |
| Silvereye | <i>Zosterops lateralis</i> | Resident | 1 4 5 | + | |
| Tachyglossidae (Echidnas) | | | | | |
| Short-beaked Echidna | <i>Tachyglossus aculeatus</i> | Regular visitor | 5 | + | |
| Dasyuridae (Dasyurids) | | | | | |
| Mardo | <i>Antechinus flavipes</i> | Regular visitor | 1 5 | + | |
| Chuditch | <i>Dasyurus geoffroii</i> | CS1 (V,S3) | Vagrant | 1 2 3 5 | + |
| Brush-tailed Phascogale | <i>Phascogale tapoatafa</i> | CS1 (S6) | Regular visitor | 1 2 5 | + |
| Peramelidae (Bandicoots) | | | | | |
| Quenda | <i>Isodon fusciventer</i> | CS2 (P4) | Resident | 1 2 5 | + |
| Phalangeridae (Brushtail possums) | | | | | |
| Brushtail Possum | <i>Trichosurus vulpecula</i> | | Resident | 1 5 | + X |
| Macropodidae (Kangaroos) | | | | | |
| Western Grey Kangaroo | <i>Macropus fuliginosus</i> | | Resident | 1 5 | + X |
| Brush Wallaby | <i>Notamacropus irma</i> | CS2 (P4) | Irregular visitor | 1 2 5 | + |
| Muridae (Rats and mice) | | | | | |
| House Mouse | <i>Mus musculus</i> | Int | Resident | 1 5 | + X |
| Water-rat, Rakali | <i>Hydromys chrysogaster</i> | CS2 (P4) | Regular visitor | 1 2 5 | + |
| Brown Rat | <i>Rattus norvegicus</i> | Int | Resident | | X |
| Black Rat | <i>Rattus rattus</i> | Int | Resident | 1 5 | + X |
| Leporidae (Rabbits and hares) | | | | | |

| Species | | Status | Expected Occurrence | Source | Recorded |
|---|---------------------------------------|---------|---------------------|--------|----------------|
| Rabbit | <i>Oryctolagus cuniculus</i> | Int | Resident | 5 | + |
| Molossidae (Freetail bats) | | | | | |
| White-striped Free-tailed Bat | <i>Austronomus australis</i> | | Regular visitor | 5 | + |
| Southern Freetail-Bat | <i>Mormopterus kitcheneri</i> | | Regular visitor | 5 | |
| Vespertilionidae (Vespertilionid bats) | | | | | |
| Gould's Wattled Bat | <i>Chalinolobus gouldii</i> | | Regular visitor | 1 | + X |
| Chocolate Wattled Bat | <i>Chalinolobus morio</i> | | Regular visitor | 5 | + |
| Western False Pipistrelle | <i>Falsistrellus mackenziei</i> | CS2(P4) | Vagrant | 2 | |
| Lesser Long-eared Bat | <i>Nyctophilus geoffroyi</i> | | Regular visitor | 1 | X ² |
| Holt's Long-eared Bat | <i>Nyctophilus holtorum (gouldii)</i> | | Regular visitor | 1 5 | |
| Western Long-eared Bat | <i>Nyctophilus major</i> | | Regular visitor | 1 | |
| Southern Forest Bat | <i>Vespadelus regulus</i> | | Regular visitor | 1 5 | + X |
| Suidae (Pigs) | | | | | |
| Pig | <i>Sus scrofa</i> | Int | Regular visitor | 1 5 | + |
| Bovidae (Horned ruminants) | | | | | |
| European Cattle | <i>Bos taurus</i> | Int | Regular visitor | 5 | + X |
| Canidae (Dogs) | | | | | |
| Red Fox | <i>Vulpes vulpes</i> | Int | Resident | 1 5 | + |
| Dog | <i>Canis familiaris</i> | Int | Regular visitor | 5 | + |
| Felidae (Cats) | | | | | |
| Cat | <i>Felis catus</i> | Int | Resident | 1 5 | + |

² Identification of long-eared bat species from recordings is uncertain, but the most likely species to have been detected is the Lesser Long-eared Bat.

Appendix 8. Species returned from the literature review that have been omitted from the expected species list because of habitat or range limitations, or because they are now considered locally extinct.

Note that some birds could still occur as extremely rare vagrants.

Status codes:

CS1, CS2, CS3 = (summary) levels of conservation significance. See Appendix 1 for full explanation.

EPBC Act listings: E = Endangered, V = Vulnerable, M = Migratory, Mar = Marine (see Appendix 2).

Biodiversity Conservation Act 2016 listings: S1 to S7 = Schedules 1 to 7 (see Appendix 2).

DBCAs Priority species: P1 to P4 = Priority 1 to 4 (see Appendix 2).

Int = introduced species.

Source:

1 = Atlas of Living Australia (ALA 2022), 2 = NatureMap (DBCAs 2022), 3 = Protected Matters Search Tool (DAWE 2022), 4 = Birdlife Australia (Birdlife 2022) 5 = BCE records.

Table i. Species considered locally extinct.

| Species | | Status | Source |
|--|-----------------------------------|-------------|--------|
| Galaxiidae (Galaxias or native minnows) | | | |
| Black-striped Minnow | <i>Galaxiella nigrostriata</i> | CS1 (E S2) | 3 |
| Otididae (Bustards) | | | |
| Australian Bustard | <i>Ardeotis australis</i> | | 1 |
| Burhinidae (Stone-curlews) | | | |
| Bush Stone-curlew | <i>Burhinus grallarius</i> | | 1 4 |
| Dasyuridae (Dasyurids) | | | |
| Dusky Dunnart | <i>Sminthopsis fuliginosus</i> | | 1 |
| Myrmecobiidae (Numbats) | | | |
| Numbat | <i>Myrmecobius fasciatus</i> | CS1 (E,S2) | 1 2 |
| Burramyidae (Pygmy possums) | | | |
| Western Pygmy-possum, Mundarda | <i>Cercartetus concinnus</i> | CS3 (LS) | 1 |
| Pseudocheiridae (Ringtail possums) | | | |
| Western Ringtail Possum | <i>Pseudocheirus occidentalis</i> | CS1 (Cr,S1) | 1 2 3 |
| Macropodidae (Kangaroos) | | | |
| Quokka | <i>Setonix brachyurus</i> | CS1 (V,S3) | 2 3 |
| Tarsipedidae (Honey Possum) | | | |
| Honey Possum, Noolbenger | <i>Tarsipes rostratus</i> | CS3 (LS) | 5 |
| Potoroidae (Bettongs) | | | |
| Woylie | <i>Bettongia penicillata</i> | CS1 (E,S1) | 2 |

| | | | | |
|--------------|------------------------|----------|----------|---|
| Perth Slider | <i>Lerista lineata</i> | CS2 (P3) | Resident | 1 |
|--------------|------------------------|----------|----------|---|

Table ii. Species omitted due to habitat or range limitations.

| Species | Status | Reason for omission | Source | |
|---|------------------------------------|---------------------|---------|---|
| Gobiidae (Gobies) | | | | |
| Southwestern Goby | <i>Afurcagobius suppositus</i> | Habitat | 1 | |
| Gonorhynchidae (Beaked Salmon) | | | | |
| Ratfish | <i>Gonorynchus greyi</i> | Habitat | 1 | |
| Hemiramphidae (Garfish) | | | | |
| River Garfish | <i>Hyporhamphus regularis</i> | Habitat | 1 | |
| Labridae (Wrasse) | | | | |
| tubemouth | <i>Siphonognathus argyrophanes</i> | Habitat | 1 | |
| Clupeidae (Herring) | | | | |
| Perth Herring | <i>Nematalosa vlaminghi</i> | Habitat | 1 | |
| Lamnidae (White Sharks) | | | | |
| Great White Shark | <i>Carcharodon carcharias</i> | CS1 (V,M,S3) | Habitat | 3 |
| Sphyrnidae (Hammerhead Sharks) | | | | |
| Scalloped Hammerhead | <i>Sphyrna lewini</i> | CS1 (CD) | Habitat | 3 |
| Mobulidae (Manta Rays and Devilfish) | | | | |
| Reef Manta Ray | <i>Mobula alfredi</i> | CS1 (M) | Habitat | 3 |
| Giant Manta Ray | <i>Mobula birostris</i> | CS1 (M) | Habitat | 3 |
| Pristidae (Sawfish) | | | | |
| Freshwater Sawfish | <i>Pristis pristis</i> | CS1 (V,M,P3) | Habitat | 3 |
| Scombridae (Mackerel, Tuna and Bonito) | | | | |
| Southern Bluefin Tuna | <i>Thunnus maccoyii</i> | | Habitat | 3 |
| Limnodynastidae (Burrowing frogs) | | | | |
| Western Spotted Frog | <i>Heleioporus albopunctatus</i> | | Range | 1 |
| Western Marsh Frog | <i>Heleioporus barycragus</i> | | Range | 1 |
| Plains Frog | <i>Heleioporus inornatus</i> | | Range | 1 |
| Myobatrachidae (Ground frogs) | | | | |

| Species | | Status | Reason for omission | Source |
|--|---|----------------|---------------------|--------|
| Turtle Frog | <i>Myobatrachus gouldii</i> | | Habitat | 1 |
| Cheloniidae (Hard-shelled sea turtles) | | | | |
| Loggerhead Turtle | <i>Caretta caretta</i> ^o | CS1 (E,Mar,S2) | Habitat | 3 |
| Green Turtle | <i>Chelonia mydas</i> ^o | CS1 (V,Mar,S3) | Habitat | 3 |
| Flatback Turtle | <i>Natator depressus</i> ^o | CS1 (V,Mar,S3) | Habitat | 3 |
| Carphodactylidae (Carphodactylid geckoes) | | | | |
| Southern Barking Gecko | <i>Underwoodisaurus milii</i> | | Habitat | 1 5 |
| Diplodactylidae (Diplodactylid geckoes) | | | | |
| Speckled Stone Gecko | <i>Diplodactylus lateroides</i> | | Range | 1 |
| Spotted Sandplain Gecko | <i>Diplodactylus polyophthalmus</i> | | Habitat | 5 |
| Scincidae (Skinks) | | | | |
| | <i>Cryptoblepharus plagioccephalus</i> | | Range | 5 |
| Bar-shouldered Ctenotus | <i>Ctenotus inornatus</i> | | Range | 1 |
| Gilled Slender Blue-tongue | <i>Cyclodomorphus branchialis</i> | | Range | 1 |
| South-western Mulch-skink | <i>Hemiergis gracilipes</i> | | Range | 1 |
| | <i>Hemiergis initialis</i> | | Range | 1 5 |
| Lowlands Earless Skink | <i>Hemiergis peronii</i> | | Range | 1 |
| Dark-flecked Garden Sunskink | <i>Lampropholis delicata</i> | Int. | Range | 1 |
| Pale-flecked Garden Sunskink | <i>Lampropholis guichenoti</i> | Int. | Range | 1 |
| Perth Slider | <i>Lerista lineata</i> | CS2 (P3) | Habitat | 1 |
| | <i>Lerista microtis</i> | | Range | 1 |
| South-western Rock-skink | <i>Liopholis pulchra</i> | | Range | 1 |
| Typhlopidae (Blind snakes) | | | | |
| Rotund Blind Snake | <i>Anilius pinguis</i> | | Range | 1 |
| Boidae (pythons) | | | | |
| Woma | <i>Aspidites ramsayi</i> (southwest subpop.) | CS2 (P1) | Range | 2 |
| Elapidae (Venomous land snakes) | | | | |
| Yellow-faced Whipsnake | <i>Demansia psammophis</i> | | Range | 1 |
| Western Brown Snake | <i>Pseudonaja mengdeni</i> | | Range | 1 |
| Megapodiidae (Megapodes) | | | | |
| Malleefowl | <i>Leipoa ocellata</i> | CS1 (V,S3) | Range | 3 |

| Species | | Status | Reason for omission | Source |
|---|---|---------------------|---------------------|---------|
| Phasianidae (Pheasants and Quail) | | | | |
| Indian Peafowl | <i>Pavo cristatus</i> | Int | Range | 1 |
| Haematopodidae (Oystercatchers) | | | | |
| Australian Pied Oystercatcher | <i>Haematopus longirostris</i> ^w | | Habitat | 1 4 |
| Charadriidae (Plovers, Dotterel and Lapwings) | | | | |
| Greater Sand Plover | <i>Charadrius leschenaultii</i> ^w | CS1 (M,Mar,S3,S5) | Habitat | 1 2 3 4 |
| Lesser Sand Plover | <i>Charadrius mongolus</i> ^w | CS1 (E,M,S2) | Habitat | 3 |
| Grey Plover | <i>Pluvialis squatarola</i> ^w | CS1 (M,Mar,S5) | Habitat | 1 2 4 |
| Scolopacidae (Snipe, Sandpipers, Godwits, Curlew, Stints and Phalaropes) | | | | |
| Ruddy Turnstone | <i>Arenaria interpres</i> ^w | CS1 (M,Mar,S5) | Habitat | 1 2 3 4 |
| Sanderling | <i>Calidris alba</i> ^w | CS1 (M,Mar,S5) | Habitat | 1 2 3 4 |
| Red Knot | <i>Calidris canutus</i> ^w | CS1 (M,Mar,S5) | Habitat | 1 3 4 |
| Great Knot | <i>Calidris tenuirostris</i> ^w | CS1 (M,Mar,S3,S5) | Habitat | 1 2 3 4 |
| Broad-billed Sandpiper | <i>Limicola falcinellus</i> ^w | CS1 (M,S5) | Habitat | 3 |
| Eastern Curlew | <i>Numenius madagascariensis</i> ^w | CS1 (C,M,Mar,S3,S5) | Habitat | 1 3 4 |
| Little Curlew | <i>Numenius minutus</i> ^w | CS1 (M,S5) | Range | 1 |
| Whimbrel | <i>Numenius phaeopus</i> ^w | CS1 (M,Mar,S5) | Habitat | 3 4 |
| Grey-tailed Tattler | <i>Tringa brevipes</i> ^w | CS1 (M,Mar,S5,P4) | Habitat | 1 3 4 |
| Common Redshank | <i>Tringa totanus</i> | CS1 (M,S5) | Range | 3 |
| Laridae (Gulls, Terns and Noddies) | | | | |
| Common Noddy | <i>Anous stolidus</i> ^o | CS1 (M,Mar,S5) | Habitat | 3 |
| Common Tern | <i>Sterna hirundo</i> | CS1 (M,S5) | Habitat | 1 |
| Fairy Tern | <i>Sternula nereis</i> ^w | CS1 (V,Mar,S3) | Habitat | 3 4 |
| Caspian Tern | <i>Hydroprogne caspia</i> ^w | CS1 (M,Mar,S5) | Habitat | 1 2 4 |
| White-winged Black Tern | <i>Chlidonias leucopterus</i> ^w | CS1 (M,Mar,S5) | Habitat | 1 |
| Crested Tern | <i>Thalasseus bergii</i> ^w | CS1 (M,Mar,S5) | Habitat | 1 4 |
| Diomedeidae (Albatrosses) | | | | |
| Amsterdam Albatross | <i>Diomedea amsterdamensis</i> ^o | CS1 (E,M,Mar,S1) | Habitat | 3 |
| Tristan Albatross | <i>Diomedea dabbenena</i> ^o | CS1 (E,M,Mar,S1) | Habitat | 3 |
| Southern Royal Albatross | <i>Diomedea epomophora</i> ^o | CS1 (V,M,Mar,S3) | Habitat | 3 |

| Species | Status | Reason for omission | Source |
|--|--|---------------------|-------------|
| Wandering Albatross | <i>Diomedea exulans</i> ^o | CS1 (V,M,Mar,S3) | Habitat 1 3 |
| Northern Royal Albatross | <i>Diomedea sanfordi</i> ^o | CS1 (E,M,Mar,S2) | Habitat 3 |
| Campbell Albatross | <i>Thalassarche impavida</i> ^o | CS1 (V,M,Mar,S3) | Habitat 3 |
| Black-browed Albatross | <i>Thalassarche melanophris</i> ^o | CS1 (V,M,Mar,S2) | Habitat 3 |
| White-capped Albatross | <i>Thalassarche steadi</i> ^o | CS1 (V,M,Mar,S3) | Habitat 3 |
| Procellariidae (Petrels and Shearwaters) | | | |
| Southern Giant-Petrel | <i>Macronectes giganteus</i> ^o | CS1 (E,M,Mar,S5) | Habitat 3 |
| Northern Giant Petrel | <i>Macronectes halli</i> ^o | CS1 (V,M,Mar,S5) | Habitat 3 |
| Antarctic Prion | <i>Pachyptila desolata</i> ^o | | Habitat 1 |
| Slender-billed Prion | <i>Pachyptila belcheri</i> ^o | | Habitat 1 |
| Fairy Prion | <i>Pachyptila turtur</i> ^o | | Habitat 3 |
| Broad-billed Prion | <i>Pachyptila vittata</i> ^o | | Habitat 1 |
| Falconidae (Falcons) | | | |
| Grey Falcon | <i>Falco hypoleucos</i> | | Range 3 |
| Cacatuidae (Cockatoos and Corellas) | | | |
| Cockatiel | <i>Nymphicus hollandicus</i> | | Range 1 4 |
| Sulphur-crested Cockatoo | <i>Cacatua galerita</i> | Int | Range 1 |
| Psittaculidae (Parrots, Lorikeets and Rosellas) | | | |
| Bourke's Parrot | <i>Neopsephotus bourkii</i> | | Range 1 |
| Ring-necked Parakeet | <i>Psittacula krameri</i> | Int. | Range 4 |
| Maluridae (Fairy-wrens, Emu-wrens and Grasswrens) | | | |
| Purple-backed Fairy-wren | <i>Malurus assimilis</i> | CS3 (HS) | Range 4 |
| Superb Fairy-wren | <i>Malurus cyaneus</i> | | Range 1 |
| Acanthizidae (Thornbills and Gerygones) | | | |
| Yellow Thornbill | <i>Acanthiza nana</i> | CS3 (HS) | Range 1 |
| Shy Heathwren | <i>Hylacola cauta</i> | CS3 (HS) | Range 5 |
| Atrichornithidae (Scrubbirds) | | | |
| Noisy Scrubbird | <i>Atrichornis clamosus</i> | CS1 (ES2) | Range 1 2 3 |
| Campephagidae (Cuckoo-shrikes and Trillers) | | | |
| Ground Cuckoo-shrike | <i>Coracina maxima</i> | | Range 1 |
| Artamidae (Woodswallows, Currawongs, Butcherbirds and Magpie) | | | |

| Species | | Status | Reason for omission | Source |
|---|--|----------------|---------------------|--------|
| Pied Butcherbird | <i>Cracticus nigrogularis</i> | | Range | 1 4 5 |
| Petroicidae (Australian Robins) | | | | |
| Eastern Yellow Robin | <i>Eopsaltria australis</i> | | Range | 1 |
| Motacillidae (Pipits and Wagtails) | | | | |
| Grey Wagtail | <i>Motacilla cinerea</i> | CS1 (M,Mar,S5) | Range | 3 |
| Dasyuridae (Dasyurids) | | | | |
| Gilbert's Dunnart | <i>Sminthopsis gilberti</i> | | Range | 1 5 |
| Otariidae (Eared seals) | | | | |
| Australian Sea Lion | <i>Neophoca cinerea</i> ^o | CS1 (V,Mar,S3) | Habitat | 3 |
| Equidae (Horses) | | | | |
| Horse | <i>Equus caballus</i> | Int | Range | 1 |
| Balaenidae (Right whales) | | | | |
| Pygmy Right Whale | <i>Caperea marginata</i> ^o | CS1 (M) | Habitat | 3 |
| Balaenopteridae (Rorquals) | | | | |
| Bryde's Whale | <i>Balaenoptera edeni</i> ^o | CS1 (M) | Habitat | 3 |
| Humpback Whale | <i>Megaptera novaeangliae</i> ^o | CS1 (V,M,S3) | Habitat | 3 |
| Kogiidae (Pygmy sperm whales) | | | | |
| Dwarf Sperm Whale | <i>Kogia sima</i> | CS1 (M) | Habitat | 1 |

Appendix 9. Annotated species list of birds observed during the site inspection of the project area, May and June 2022.

1. Australian Shelduck. Five in dam near Black Tom Brook.
2. Pacific Black Duck. One on dam near Black Tom Brook.
3. Little Pied Cormorant. One on dam near Black Tom Brook.
4. Darter. One on dam near Black Tom Brook.
5. Common Bronzewing. One on cameras BCE11.
6. White-faced Heron. Several seen along drains and in cameras.
7. Spotless Crake. Heard in drain near BCE11.
8. Buff-banded Rail. One on camera BCE11.
9. Nankeen Kestrel. Pair over paddocks in NW.
10. Black-shouldered Kite. Pair over paddocks in NW. Nest building in clump of trees in paddocks.
11. Peregrine Falcon. One in tree near Black-shouldered Kites.
12. Elegant Parrot. Few in W paddocks.
13. Australian Ringneck. Pairs and small groups where there are trees.
14. Red-capped Parrot. Few in Marri along roads in north.
15. Yellow-rumped Thornbill. Few along remnant Marri along road in north.
16. White-browed Scrubwren. Heard along drain in lower west and on BCE02.
17. Grey Fantail. Few in areas of remnant and planted trees.
18. Willie Wagtail. Few along drains and in paddocks.
19. Red Wattlebird. Few in areas of remnant and planted trees.
20. Brown Honeyeater. Few along drain near BCE41.
21. Black-faced Woodswallow. Few in paddocks in west.
22. Grey Butcherbird. Heard and seen along Marri verge in north.
23. Australian Magpie. Several parties in paddocks and near trees.
24. Australian Raven. Few throughout.
25. Magpie-lark. Pairs in paddocks.
26. Welcome Swallow. Few flying along drains.
27. Australian Pipit. Pair along track near BCE11.

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