



Kwinana Nickel Refinery, Flora, Vegetation and Fauna Assessment

BHP Nickel West

9 April 2019



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EXECUTIVE SUMMARY

BHP Nickel West (Nickel West) operates the Kwinana Nickel Refinery in Kwinana, approximately 45 kilometres (km) south of Perth, Western Australia, with the Northern end of the Site in the City of Kwinana and the Southern end of the Site in the City of Rockingham. Biologic Environmental Survey Pty Ltd (Biologic) was commissioned by Nickel West to undertake flora (Reconnaissance Flora Survey) and fauna (Level 1 fauna and black cockatoo Habitat) assessments, specifically to document any significant values (conservation significant flora, vegetation, fauna and habitat trees) to assist with a Native Vegetation Clearing Permit (NVCP) application. The Study Area is approximately 38 hectares (ha) and includes the current refinery area and indicative future disturbance areas.

A total of 50 vascular flora taxa, including 22 native and 28 non-native taxa, were recorded from the Study Area. No threatened or priority listed flora occur or potentially occur in the Study Area. Of the 28 non-native taxa recorded from the Study Area, three are considered to be significant environmental weeds, **Asparagus asparagoides*, **Tamarix aphylla* and **Gomphocarpus fruticosus*. Of the three significant environmental weeds, two (**Asparagus asparagoides* and **Tamarix aphylla*) are listed as Weeds of National Significance, while also being listed as Declared Plant Pests under Section 22(2) of the *Biosecurity and Agriculture Management Act 2007* (BAM Act). **Gomphocarpus fruticosus* is listed as a Declared Plant Pest, however not for the local government areas of the City of Kwinana and the City of Rockingham.

Five vegetation units were described and delineated from the Study Area with only one unit, EgR, consisting of a natural structural differentiation with an upper, middle and lower stratum. The remaining vegetation units mainly consisted of an upper and a lower stratum, of which the lower stratum was dominated by grasses and herbs. In addition to the introduced herbs and grasses, many of the upper storey species are non-native or naturalised. The condition of the vegetation units ranged from degraded to completely degraded, with the majority completely degraded. Vegetation unit EgR was considered to be degraded, while the remainder were completely degraded. Excluding the areas of vegetation, the remainder of the Study Area is considered to be cleared and consists of the infrastructure associated with the Nickel Refinery.

Despite the occurrence of the Study Area within the buffer zone of a TEC, the vegetation units mapped in the Study Area are not representative of any known TECs or PECs. This is mostly due to the highly altered structure and composition of the vegetation units and the fact they do not represent native vegetation units in good or better condition. No wetlands or environmentally sensitive areas occur within or in close proximity to the Study Area.

The vertebrate fauna desktop assessment was conducted by undertaking several relevant database searches. A total of 77 conservation significant vertebrate fauna species were identified in the desktop review as potentially occurring within the Study Area.

A single fauna habitat was recorded and mapped from the Study Area, rehabilitated woodland, occupying approximately 25.9% of the Study Area, with the remainder comprising existing cleared and

operational areas. The fauna habitat of the Study Area was considered to be of low significance due to its degraded condition and abundance of introduced species, including Red Fox and Rabbit.

A single conservation significant species was recorded during the field survey, Carnaby's Cockatoo. The species was recorded from direct observation of a flock of seven individuals flying overhead, although the species was not observed landing in the Study Area. No evidence of foraging, roosting or nesting by the species was observed.

Potential habitat was recorded for a further seven of the 77 conservation significant species identified in the desktop review and may possibly occur within the Study Area:

- Black-striped Snake (*Neelaps calonotos*) – Priority 3 (DBCA)
- Perth Lined Skink (*Lerista lineata*) – Priority 3 (DBCA)
- Southern Brown Bandicoot (*Isodon fusciventer*) – Priority 4 (DBCA)
- Fork-tailed Swift (*Apus pacificus*) – Migratory (EPBC Act, BC Act)
- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) – Vulnerable (EPBC Act, BC Act)
- Baudin's Cockatoo (*Calyptorhynchus baudinii*) – Endangered (EPBC Act, BC Act)
- Peregrine Falcon (*Falco peregrinus*) – Specially Protected (BC Act)

Of the eight species recorded or considered to possibly occur within the Study Area, all are considered to only be infrequent or occasional visitors due to the degraded condition of fauna habitat within the Study Area as a result of past and current operations and associated impacts.

All three black cockatoo species may occasionally occur within the Study Area to forage and possibly roost; however, nesting is unlikely to occur. A total of 48 black cockatoo potential breeding trees were recorded, including five containing hollows; however, none were current considered suitable for black cockatoo species and none are considered likely to nest within the Study Area. A foraging habitat assessment of the Study Area, with further consideration of other factors not forming part of the standard assessment criteria, such as vegetation condition, habitat quality and other disturbance scored habitat within the Study Area as 'Low' for all three black cockatoo species. Although the initial score for Carnaby's Cockatoo was 'Quality', the actual foraging score is treated as 'Low' given the degraded condition of habitat observed and lack of any past or recent foraging evidence.

Of the eight species recorded of have the potential to occur within the Study Area, it is considered unlikely that any would be dependent on the habitat occurring within the Study Area at a broad scale or that the habitat is critical to the survival of the species.

1 INTRODUCTION

1.1 Background

BHP Nickel West (Nickel West) operates the Kwinana Nickel Refinery in Kwinana, approximately 45 kilometres (km) south of Perth, Western Australia, with the Northern end of the Site in the City of Kwinana and the Southern end of the Site in the City of Rockingham. Biologic Environmental Survey Pty Ltd (Biologic) was commissioned by Nickel West to undertake flora (Reconnaissance Flora Survey) and fauna (Level 1 fauna and black cockatoo habitat) assessments, specifically to document any significant values (conservation significant flora, vegetation, fauna and habitat trees) to assist with a Native Vegetation Clearing Permit (NVCP) application. The Study Area is approximately 38 hectares (ha) and includes the current refinery area and indicative future disturbance areas (Figure 1.1). Biologic are of the understanding that the assessment is required to assist Nickel West with approval for a Native Vegetation Clearing Permit application.

1.2 Objectives

The overarching objective of this assessment was to broadly document the flora, vegetation and fauna values of the Study Area, specifically, to document any significant values (conservation significant flora, vegetation, fauna and habitat trees) that may occur. The key objectives of the assessment are:

- Identify and map the broad vegetation units / habitat types occurring across the Study Area;
- Assess the likelihood of occurrence of flora, vegetation units and vertebrate fauna of conservation significance;
- Provide a report, including an assessment against the 10 Clearing Principles; and
- Provide the spatial data suitable for submission with IBSA.

A letter report detailing the assessment against the 10 Clearing Principles has also been provided on 22 March 2019 (our Ref: 1864_NiW_Kwinana_ClearingPrinciples_v1.0).

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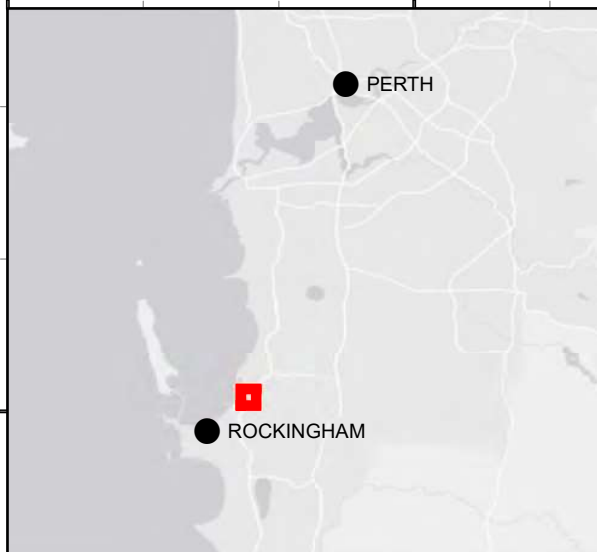
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Legend

 Study Area



N

1:7,000

0 0.05 0.1 0.2 km

BHP Nickel West
Kwinana Nickel Refinery Flora,
Vegetation and Fauna Assessment
Fig. 1.1: Study Area

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A4. Created 03/04/2019

1.3 Background to Protection of Flora and Fauna

Within Western Australia, native flora and fauna are protected under the *Biodiversity Conservation Act 2016* (BC Act) and at a national level under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Any action that has the potential to impact on native fauna or flora needs to be approved by relevant state and/or federal departments as dictated by the state *Environmental Protection Act 1986* (EP Act).

Some species of flora and fauna that are determined to be at risk of extinction or decline are afforded extra protection under these Acts. For the purposes of this report, these species are deemed to be of conservation significance. A summary of applicable legislation and status codes is provided in Table 1.1 and additional information on status codes is provided in Appendix A. A number of migratory bird species are also prioritised for conservation under international agreements and therefore protected under the EPBC Act and BC Act as Migratory.

The EPBC Act identifies Threatened Ecological Communities (TECs) as ecological communities at risk of extinction. The BC Act provides for the statutory listing of TECs by the WA Minister for Environment (the Minister). The Minister has endorsed 69 ecological communities as threatened under critically endangered (20 communities), endangered (17 communities), vulnerable (28 communities) and presumed totally destroyed (four communities).

For some species and ecological communities, there is insufficient information to determine their status. These species are generally considered by the Environmental Protection Authority (EPA) and the Department of Biodiversity, Conservation and Attraction's (DBCA) as being of conservation significance for all development related approvals and are listed on a 'Priority List' that is regularly reviewed and maintained by the DBCA (Table 1.1). TECs that do not meet the criteria for statutory listing by the Minister for Environment are added to DBCA's 'Priority Ecological Communities' (PECs) lists under Priorities 1, 2, 3, 4 (near threatened) or 5 (conservation dependent).

Table 1.1: Definitions and terms for fauna of conservation significance

Agreement, Act or List	Status Codes
Federal	
<p><i>Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)</i></p> <p>The Department of the Environment and Energy (DoEE) lists threatened flora and fauna, which are determined by the Threatened Species Scientific Committee (TSSC) per criteria set out in the Act. The Act lists flora and fauna that are considered to be of conservation significance under one of eight categories (listed under 'Status Codes').</p> <p>Threatened Ecological Communities (TECs) are those that are at risk of extinction.</p>	<ul style="list-style-type: none"> • Extinct (EX) • Extinct in the Wild (EW) • Critically Endangered (CR) • Endangered (EN) • Vulnerable (VU) • Conservation Dependent (CD) • Migratory (MI) • Marine (MA)
State	
<p><i>Biodiversity Conservation Act 2016 (BC Act)</i></p> <p>At a state level, native flora and fauna is protected under the <i>Biodiversity Conservation Act 2016</i>. Species in need of conservation are given a ranking ranging from Critically Endangered to Vulnerable.</p>	<ul style="list-style-type: none"> • Extinct (EX) • Extinct in the Wild (EW) • Critically Endangered (CR) • Endangered (EN) • Vulnerable (VU) • Migratory (MI) • Conservation Dependent Fauna (CD) • Other specially protected species (OS)
<p><i>DBCA Priority List</i></p> <p>DBCA produces a list of Priority species that have not been assigned statutory protection under the <i>Wildlife Conservation Act 1950</i>. This system gives a ranking from Priority 1 to Priority 5.</p>	<ul style="list-style-type: none"> • Priority 1 (Poorly-known species) (P1) • Priority 2 (Poorly-known species) (P2) • Priority 3 (Poorly-known species) (P3) • Priority 4 (Rare, Near Threatened, and other species in need of monitoring) (P4) • Priority 5 (P5)

2 ENVIRONMENT

2.1 Biogeography

The Interim Biogeographic Regionalisation for Australia (IBRA) divides Australia into 89 bioregions based on major biological and geographical or geological attributes (Thackway & Cresswell, 1995). The bioregions have been further divided into 419 subregions which are more localised and homogenous geomorphological units within each bioregion. The Study Area is located within the Perth subregion (SWA02) of the Swan Coastal Plain (SCP) bioregion. The subregional area is 1,333,901 ha in size (Mitchell *et al.*, 2002).

The SCP bioregion is characterised by woodlands and heaths on low-lying colluvial and Aeolian sands, alluvial river flats and a series of wetland networks (Mitchell *et al.*, 2002). The SCP is a low - lying coastal plain, mainly covered with woodlands. It is dominated by Banksia (*Banksia* spp.) or Tuart (*Eucalyptus gomphocephala*) on sandy soils, *Casuarina obesa* on outwash plains, and paperbark (*Melaleuca* spp.) in swampy areas. In the east, the plain rises to duricrusted Mesozoic sediments dominated by Jarrah (*E. marginata*) woodland (Mitchell *et al.*, 2002).

The Perth subregion is composed of colluvial and Aeolian sands, alluvial river flats and coastal limestone. Heath and/or Tuart woodlands on limestone, Banksia and Jarrah - Banksia woodlands on Quaternary marine dunes of various ages, and Marri (*Corymbia calophylla*) on colluvial and alluvial soils. The subregion also includes a complex series of seasonal wetlands (Mitchell *et al.*, 2002).

2.2 Climate

Kwinana, Rockingham and the Swan Coastal Plain is characterised by a Mediterranean climate with warm to hot summers and cool to mild, wet winters (Beard, 1990).

The nearest operating Bureau of Meteorology (BoM) weather station for the Study Area, with relevant long-term and recent climatic data, is located at the Garden Island naval base weather station (station number 009256) (BoM, 2019). The Garden Island naval base weather station is located approximately 7.5 km to the west of the Study Area. The long-term annual rainfall is 603.4 millimetres (mm) per annum (based on 17 years of data collection) with the majority (approximately 76%) falling during the cooler months of May to September (Figure 2.1) (BoM, 2019). The hottest months occur between January and March with temperatures regularly exceeding 30°C (Figure 2.1) (BoM, 2019). The coolest months occur between June and August, with temperatures consistently below 10°C (Figure 2.1) (BoM, 2019).

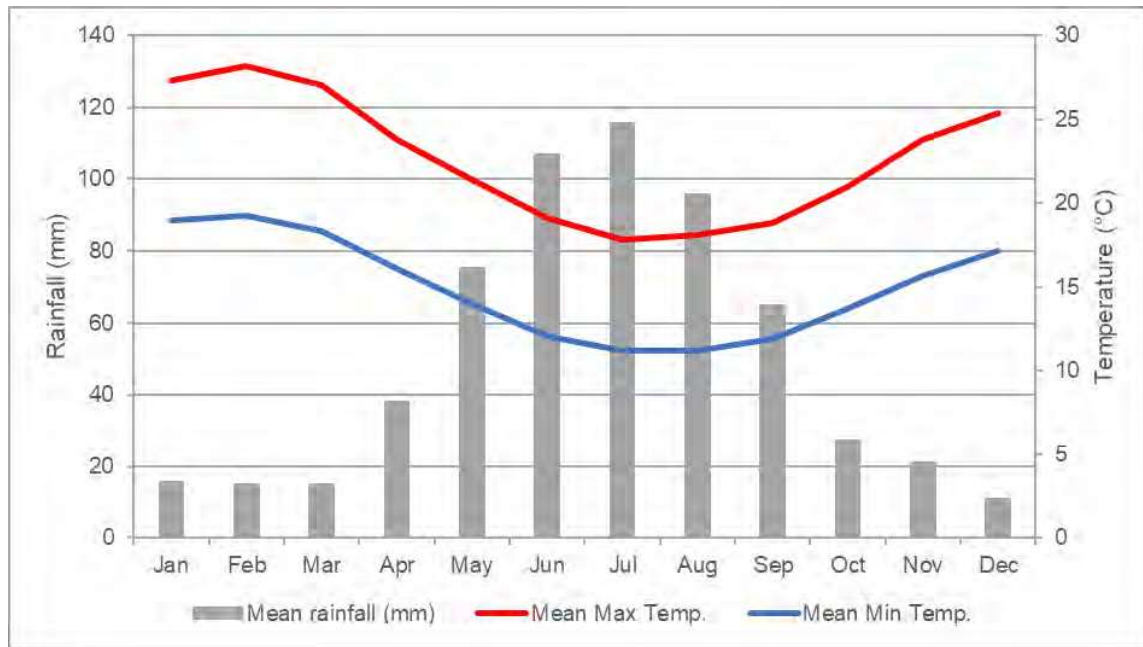


Figure 2.1: Long-term average monthly rainfall and temperature data for the Garden Island Naval Base (BoM, 2019)

2.3 Landforms, Geology and Soils

The Swan Coastal Plain (SCP) is divided into five primary geomorphic units; the Ridge Hill Shelf, the Pinjarra Plain, and three dune systems comprising of the Bassendean Dunes to the east, bordering the Pinjarra Plain, the Spearwood Dunes in the middle and the Quindalup Dunes adjacent to the coast in the west (McArthur & Bettenay, 1974). The Study Area is located within the Quindalup Dunes landforms of the SCP, which consists of calcareous sand, generally unconsolidated and often exhibiting a linear arrangement parallel to the present coastline (McArthur & Bettenay, 1974).

The landforms and soils of the Study Area mostly consist of relict foredunes forming a plain which is topographically low with prominent ridges and swales (Purdie *et al.*, 2004; van Gool *et al.*, 2005). Swamps frequently occupy the swales, while areas of deep calcareous sands have variable organic matter (Purdie *et al.*, 2004; van Gool *et al.*, 2005).

One soil system occurs across the Study Area as described by the Atlas of Australian Soils (ASRIS) (Northcote *et al.*, 1960-1968), which was compiled by the Commonwealth Scientific and Industrial Resource Organisation (CSIRO) to provide a consistent national description of Australia's soils. The soil system is described as: coastal dune formations backed by the low-lying deposits of inlets and estuaries. The chief soils are calcareous sands on the dunes.

2.4 Acid Sulfate Soils

Acid sulfate soils (ASS) is a general term to include potential acid sulfate soils (PASS) and/ or actual acid sulfate soils (AASS), which constitute soils, sediments and/or substrates that contain iron sulfides. ASS are commonly associated with freshwater wetlands, tidal flats, flood plains, shallow estuarine marine deposits and saline sulfate rich groundwater in WA (DER, 2015). Two classes of ASS are recognised:

- Class 1 – high to moderate risk of ASS occurring within 3 m of natural soil surface; and
- Class 2 – moderate to low risk of ASS occurring within 3 m of natural soil surface but high to moderate risk of ASS beyond 3 m of natural soil surface.

The Study Area is not considered to occur within an area considered to be at risk of ASS. The nearest area with a high to moderate risk of ASS is located 1.5 km to the east, associated with wetlands on the east of Mandurah Road.

2.5 Hydrogeology

The groundwater aquifer located below the Study Area is a shallow aquifer of surficial sediments (DoW, 2019). The lithology consists of limestone and calcrete. The age of the geology is Quaternary and is not considered to be a confined aquifer. Depth to groundwater is approximately 3 m below the natural surface, with the base of the aquifer approximately 29 m below the natural surface (DoW, 2019).

2.6 Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESAs) are declared by the Minister for Environment under Section 51B of the *Environmental Protection Act 1986* (EP Act) to prevent incremental degradation of important environmental values such as declared rare flora, threatened ecological communities or significant wetlands. The Study Area occurs within an ESA; however, the part of the ESA the Study Area occurs is associated with the 2 km buffer of a nearby TEC located to the southeast of the Study Area - TEC SCP19b (Woodlands over sedgeland in Holocene dune swales of the southern SCP). The precise locality of the TEC is not known; however, no representative vegetation associations were recorded within the Study Area. Numerous other ESAs occur within the broader vicinity of the Study Area, mostly associated with TECs and PECs occurring within the Rockingham Industrial Zone; however, none occur within 1.5 km of the Study Area.

2.7 Geomorphic Wetlands

The DBCA Geomorphic Wetlands SCP dataset displays the location, boundary, geomorphic classification (wetland type) and management category of wetlands on the SCP, mapped at a scale of 1:25,000 (originally captured by Hill *et al.*, 1996). Three wetland management categories based on ecological, hydrological and geomorphological significant factors have been designated, these being:

- Conservation Category (CC) – wetlands that support a high level of ecological attributes and functions (generally having intact vegetation and natural hydrological processes), or that have a reasonable level of functionality and are representative of wetland types that are rare or poorly protected.
- Resource Enhancement (RE) – wetlands that have been modified (degraded) but still support substantial ecological attributes (wetland dependant vegetation covering more than 10%) and functions (hydrological properties that support wetland dependent vegetation and associated fauna), and have some potential to be restored to the Conservation management category. Typically, such wetlands still support some elements of the original native vegetation, and hydrological function.

- Multiple Use (MU) – wetlands that are assessed as possessing few remaining ecological attributes and functions. While such wetlands can still play an important role in regional or landscape ecosystem management, including water management, they are considered to have low intrinsic ecological value. Typically, they have very little or no native vegetation remaining (less than 10 %).

No geomorphic wetlands occur within the Study Area. The nearest wetlands occur 1 km to the south (RE Unique Feature Identifier [UFI] 6227, 6316, 6318 and 6317), while there are nine CC wetlands occurring within 2 km of the Study Area (UFI 6389, 6392, 6219, 6220, 6383, 6221, 6222, 6223 and 6224) (Figure 2.2).

2.8 Vegetation Complexes

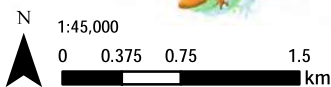
Vegetation complexes of the SCP have been mapped by Heddle *et al.* (1980) at a scale of 1:250,000 (within the former System 6 boundary). This assessment described and mapped Vegetation Complexes across the SCP according to vegetation characteristics, the underlying soil profile of a specific landform unit, and climatic factors. Vegetation complexes represent the most appropriate assessment level for remnant vegetation based on land area for the SCP and most of the south-west WA. One vegetation complex occurs across the Study Area (Figure 2.3), Quindalup Complex: coastal dune complex with a low closed forest and closed scrub. The Quindalup Complex is a coastal dune complex consisting mainly of two alliances - the strand and fore-dune alliance and the mobile and stable dune alliance. Local variations include the low closed forest of *Melaleuca lanceolata* (Rottnest Teatree) - *Callitris preissii* (Rottnest Island Pine), the closed scrub of *Acacia rostellifera* (Summer-scented Wattle) and the low closed *Agonis flexuosa* (Peppermint) forest of Geographe Bay to the south of the Study Area.

Currently there is over 60% (or 32,983 ha) of the pre-European extent (54,574 ha) of the Quindalup complex remaining on the SCP (Government of Western Australia, 2018). This is above the recommended 30% threshold where biodiversity loss increases exponentially (EPA, 2002). Of the pre-European extent remaining, 4,566 ha or 8.4% is protected within IUCN (International Union of Conservation of Nature) Class I to IV reserves (i.e. National Parks, Nature Reserves) (Government of Western Australia, 2018).



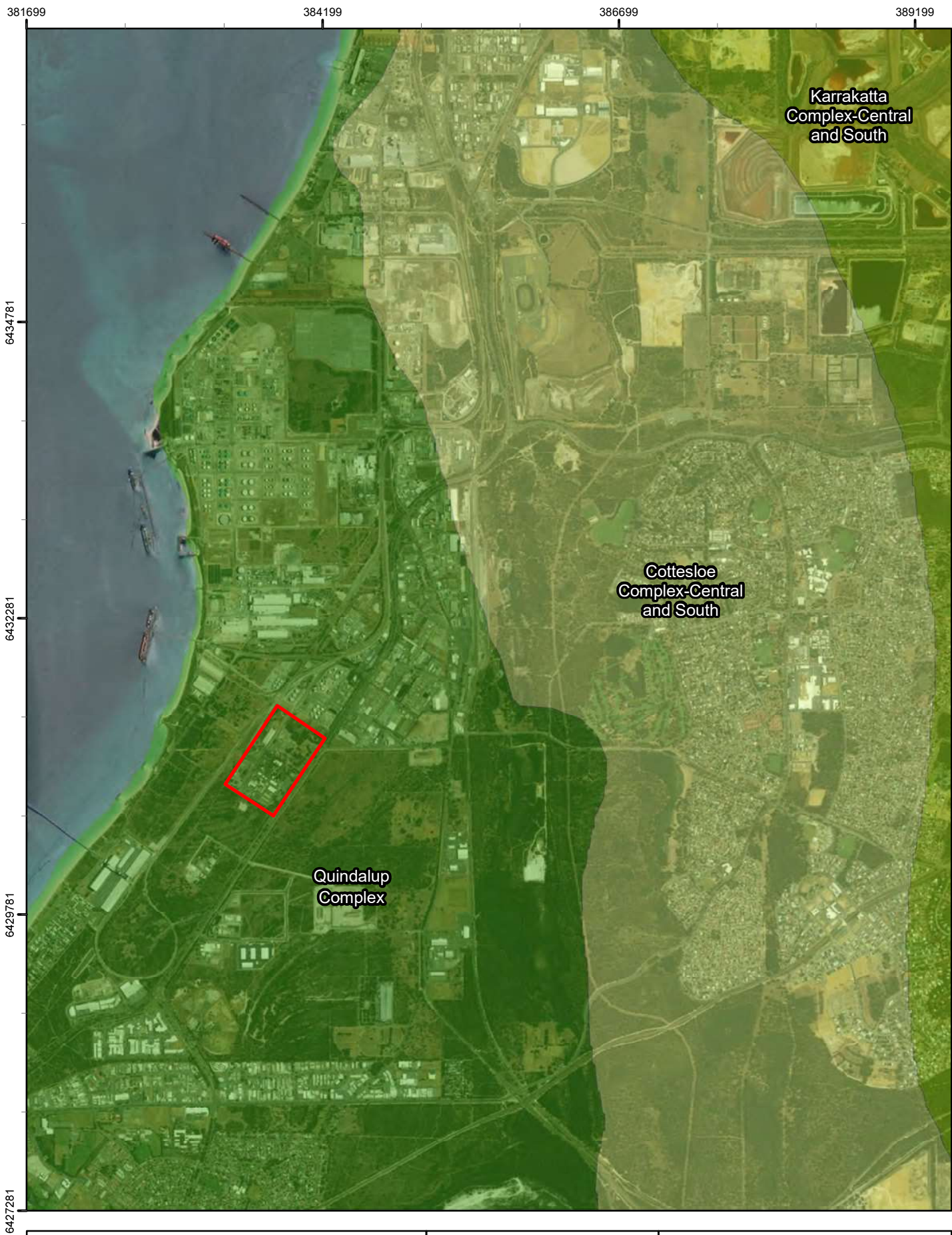
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 	Study Area
Wetland Management Category	
	Conservation
	Multiple Use
	Resource Enhancement



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Fig. 2.2: Geomorphic Wetlands in close
proximity to the Study Area

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994
Size A4. Created 03/04/2019

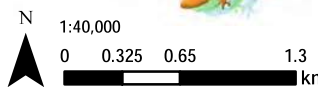


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Study area

Vegetation Complex

- Cottesloe Complex-Central and South: Woodland and open forest and closed heath
- Karrakatta Complex-Central and South: Open forest and woodland
- Quindalup Complex: Coastal dune complex - Low closed forest and closed scrub



BHP Nickel West
Kwinana Nickel Refinery Flora,
Vegetation and Fauna Assessment
Fig. 2.3: Vegetation Complexes

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Size A4. Created 03/04/2019

3 METHODOLOGY

3.1 Compliance

The survey was carried out in a manner consistent with the Western Australian EPA, DBCA and the Commonwealth Department of the Environment and Energy (DoEE) for the environmental surveying and reporting of flora and fauna. The relevant government guidelines include:

- EPA (2018) Statement of Environmental Principles, Factors and Objectives;
- EPA (2016c) Environmental Factor Guideline: Flora and Vegetation;
- EPA (2016d) Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment;
- EPA (2016a) Technical Guidance: Sampling Methods for Terrestrial Vertebrate Fauna;
- EPA (2016b) Technical Guidance: Terrestrial Fauna Surveys;
- DoEE (2017a) Revised draft referral guideline for three threatened black cockatoo species;
- Department of Sustainability, Environment, Water, Populations and Communities (now DoEE) (DSEWPaC, 2012) EPBC Act Referral Guidelines for Three Threatened Black Cockatoo Species;
- Department of the Environment (now DoEE) (DoE, 2014) Survey Guidelines for Australia's threatened orchids;
- DoE (2013) Significant Impact Guidelines 1.1: Matters of National Environmental Significance.

3.2 Desktop Assessment

3.2.1 Database Searches

Database searches were undertaken to generate a list of vascular flora and vertebrate fauna taxa previously recorded within, and near, the Study Area, including introduced species and taxa of conservation significance. The database searches also identified ecological communities/ vegetation types of conservation significance that occur, or may occur, within, and near, the Study Area. Conservation codes for flora, fauna and vegetation of conservation significance are provided in Appendix A. Five database searches were conducted around a central coordinate (32°15'03"S; 115°45'59"E), with varying buffers as deemed appropriate (Table 3.1).

Table 3.1: Details of database searches conducted

Provider	Reference	Database	Parameters
Department of Biodiversity, Conservation and Attractions (DBCA)	(DBCA, 2019c)	Threatened and Priority Flora. Accessed 15 March 2019	Circle of radius 10 km centred on the coordinates: 32°15'03"S; 115°45'59"E
Department of Biodiversity, Conservation and Attractions (DBCA)	(DBCA, 2019a)	Threatened and Priority Ecological Communities. Accessed 29 March 2019	Circle of radius 5 km centred on the coordinates: 32°15'03"S; 115°45'59"E
Department of Biodiversity, Conservation and Attractions (DBCA)	(DBCA, 2019a)	NatureMap. Accessed 26 March 2019	Circle of radius 10 km centred on the coordinates: 32°15'03"S; 115°46'02"E

Provider	Reference	Database	Parameters
Department of Biodiversity, Conservation and Attractions (DBCA)	(DBCA, 2019b)	Threatened Fauna Database. Received 19 March 2019	Circle of radius 5 km centred on the coordinates: 32°15'03.16" S; 115° 45' 59.60" E
Department of Environment and Energy (DoEE)	(DoEE, 2019a)	Protected Matters Database Search Tool. Accessed 26 March 2019	Circle of radius 10 km centred on the coordinates: 32°15'03.16" S; 115° 45' 59.60" E

3.3 Field Survey

The survey was undertaken on the 8th of March 2019. In the twelve months prior to the field survey (March 2018 to February 2019), Garden Island naval base recorded 519 mm of rainfall (Figure 3.1) (BoM, 2019). This was below the long-term average (LTA) rainfall for the same period (603.4 mm, BoM, 2019) and the long-term median (LTM) rainfall for the same period (549.7 mm, BoM, 2019) (Figure 3.1). Minimum temperature during the survey was 20.4°C and the maximum temperature was 24.6°C (BoM, 2019). On the day of the survey, 2.0 mm of rainfall was recorded. The focus of the Level 1 fauna component was to identify habitats and assess for their likelihood to support fauna of conservation significance, therefore, weather conditions experienced prior and during the survey did not hamper the assessment. The flora reconnaissance survey was outside of the optimal survey period (i.e. Spring) for the SCP, however, the vegetation has been highly disturbed, so timing is unlikely to have been a significant constraint on the survey outcomes.

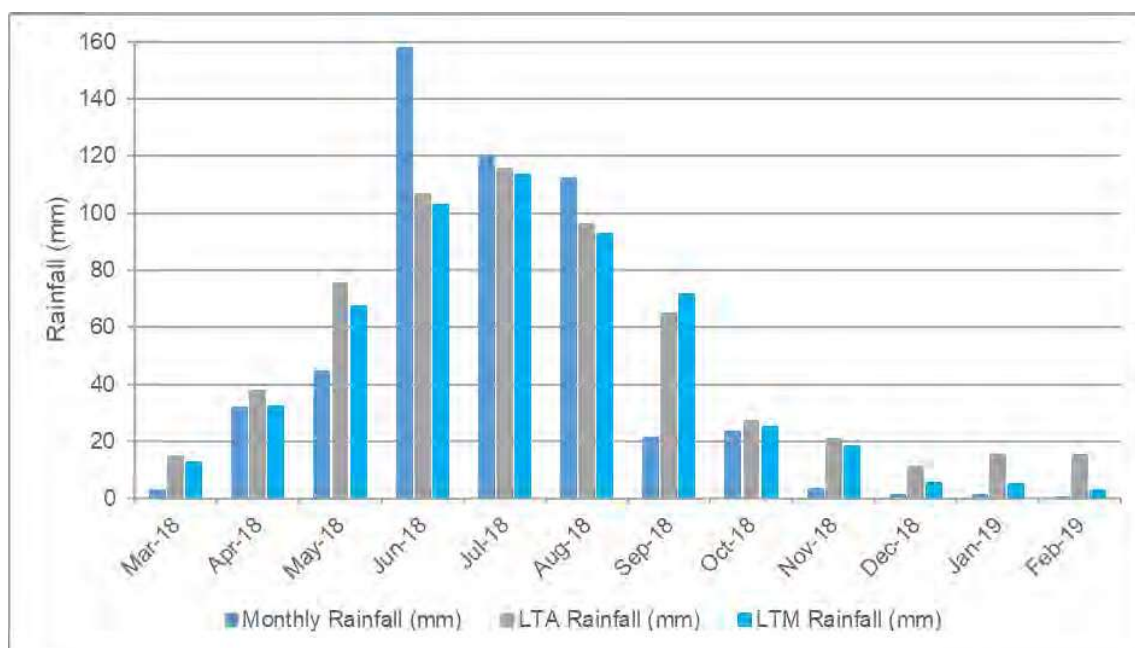


Figure 3.1: Monthly, long-term average (LTA) and long-term median (LTM) rainfall between March 2018 and February 2019 at the Garden Island Naval Base (BoM, 2019)

3.3.1 Survey Team and Licensing

The field survey was completed by Biologic's senior ecologist [REDACTED] who has over 12 years' experience completing flora and fauna surveys on the SCP. This is greater than the 5 year minimum experience required to lead and manage flora surveys on the SCP as set prescribed by the EPA (2016d). [REDACTED] holds a flora collecting permit (SL012369) pursuant to the *Wildlife Conservation Act 1950* (WC Act) Section 23C and 23F (transitional arrangements ensure validity of licence under the BC Act until expiration of the licence). [REDACTED] also holds a *Permit to Take Declared Rare Flora* for identification purposes (167-1718).

3.3.2 Flora and Vegetation Survey Design

A reconnaissance flora and vegetation survey was deemed to be the most appropriate method to sample the vegetation within the Study Area. This is due to the timing of the survey (March 2019), the limited representation of remnant native vegetation in the Study Area and the degraded nature of the vegetation. The reconnaissance flora and vegetation was conducted in accordance with the Technical Guidance (EPA, 2016d), with the entire extent of vegetation traversed on foot.



Remnant native vegetation was sampled utilising relevés (unbounded sample sites) and mapping points to characterise the vegetation types and condition, and ensure appropriate representation of the flora and vegetation present. The remainder of the Study Area was traversed on foot to record and describe the vegetation types and condition, and to search for conservation significant flora. Broad flora and vegetation data was collected from degraded areas of the Study Area to determine the significance of the remnant native vegetation (where present). A total of two relevés were established and sampled (Figure 3.2) within the Study Area. The following information was recorded at each relevé:

- survey date and personnel;
- GPS coordinates of a central coordinate (GDA 94);
- site photograph;
- soil characteristics (texture and colour);
- geology (type, size and nature of any rocks, stones, gravel, or outcropping);
- topography (landform type and aspect);
- vegetation condition (based on Keighery, 1994) (Appendix B);
- vegetation structure description (based on NVIS Technical Working Group, 2017) (Appendix C);
- collection of flora species present, including conservation significant and naturalised species;
- disturbance (if present); and
- approximate time since last fire.

All vascular flora taxa within each relevé, and all taxa found during opportunistic searches while traversing the Study Area, were recorded. A brief summary of the vegetation assemblage at each site was also recorded to aid in producing vegetation unit descriptions (NVIS Technical Working Group, 2017) (Appendix C).



Legend

-  Study Area
-  GPS Tracks
-  Sample Sites



BHP Nickel West
Kwinana Nickel Refinery Flora,
Vegetation and Fauna Assessment
Fig. 3.2: Sample Sites and Traverses

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994
Size A4. Created 03/04/2019

Identification of Flora Specimens

All plant taxa were identified during the field survey with no collections made at the time of the field survey. Due to the timing of the survey (March 2019), many of the flora, including non-native species, were not flowering or fruiting. In addition, there were numerous flora species that have been selectively planted throughout the Study Area and are not known to occur on the SCP bioregion. As such, the identification of these species can be difficult as they may be eastern states plants where the Western Australian Herbarium does not have any reference specimens. Photographs of some plant taxa were taken and compared later to images available on Florabase.

Vegetation Unit Mapping

Broad vegetation mapping was conducted in the field, with vegetation boundaries delineated over aerial photography. Following the completion of the relevé sampling, the broad vegetation units were refined based on the review of the floristic data collected from the relevés and the results of flora and vegetation surveys that occur in close proximity to the Study Area. The vegetation structure information collected from the relevés was reviewed to describe the vegetation units based on the dominant taxa, foliage cover and height of the three traditional strata (upper, mid and lower/ ground). This method of vegetation type determination is consistent with EPA (2016d). The vegetation type mapping was then digitised using geographic information systems (GIS) software.

The vegetation types have been described to Level 5 (Vegetation Association), where possible, in the National Vegetation Information System (NVIS) hierarchical structure (NVIS Technical Working Group, 2017). The vegetation associations have been described and coded according to standard practice leading with the dominant taxon in the upper stratum.

Vegetation Condition Mapping

Vegetation condition was defined within the Study Area using the vegetation condition scale in EPA (2016d), which has been adapted from (Keighery, 1994) (Appendix B). The vegetation condition was determined based on the level of disturbance observed in an area. Condition was recorded at each relevé, while additional notes were taken while traversing the Study Area to broadly map vegetation condition boundaries. The vegetation condition mapping was then digitised using GIS software.

3.3.3 Terrestrial Fauna Assessment

Habitat Assessments and Mapping

Habitat assessments were undertaken at two locations across the Study Area (Figure 3.2). Habitats in the Study Area were assessed using methodology and terminology modified from the Australian Soil and Land Survey Field Handbook (National Committee on Soil and Terrain, 2009). The characteristics recorded during the habitat assessments were:

- site information, photo and location;
- landform: slope, relative inclination of slope, morphological type and landform type;

- vegetation: leaf litter %, twig litter %, wood litter, dead stags and hollow bearing trees, broad floristic formation, vegetation structure (tall, mid and low), and dominant species;
- land surface: micro relief, sheet erosion, rill erosion, gully erosion, gully depth, abundance and size of coarse fragments, rock outcropping, water bodies, comments on nests, burrows, roosts and diggings;
- soil: texture, colour;
- substrate: bare ground, rock size, rock type, rock outcropping; and
- disturbance: time since last fire, evidence of weeds, grazing, or human disturbances.

Fauna habitats were assessed for the likelihood that they may support conservation significant fauna. All major fauna habitats present within the Study Area were rated (High, Medium or Low) per the criteria in Table 3.2.

Table 3.2 Fauna habitat significance assessment criteria

Score	Possible criteria (score results from any possible criterion being met)
High	Fauna listed as threatened under the EPBC Act or BC Act have been recorded from this habitat type within the Assessment Areas.
	Habitat known to be suitable core habitat ¹ for EPBC Act and/or BC Act listed threatened fauna, and there are records of this species within 40 km ² .
	Habitat is regionally uncommon or limited in extent and known to support species listed as: <ul style="list-style-type: none"> • Threatened fauna under the EPBC Act and/or BC Act, but it is not their core habitat (e.g., may be used periodically/ seasonally or for dispersal). • Species of Special Conservation Interest or Other Specially Protected Species under the BC Act. • DBCA listed Priority fauna, which are known to be solely reliant on this habitat.
Moderate	Habitat known to support EPBC Act and/or BC Act listed Migratory fauna.
	Habitat that is regionally uncommon (e.g., occurs in small and isolated areas) and supports a particularly diverse and uncommon faunal assemblage.
	Habitat is common and widespread and known to support species listed as: <ul style="list-style-type: none"> • Threatened fauna under the EPBC Act and/or BC Act, but it is not their core habitat (e.g., may be used periodically/ seasonally or for dispersal). • Species of Special Conservation Interest or Other Specially Protected Species under the BC Act • DBCA listed Priority fauna, which are known to be solely reliant on this habitat.
Low	Habitat is widespread/common and does not solely support any DBCA listed Priority fauna.

Black Cockatoo Assessment

The Study Area is located on the SCP, which is used by black cockatoos, primarily for foraging resources with some regions of breeding habitat. This survey and subsequent assessment took into consideration two key guidelines:

- the current black cockatoo guidelines: EPBC Act referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo (endangered) *Calyptorhynchus latirostris*, Baudin's cockatoo (vulnerable) *Calyptorhynchus baudinii*, Forest red-tailed black cockatoo (vulnerable) *Calyptorhynchus banksii naso* (DSEWPac, 2012); and

- the revised draft referral guideline for three threatened black cockatoo species: Carnaby's Cockatoo (Endangered) *Calyptorhynchus latirostris*, Baudin's Cockatoo (Vulnerable) *Calyptorhynchus baudinii*, Forest Red-tailed Black Cockatoo (Vulnerable) *Calyptorhynchus banksii naso* (DoEE, 2017a).

According to the DoEE, the decision to revise the original guideline arose from the publication of new scientific information and subsequent concern regarding the ongoing loss of important foraging habitat. Additionally, there were concerns regarding the consistency in decision making on adequacy of surveys. Subsequently, revisions to the current guidelines were developed during workshops held in Perth in April and May 2016. Although the DoEE advise that the current guidelines should be used for all assessments until a final version of the revised guideline is published, this survey and assessment has also incorporated the changes suggested in the revised draft. The key change in the revised draft is the greater emphasis on foraging habitat and the application of a foraging habitat assessment tool. This foraging habitat assessment tool has been incorporated into this survey and is outlined in the methods presented below and detailed in Table 3.3.

Habitat assessments are the primary method used to identify any habitat used for foraging, breeding or roosting by the species (DoEE, 2017a; DSEWPaC, 2012). The objectives were to:

- identify and map significant habitat and trees (breeding, night roosting and foraging);
- assign a quality score to potential foraging habitat; and
- record evidence/signs of black cockatoo species in the area (e.g. feeding debris, feathers, droppings).

Survey effort focused on habitat likely to support black cockatoos, and this was classified into breeding trees, roosting trees and foraging habitat based on the revised draft DoEE (2017a) guidelines and summarised in Table 3.3. Potential breeding trees (trees with a diameter breast height of >50 cm or trees with appropriate sized hollows) were recorded with a GPS. The species of tree and presence of hollows were recorded, along with photographs, where relevant.

The foraging ecology for all three black cockatoo species is well documented (Cooper *et al.*, 2002; DoEE, 2017a; Groom, 2011; Johnstone & Kirkby, 2008; Saunders, 1980; Valentine & Stock, 2008). Suitable foraging resources were identified during the targeted black cockatoo assessment and from sampling undertaken during the flora relevés (Appendix D). A foraging habitat quality score was used to classify habitats within the Study Area for their suitability to black cockatoo species. The scoring system, as detailed in DoEE (2017a), ranks habitat from 0 to 10, where 0 is low quality habitat and 10 is high quality habitat. The scoring tool incorporated aspects including habitat suitability and condition, evidence or signs of the species, proximity to known breeding and roost sites, and black cockatoo distributions (Table 3.4). In addition to the classification of habitats, searches were also undertaken for evidence of occurrence of the three species, including chewed hollows, feeding signs or feeding debris, and sighting records. Other signs that can indicate feeding include black cockatoo droppings and feathers, or 'chewed' banksia, pine cones or marri nuts, as well as broken or scattered flowers. Bite patterns were used to determine species (where possible) using available guides (Fleming, 2011).

Table 3.3: Habitats used by black cockatoos for breeding, night roosting and foraging

Habitat	Baudin's	Carnaby's	Forest Red-tailed
Breeding	Generally in woodland or forest, but may also breed in partially cleared woodland or forest, including isolated trees. Nest in hollows in live or dead trees (any tree species may provide suitable hollows), particularly karri (<i>Eucalyptus diversicolor</i>), marri (<i>Corymbia calophylla</i>), jarrah (<i>E. marginata</i>), wandoo (<i>E. wandoo</i>), bullich (<i>E. megacarpa</i>) and tuart (<i>E. gomphocephala</i>).	Generally in woodland or forest, but also breeds in partially cleared woodland or forest, including isolated trees. Nest in hollows in live or dead trees (any tree species may provide suitable hollows), particularly salmon gum (<i>E. salmonophloia</i>), wandoo, tuart, jarrah, flooded gum (<i>E. rudis</i>), york gum (<i>E. loxophleba</i> subsp. <i>loxophleba</i>), powderbark (<i>E. accedens</i>), karri and marri.	Generally in woodland or forest, but may also breed in partially cleared woodland or forest, including isolated trees. Nest in hollows in live or dead trees (any tree species may provide suitable hollows), particularly marri, karri, wandoo, bullich, blackbutt (<i>E. patens</i>), tuart and jarrah.
Night roosting	Generally in or near riparian environments or other permanent water sources. Any tall trees may provide suitable roosting, but particularly jarrah, flooded gum, blackbutt, tuart and introduced eucalypts (blue gum (<i>E. globulus</i>), lemon scented gum (<i>C. citriodora</i>)).	Generally in or near riparian environments or natural and artificial permanent water sources. Any tall trees may provide suitable roosting, but particularly flat-topped yate (<i>E. occidentalis</i>), salmon gum, wandoo, marri, karri, blackbutt, tuart, introduced eucalypts and introduced pines	Any tall trees may provide suitable roosting, but particularly tall jarrah, marri, blackbutt, tuart and introduced eucalypt trees or large trees on the edges of forests.

Habitat	Baudin's	Carnaby's	Forest Red-tailed
Foraging and common food items	<p>Primarily seeds of marri and jarrah in woodlands and forest, and seeds of native proteaceous plant species (for example, Banksia spp., Hakea spp. and Dryandra spp.). During the breeding season feed primarily on native vegetation, particularly marri (seeds, flowers, nectar and grubs). Also insects and insect larvae; pith of kangaroo paw (<i>Anigozanthos flavidus</i>); juice of ripe persimmons; tips of Pinus spp.; and seeds of apples and pears.</p> <p>Native shrubland, kwongan heathland and woodland on seeds, flowers and nectar of native proteaceous plant species (Banksia spp., Hakea spp., Dryandra spp., and Grevillea spp.), as well as Callistemon spp. and marri. Also seeds of introduced species including Pinus spp., Erodium spp., wild radish, canola, almonds and pecan nuts; insects and insect larvae; occasionally flesh and juice of apples and persimmons.</p>	<p>Native shrubland, kwongan heathland and woodland on seeds, flowers and nectar of native proteaceous plant species (Banksia spp., Hakea spp., Dryandra spp., and Grevillea spp.), as well as Callistemon spp. and marri. Also seeds of introduced species including Pinus spp., Erodium spp., wild radish, canola, almonds and pecan nuts; insects and insect larvae; occasionally flesh and juice of apples and persimmons.</p>	<p>Primarily seeds of jarrah and marri in woodlands and forest, and edges of karri forests, including wandoo and blackbutt. Forages on Eucalyptus caesia, E. erythrocorys, Allocasuarina cones, fruits of snottygobble (<i>Persoonia longifolia</i>) and mountain marri (<i>Corymbia haematoxylon</i>). Also some introduced eucalypts such as river red gum (<i>E. camaldulensis</i>) and flooded or rose gum (<i>E. grandis</i>). On the Swan Coastal Plain, often feeds on introduced Cape lilac (<i>Melia azedarach</i>).</p>

Table 3.4: Foraging habitat scoring tool

Starting Score	Foraging habitat for Carnaby's Cockatoo	Foraging habitat for Baudin's Cockatoo	Foraging habitat for Forest Red-tailed Black Cockatoo
10 (Very high quality)	Foraging habitat that is being managed for black cockatoos such as habitat that is the focus of successful rehabilitation, and/or has some level of protection from clearing, and/or is quality habitat described below with attributes contributing to meet a score of ≥ 10 .	Foraging habitat that is being managed for black cockatoos such as habitat that is the focus of, successful rehabilitation, and/or has some level of protection from clearing, and/or is quality habitat described below with attributes contributing to meet a score of ≥ 10 .	Foraging habitat that is being managed for black cockatoos such as habitat that is the focus of successful rehabilitation, and/or has some level of protection from clearing, and/or is quality habitat described below with attributes contributing to meet a score of ≥ 10 .
7 (High quality)	Native shrubland, kwongan heathland and woodland dominated by proteaceous plant species such as Banksia spp. (including Dryandra spp.), Hakea spp. and Grevillea spp., as well as native eucalypt woodland and forest that contains foraging species, including along roadsides. Does not include orchards, canola, or areas under a RFA.	Native eucalypt woodlands and forest, and proteaceous woodland and heath, particularly marri, including along roadsides. Does not include orchards or areas under a RFA.	Jarrah and marri woodlands and forest, and edges of karri forests, including wandoo and blackbutt, within the range of the subspecies, including along roadsides. Does not include areas under a RFA.
5 (Quality)	Pine plantation or introduced eucalypts.	Pine plantation or introduced eucalypts.	Introduced eucalypts as well as the introduced Cape lilac (<i>Melia azedarach</i>).
1 (low quality)	Individual foraging plants or small stand of foraging plants.	Individual foraging plants or small stand of foraging plants.	Individual foraging plants or small stand of foraging plants.
Additions	Context adjustor – attributes improving functionality of foraging habitat	Context adjustor – attributes improving functionality of foraging habitat	Context adjustor – attributes improving functionality of foraging habitat
+3	Is within the Swan Coastal Plain (important foraging area).	Is within the known foraging area (see map).	Jarrah and/or marri show good recruitment (i.e. evidence of young trees).
+3	Contains trees with suitable nest hollows.	Contains trees with suitable nest hollows.	Contains trees with suitable nest hollows.
+2	Contains trees with potential to be used for breeding (dbh ≥ 500 mm or ≥ 300 mm dbh for salmon gum and wandoo).	Contains trees with potential to be used for breeding (dbh ≥ 500 mm or ≥ 300 mm dbh for salmon gum and wandoo).	Contains trees with potential to be used for breeding (dbh ≥ 500 mm or ≥ 300 mm dbh for salmon gum and wandoo).
+1	Is known to be a roosting site	Is known to be a roosting site	Is known to be a roosting site
Subtractions	Context adjustor – attributes reducing functionality of foraging habitat	Context adjustor – attributes reducing functionality of foraging habitat	Context adjustor – attributes reducing functionality of foraging habitat
-2	No clear evidence of feeding debris	No clear evidence of feeding debris	No clear evidence of feeding debris
-2	No other foraging habitat within 6km	No other foraging habitat within 6km	No other foraging habitat within 6km

Starting Score	Foraging habitat for Carnaby's Cockatoo	Foraging habitat for Baudin's Cockatoo	Foraging habitat for Forest Red-tailed Black Cockatoo
-1	Is > 12 km from a known breeding location.	Is > 12 km from a known breeding location.	Is > 12 km from a known breeding location.
-1	Is > 12 km from a known roosting site.	Is > 12 km from a known roosting site.	Is > 12 km from a known roosting site.
-1	Is > 2 km from a watering point.	Is > 2 km from a watering point.	Is > 2 km from a watering point.
-1	Disease present (e.g. Phytophthora cinnamomi or marri canker).	Disease present (e.g. Phytophthora cinnamomi or marri canker).	Disease present (e.g. Phytophthora cinnamomi or marri canker).

Opportunistic Vertebrate Fauna Records

Opportunistic records of vertebrate species encountered during the survey were documented. Birds were recorded on a presence/absence basis, determined by call identification, visual identification and/or tracks and traces.

Taxonomy and Nomenclature

The latest checklist of mammal, reptile and amphibian names published by the Western Australian Museum (WAM, 2017) was used as a guide to the current taxonomy and nomenclature of these groups. For birds, the current checklist of Australian birds maintained by Birdlife Australia (based on Christidis & Boles, 2008) was used in conjunction with the WAM species list (WAM, 2017).

3.4 Assessment on Occurrence

3.4.1 Flora

The likelihood of occurrence of each flora and fauna species of conservation significance in the Study Area was assessed and ranked. The rankings were assigned using the following definitions:

- **Confirmed** – the presence of the species in the Study Area has been recorded unambiguously during the last 15 years;
- **Very Likely** – the Study Area lies within the known distribution of the species; the species has been recorded from within 10 km and within the last 15 years and suitable habitat is present;
- **Likely** – the Study Area lies within the known distribution of the species and the species has been recorded within 20 km in the last 20 years; however, either:
 - the Study Area is likely to contain only a small area of suitable habitat, or habitat that is only marginally suitable; or
 - the species is generally rare and patchily distributed in suitable habitat;
- **Possible** – there is an outside chance of occurrence, because:
 - The Study Area is just outside the known distribution of the species, but is likely to contain suitable and sufficient habitat (the species may be common, rare, or patchily distributed); or
 - the Study Area lies within the known distribution of the species, but the species is very rare and/or patchily distributed; or
 - the Study Area lies on the edge of, or within, the known distribution and is likely to contain suitable habitat, but the species has not been recorded in the area for over 20 years;
- **Unlikely** – the Study Area lies outside the known distribution of the species, the Study Area is unlikely to contain suitable habitat, and the species has not been recorded in the area for over 20 years; and
- **Highly Unlikely** – The Study Area lies a significant distance outside of the known distribution, for example, greater than 150 km to the nearest record, and has never been recorded from the area.

3.4.2 Fauna

Conservation significant fauna species recorded from the databases were assessed for their likelihood to occur within the Study Area using the decision matrix below (Table 3.5).

Table 3.5: Species likelihood of occurrence decision matrix

Range categories:	Habitat Categories				
	Core habitat known to occur	Foraging habitat known to occur	Dispersal habitat known to occur	Potential dispersal habitat	No known habitat occurs
Species recorded <5 km	Highly Likely	Likely	Likely	Possible	Possible
Species recorded 5-10 km	Likely	Likely	Possible	Possible	Rarely
Species recorded 10-40 km	Likely	Possible	Possible	Rarely	Unlikely
Species recorded >40 km	Possible	Possible	Rarely	Rarely	Unlikely
Species rarely recorded in region	Possible	Rarely	Unlikely	Unlikely	Highly Unlikely

This decision matrix is only intended to be an indicative guide, and was applied with the following considerations:

- The range categories are subject to interpretation based on the known range of each species and its natural dispersal capabilities (for example, >50 km range may be a significant distance for a fossorial skink, but not a migratory bird);
- Both the range categories and the habitat categories can vary markedly for different types of fauna such as birds, reptiles, mammals, and amphibians, and fauna with different ecological niches within each of these groups;
- The degree of habitat specificity for each species is a major determining factor for each of the habitat categories, and this in turn is dependent on the current state of ecological knowledge of the species;
- The amount and location of previous sampling is a major factor influencing the applicability of the range categories, as well as the amount of effort that has been expended in (and the accessibility of) the area in question for sampling;
- The current state of taxonomy is another major factor for species that are poorly known taxonomically and thus difficult to identify accurately, as well as for any recent changes of classification and/or conservation category. Such taxonomic changes can affect the reliability of previous records within fauna databases, the conservation status of the newly defined species/ populations, and the assumptions regarding species ranges and habitat preferences; and
- The language used in each of the habitat and range categories may be useful for some taxa and not for others (for example, 'rarely' occurrences may be useful for describing birds or fauna

which can traverse large distances, but in the case of fauna with more limited dispersal capabilities such as reptiles, there is no basis for 'rarely' occurrences. Such likelihoods may be more likely to represent range extensions.

3.5 Potential Limitation and Constraints

There are a number of possible limitations and constraints that can impinge on the adequacy of flora, fauna and vegetation surveys (EPA, 2016b, 2016d). The limitations of the current assessment are presented in accordance with the Technical Guidance's (EPA, 2016b, 2016d) (Table 3.6).

The survey was undertaken during a time considered to be sub-optimal for the SCP bioregion (optimal timing is considered to be between September and November). This was further emphasised by the dry conditions observed in the field. There were limited annual and ephemeral flora taxa present and perennial species were generally lacking flowering and fruiting material. Although the survey was undertaken outside of the optimal survey period, the degraded nature of the vegetation ensured that the timing was not considered to be a constraint.

Table 3.6: Survey limitations and constraints

Potential limitation or constraint	Constraint (Yes / No)	Applicability to this survey
Experience of personnel.	No	The ecologist whom undertook the survey has more than 12 years of ecological survey experience, with direct and relevant experience on the Swan Coastal Plain.
Scope (floral and faunal groups sampled and whether any constraints affect this)	No	The scope was a Reconnaissance flora and vegetation survey, a Level 1 fauna survey and a black cockatoo habitat assessment. The field survey was conducted within that framework. The field survey was undertaken out of season for flora surveys so spring germinating and flowering annuals, herbs and grasses were not recorded. No nocturnal work was undertaken by the field personal; this reduced the ability for opportunistic detection of nocturnally active species.
Proportion of flora and fauna identified	No	All observed flora and fauna were identified at the point of observation. Some flora identifications were verified by comparing photographs and site knowledge with reference material.
Sources of information (recent or historic) and availability of contextual information	No	The Swan Coastal Plain has been subjected to numerous biological surveys, while a significant amount of contextual work is available for the Swan Coastal Plain.
Proportion of the task achieved	No	A Reconnaissance flora and vegetation survey, a Level 1 fauna survey and a black cockatoo habitat assessment was completed and related to the broader contextual knowledge of the area.

Potential limitation or constraint	Constraint (Yes / No)	Applicability to this survey
Disturbances (e.g. fire or flood)	No	The field survey was undertaken in March 2019, which is considered to be outside of the optimal time for completing flora and vegetation surveys, while the Level 1 fauna survey and black cockatoo habitat assessment is not constrained by seasonality. Although the flora component of the field survey was undertaken out of season, the scope and level of disturbances (historic clearing, weeds, rubbish, operational refinery) within the Study Area ensured that the field survey was adequate.
Intensity of survey	No	A Reconnaissance flora and vegetation survey, a Level 1 fauna survey and a black cockatoo habitat assessment was identified as the most appropriate survey intensity for the Study Area and to inform a Native Vegetation Clearing Permit application.
Completeness of survey	No	The survey was adequately completed to meet the requirements of a Reconnaissance flora and vegetation survey, a Level 1 fauna survey and a black cockatoo habitat assessment.
Resources (e.g. degree of expertise available)	No	All resources required to complete the survey were available.
Remoteness or access issues	No	The majority of the Study Area was accessible either by vehicle or on foot, thus the sampling techniques used during this survey were unconstrained by accessibility.

4 RESULTS AND DISCUSSION

4.1 Database Search Results

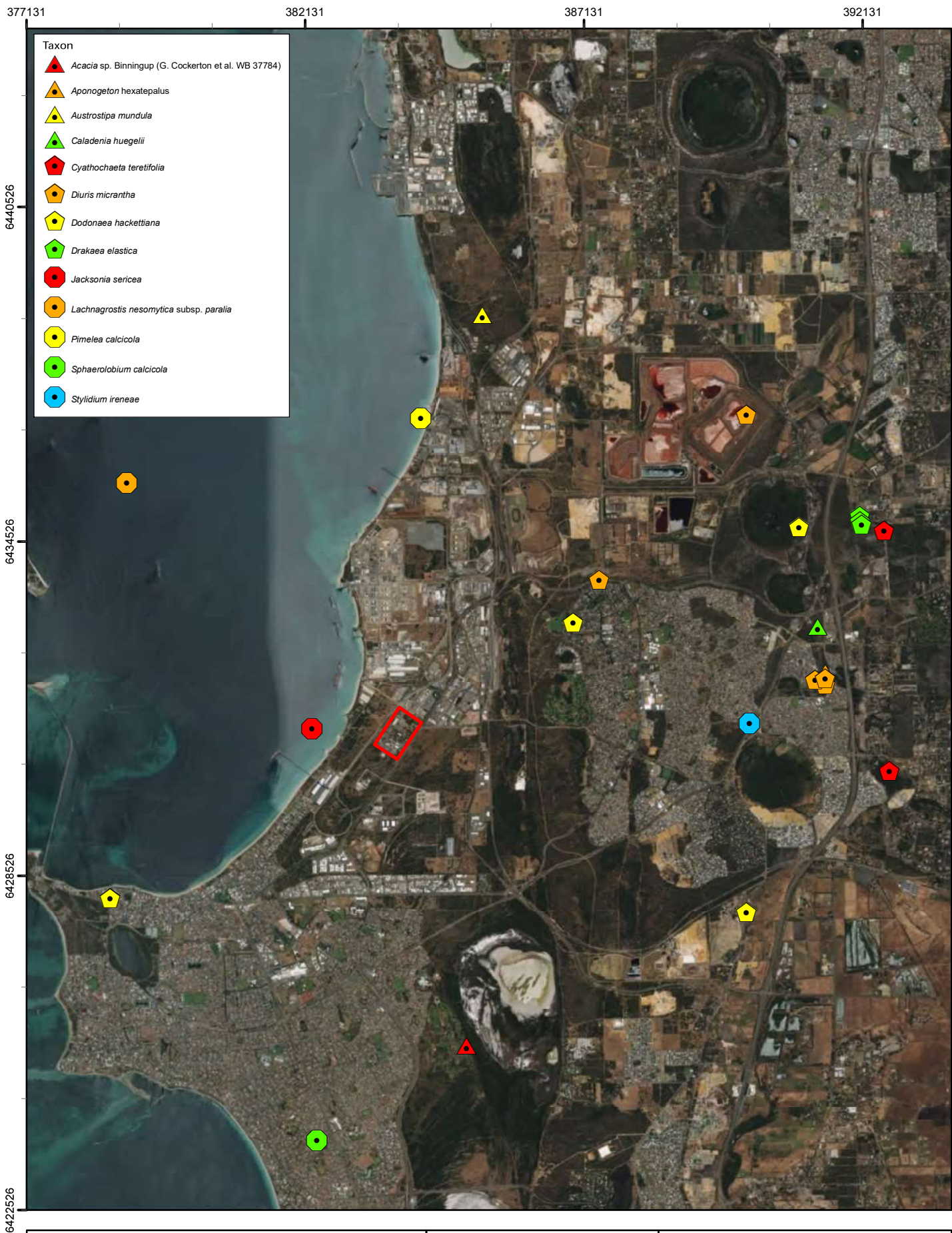
4.1.1 Flora of Conservation Significance

A total of 22 conservation significant flora taxa were identified from the database searches (Table 4.1). Of the 22 taxa, 11 are listed as threatened flora under the BC Act and the EPBC Act. The 11 threatened flora taxa are considered highly unlikely to occur within or in close proximity to the Study Area based on known habitat preferences and distribution (Appendix E).

The remaining 11 taxa are Priority listed by DBCA, with none known to occur in the Study Area (Figure 4.1). The nearest known record is *Jacksonia sericea* (P4) located 1.3 km west, in Cockburn Sound. As this record is located in Cockburn Sound, the GPS is erroneous. The next nearest known records are three separate records of *Dodonaea hackettiana* (P4) located between 3.5 and 6 km to the southwest, southeast and northeast. The likelihood of any conservation significant flora occurring within the Study Area is unlikely to highly unlikely due to historical and ongoing clearing and disturbance associated with the Nickel Refinery. The assessment of likelihood of occurrence is presented in Appendix E.

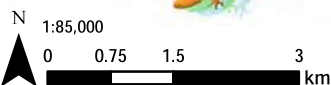
Table 4.1: Threatened and Priority Flora known to occur in close proximity to the Study Area

Family	Taxon	Current Conservation Status		
		EPBC Act	BC Act	DBCA
Proteaceae	<i>Synaphea</i> sp. Fairbridge Farm (D. Papenfus 696)	CR	CR	T
Proteaceae	<i>Synaphea</i> sp. Serpentine (G.R. Brand 103)	CR	CR	T
Orchidaceae	<i>Caladenia huegelii</i>	EN	CR	T
Orchidaceae	<i>Drakaea elastica</i>	EN	CR	T
Myrtaceae	<i>Eucalyptus x balanites</i>	EN	CR	T
Orchidaceae	<i>Diuris purdiei</i>	EN	EN	T
Cyperaceae	<i>Lepidosperma rostratum</i>	EN	EN	T
Ericaceae	<i>Andersonia gracilis</i>	EN	EN	T
Orchidaceae	<i>Drakaea micrantha</i>	VU	EN	T
Orchidaceae	<i>Diuris micrantha</i>	VU	VU	T
Cyperaceae	<i>Eleocharis keigheryi</i>	VU	VU	T
Fabaceae	<i>Acacia</i> sp. Binningup (G. Cockerton et al. WB 37784)			P1
Poaceae	<i>Lachnagrostis nesomytica</i> subsp. <i>paralia</i>			P1
Poaceae	<i>Austrostipa mundula</i>			P3
Cyperaceae	<i>Cyathochaeta teretifolia</i>			P3
Dilleniaceae	<i>Hibbertia spicata</i> subsp. <i>leptotheca</i>			P3
Thymelaeaceae	<i>Pimelea calcicola</i>			P3
Fabaceae	<i>Sphaerolobium calcicola</i>			P3
Aponogetonaceae	<i>Aponogeton hexatepalus</i>			P4
Sapindaceae	<i>Dodonaea hackettiana</i>			P4
Fabaceae	<i>Jacksonia sericea</i>			P4
Stylidiaceae	<i>Stylidium ireneae</i>			P4



Legend

Study Area



BHP Nickel West
Kwinana Nickel Refinery Flora,
Vegetation and Fauna Assessment
Fig. 4.1: DBCA Threatened Flora
Search Results

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Size A4. Created 03/04/2019

4.1.2 Ecological Communities of Conservation Significance

Six ecological communities of conservation significance were identified in the desktop review as occurring or potentially occurring within the vicinity of the Study Area (Table 4.2; Figure 4.2). Of the six ecological communities, five occur within 10 km of the Study Area, including three TECs and two PECs (Table 4.2; Figure 4.2).

The Study Area occurs within the mapped 2 km buffer zone of one TEC located approximately 600 m southeast of the Study Area, SCP19b – Woodlands over sedgeland in Holocene dune swales of the southern Swan Coastal Plain (original description; Gibson et al. (1994). With the exception of the SCP19b buffer, no mapped TECs or PECs occur within the Study Area (Table 4.2; Figure 4.2).

Table 4.2: Threatened and Priority Ecological Communities known to occur near the Study Area

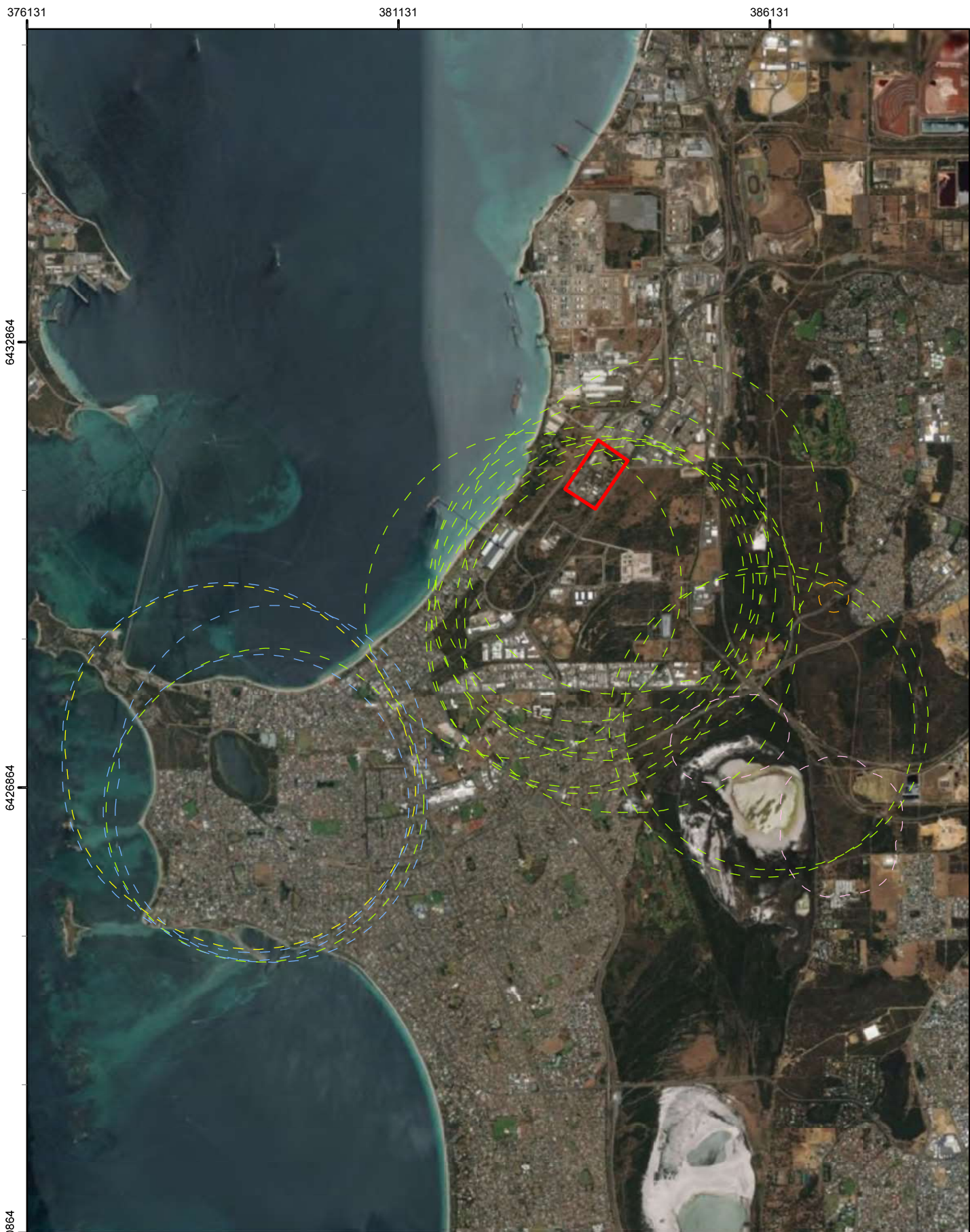
Community ID	Community Name	Current Conservation Status			Distance from Study Area	Buffer (m)
		EPBC Act	BC Act	DBCA		
SCP19a	Sedgeland in Holocene dune swales of the southern Swan Coastal Plain	EN	CR		~3.9 km southwest	2,000
Richmond-microbial	Stromatolite like microbialite community of coastal freshwater lakes	EN	CR		~3.5 km southwest	2,000
SCP19b	Woodlands over sedgeland in Holocene dune swales of the southern Swan Coastal Plain (original description; Gibson et al. (1994).	EN	CR		Study Area within 2 km buffer only	2,000
Banksia woodland	Banksia Woodlands of the Swan Coastal Plain ecological community ¹	EN		P3	N/A ¹	NA ¹
SCP24	Northern Spearwood shrublands and woodlands			P3	~3 km southeast	500
SCP25	Southern <i>Eucalyptus gomphocephala</i> - <i>Agonis flexuosa</i> woodlands			P3	~3.1 km east	200

¹ – Identified from the Protected Matters Search tool as potentially occurring in the area only.

4.1.3 Vertebrate Fauna of Conservation Significance

The database searches identified a total of 77 species of vertebrate fauna of conservation significance, comprising 68 birds, seven mammals, and two reptiles (Table 4.3). Of the 77 species, 40 are listed as Threatened, Conservation Dependent or Specially Protected under the EPBC Act and/or BC Act. A further 53 species are listed as Migratory under the EPBC Act and/or BC Act, including some species also listed as Threatened. Eleven species are listed as Priority by the DBCA.

Due to the size of the database search area, the number of species identified as potentially occurring within the Study Area is likely to be an overestimate due to the search area containing habitats that do not occur within the Study Area, such as shoreline and marine habitats. Additionally, many species tend to be patchily distributed even where appropriate habitats are present, and many species of birds can occur as regular migrants, occasional visitors or vagrants. None of the 77 species of vertebrate fauna identified in the desktop review have previously been recorded with the Study Area; however, six species have previously been recorded within 2 km of the Study Area: the Perth Lined Skink (*Lerista lineata*), Southern Brown Bandicoot (*Isodon fusciventer*), Carnaby's Cockatoo (*Calyptorhynchus latirostris*), Crested Tern (*Thalasseus bergii*), Grey-headed Albatross (*Thalassarche chrysostoma*) and Peregrine Falcon (*Falco peregrinus*)



Legend

Study Area

Record description

- Northern Spearwood shrublands and woodlands
- Sedgelands in Holocene dune swales of the southern Swan Coastal Plain
- Southern Eucalyptus gomphocephala-Agonis flexuosa woodlands
- Stromatolite like microbialite community of coastal freshwater lakes
- Woodlands over sedgelands in Holocene dune swales of the southern Swan Coastal Plain



BHP Nickel West
Kwinana Nickel Refinery Flora,
Vegetation and Fauna Assessment
Fig. 4.2: DBCA Ecological Communities
Search Results

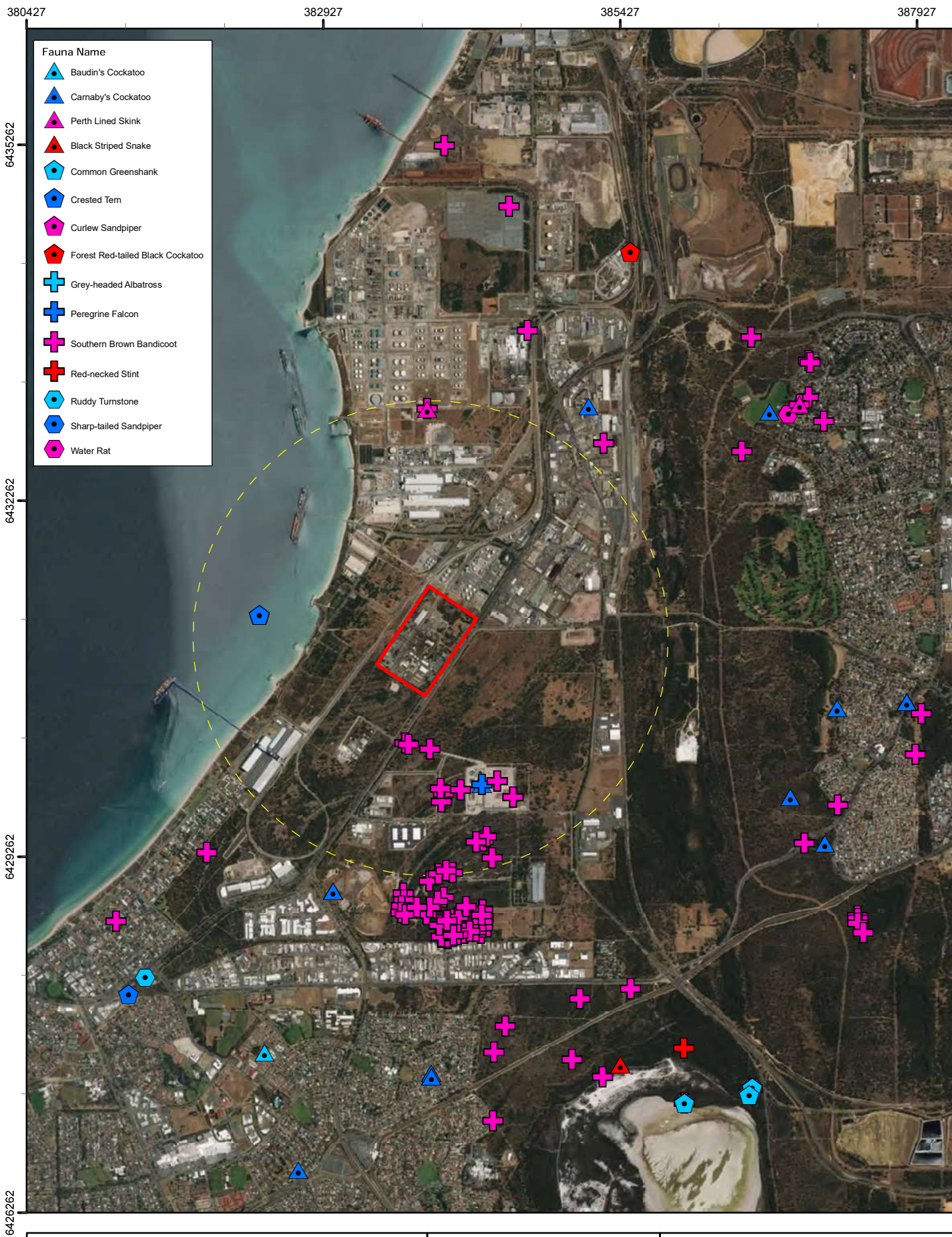
Coordinate System: GDA 1994 MGA Zone 50
 Projection: Transverse Mercator
 Datum: GDA 1994
 Size A4. Created 03/04/2019

Table 4.3: Threatened and Priority Fauna database search results

Scientific Name	Common Name	Current Conservation Status		
		EPBC Act	BC Act	DBCA
Reptiles				
<i>Neelaps calonotos</i>	Black-striped Snake			P3
<i>Lerista lineata</i>	Perth Lined Skink			P3
Mammals				
<i>Dasyurus geoffroii</i>	Chuditch	VU	VU	
<i>Macropus irma</i>	Western Brush Wallaby			P4
<i>Hydromys chrysogaster</i>	Water-rat			P4
<i>Isoodon fusciventer</i>	Southern Brown Bandicoot			P4
<i>Bettongia penicillate</i>	Woylie	EN	CR	
<i>Phascogale tapoatafa wambenger</i>	Brush-tailed Phascogale		CD	
<i>Pseudocheirus occidentalis</i>	Western Ringtail Possum	CR	VU	
Birds				
<i>Pandion haliaetus</i>	Osprey	MI	MI	
<i>Oxyira australis</i>	Blue-billed Duck			P4
<i>Botaurus poiculoptilus</i>	Australasian Bittern	EN	EN	
<i>Apus pacificus</i>	Fork-tailed Swift	MI	MI	
<i>Calyptorhynchus banksia naso</i>	Forest Red-tailed Black Cockatoo	VU	VU	
<i>Calyptorhynchus baudinii</i>	Baudin's Cockatoo	EN	EN	
<i>Calyptorhynchus latirostris</i>	Carnaby's Cockatoo	EN	EN	
<i>Charadrius dubius</i>	Little Ringed Plover	MI	MI	
<i>Charadrius leschenaultia</i>	Greater Sand Plover	VU/MI	VU	
<i>Charadrius mongolus</i>	Lesser Sand Plover	EN/MI	EN	
<i>Pluvialis squatarola</i>	Grey Plover	MI	MI	
<i>Thinornis rubricollis</i>	Hooded Plover			P4
<i>Diomedea dabbenena</i>	Northern Royal Albatross	EN/MI	EN	
<i>Diomedea exulans</i>	Wandering Albatross	VU/MI	VU	
<i>Diomedea exulans amsterdamens</i>	Amsterdam Albatross	EN/MI	CR	
<i>Diomedea exulans dabbenena</i>	Tristan Albatross	EN/MI	CR	
<i>Diomedea epomophora</i>	Royal Albatross	VU/MI	VU	
<i>Phoebetria fusca</i>	Sooty Albatross	VU/MI	EN	
<i>Thalassarche carteri</i>	Indian Yellow-nosed Albatross	VU/MI	EN	
<i>Thalassarche chlororhynchos</i>	Yellow-nosed Albatross	MI	VU	
<i>Thalassarche chrysostoma</i>	Grey-headed Albatross	EN/MI	VU	
<i>Thalassarche cauta</i>	Shy Albatross	VU/MI	VU	

Scientific Name	Common Name	Current Conservation Status		
		EPBC Act	BC Act	DBCA
<i>Thalassarche cauta steadi</i>	White-capped Albatross	VU/MI	VU	
<i>Thalassarche melanophris</i>	Black-browed Albatross	VU/MI	EN	
<i>Thalassarche melanophris impavida</i>	Campbell Albatross	VU/MI	VU	
<i>Falco peregrinus</i>	Peregrine Falcon		OS	
<i>Glareola maldivarum</i>	Oriental Pratincole	MI	MI	
<i>Oceanites oceanicus</i>	Wilson's Storm-petrel	MI	MI	
<i>Anous stolidus</i>	Common Noddy	MI	MI	
<i>Anous tenuirostris melanops</i>	Australian Lesser Noddy	VU	EN	
<i>Hydroprogne caspia</i>	Caspian Tern	MI	MI	
<i>Sterna abaethetus</i>	Bridled Tern	MI	MI	
<i>Sterna dougallii</i>	Roseate Tern	MI	MI	
<i>Sterna hirundo</i>	Common Tern	MI	MI	
<i>Sterna leucoptera</i>	White-winged Black Tern	MI	MI	
<i>Stercorarius antarcticus</i>	Brown Skua			P4
<i>Stercorarius parasiticus</i>	Arctic Jaeger	MI	MI	
<i>Sterna nereis nereis</i>	Australian Fairy Tern	VU	VU	
<i>Thalasseus bergii</i>	Crested Tern	MI	MI	
<i>Leipoa ocellata</i>	Mallefowl	VU	VU	
<i>Motacillia cinerea</i>	Grey Wagtail	MI	MI	
<i>Phaethon rubricauda</i>	Red-tailed Tropicbird	MI	MI	P4
<i>Halobaena caerulea</i>	Blue Petrel	VU		
<i>Macronectes giganteus</i>	Southern Giant Petrel	EN/MI	MI	
<i>Macronectes halli</i>	Northern Giant Petrel	MI	MI	
<i>Puffinus carneipes</i>	Fleshy-footed Shearwater	MI	VU	
<i>Pterodroma mollis</i>	Soft-plumage Petrel	VU		
<i>Pachyptila turtur</i>	Fairy Prion	VU		
<i>Rostratula australis</i>	Australian Painted Snipe	EN	EN	
<i>Areharia interpres</i>	Ruddy Turnstone	MI	MI	
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	MI	MI	
<i>Calidris alba</i>	Sanderling	MI	MI	
<i>Calidris canutus</i>	Red Knot	EN/MI	EN	
<i>Calidris ferruginea</i>	Curlew Sandpiper	CR/MI	CR	
<i>Calidris melanotos</i>	Pectoral Sandpiper	MI	MI	
<i>Calidris ruficollis</i>	Red-necked Stint	MI	MI	
<i>Calidris subminuta</i>	Long-toed Stint	MI	MI	

Scientific Name	Common Name	Current Conservation Status		
		EPBC Act	BC Act	DBCA
<i>Calidris tenuirostris</i>	Great Knot	CR/MI	CR	
<i>Limosa lapponica baueri</i>	Bar-tailed Godwit (Western Alaskan)	VU/MI	VU/MI	
<i>Limosa lapponica menzbieri</i>	Bar-tailed Godwit (Northern Siberian)	CR/MI	CR/MI	
<i>Limosa limosa</i>	Black-tailed Godwit	MI	MI	
<i>Numenius madagascariensis</i>	Eastern Curlew	CR/MI	CR	
<i>Philomachus pugnax</i>	Ruff	MI	MI	
<i>Tringa brevipes</i>	Grey-tailed Tattler	MI	MI	P4
<i>Tringa glareola</i>	Wood Sandpiper	MI	MI	
<i>Tringa hypoleucos</i>	Common sandpiper	MI	MI	
<i>Tringa nebularia</i>	Common Greenshank	MI	MI	
<i>Tringa stagnatilis</i>	Marsh Sandpiper	MI	MI	



4.2 Flora and Vegetation

4.2.1 Flora Composition

A total of 50 flora taxa, including native and non-native taxa, were recorded from the Study Area. This number included 22 native taxa and 28 non-native taxa. The 50 flora taxa were representative of 22 families and 42 genera, with only five genera represented by two or more taxa.

The floristic diversity of the Study Area is low and not representative of what is expected from remnant native vegetation in good or better condition along the Quindalup dunes south of Perth. The diversity of the Study Area is representative of what is expected in highly disturbed environments, with a high diversity of weeds.

4.2.2 Threatened and Priority Flora

No threatened or priority flora taxa were recorded from the Study Area, and none are considered to occur based on the highly disturbed nature of the Study Area.

4.2.3 Introduced Flora

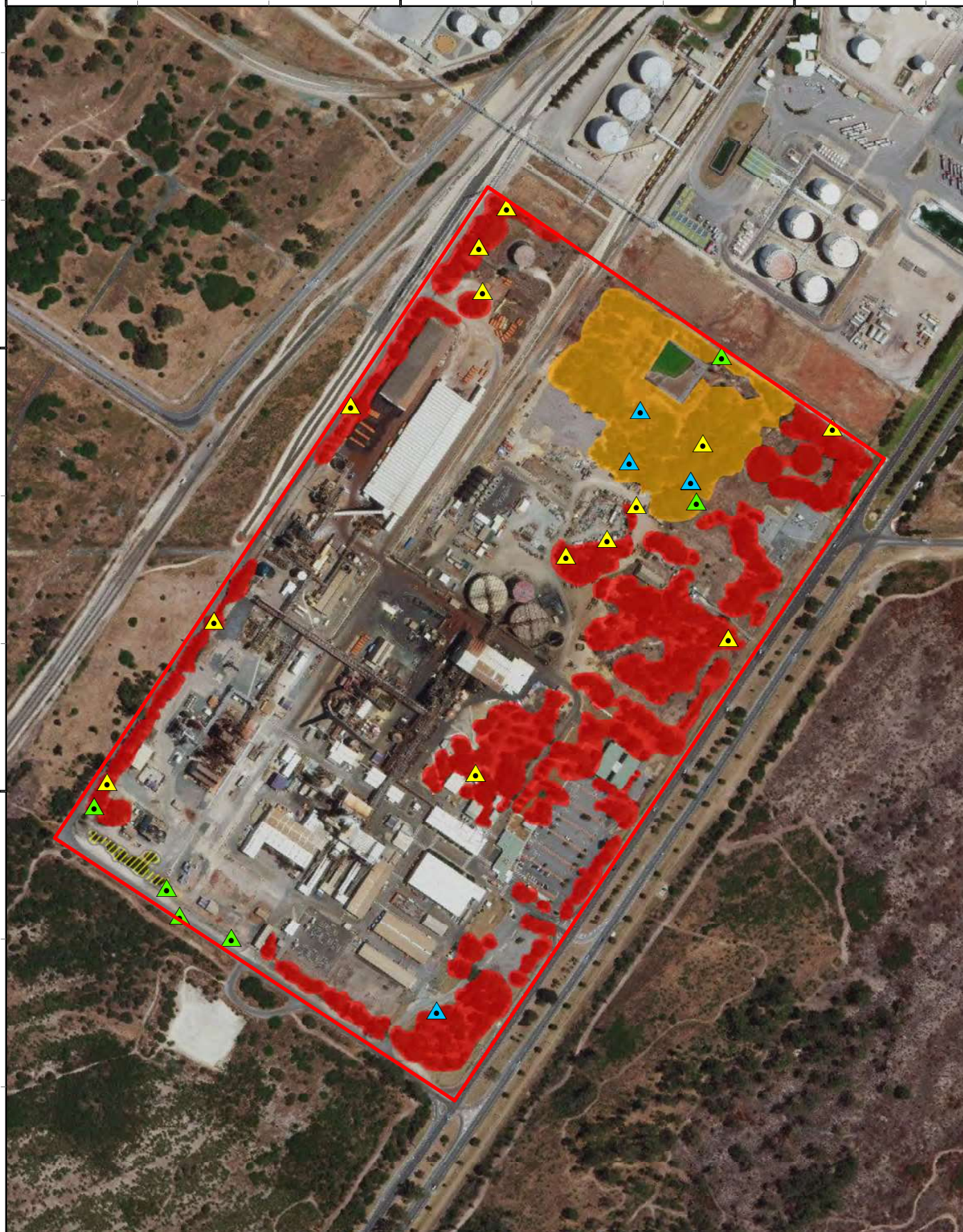
A total of 28 non-native taxa were recorded from the Study Area, including three taxa that are considered to be environmentally significant weeds. The 28 non-native taxa included several taxa that are considered native to WA, however the majority are not known to occur on the Swan Coastal Plain (i.e. *Melaleuca nesophila*) or in the Rockingham area (i.e. *Eucalyptus erythrocorys*). Several other taxa are known to occur in the immediate region (i.e. *Casuarina obesa*) but have been planted within the Study Area.

Three taxa are listed as a Weed of National Significance (WoNS) and/or a Declared Plant Pest (DPP) under Section 22 of the BAM Act. The three taxa are **Asparagus asparagoides* (Bridal Creeper) and **Tamarix aphylla* (Athel Pine) which are listed as both a WoNS and a DPP, and **Gomphocarpus fruticosus* (Narrowleaf Cottonbush) which is listed as a DPP across numerous local government areas, not including the City of Rockingham or City of Kwinana.

Asparagus asparagoides

Bridal creeper (**Asparagus asparagoides*) (Plate 4.1) was recorded from five locations totalling approximately 11 individual plants (Figure 4.4 and Appendix F). The five locations were recorded from the north-eastern and south-eastern portions of the Study Area. The individuals were noted as being small in size, however numerous underground tubers may exist within the soil, potentially representing a substantial larger extent than recorded.

It is regarded as one of the worsts weeds in Australia because of its invasiveness, potential for spread, and economic and environmental impacts (CRC, 2003). Bridal creeper is highly invasive and is able to establish in undisturbed native vegetation (DoEE, 2019b).



Legend

Study Area

Significant Environmental Weeds

▲ **Asparagus asparagoides*

▲ **Gomphocarpus fruticosus*

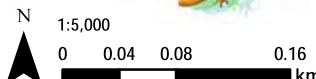
▲ **Tamarix aphylla*

Vegetation Condition

Completely Degraded

Degraded

Now Cleared



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Vegetation and Fauna Assessment
Fig. 4.4: Vegetation Condition and
Significant Environmental Weed
Mapping

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A4. Created 03/04/2019



Plate 4.1: Bridal Creeper (*Asparagus asparagoides*) recorded within the Study Area

Tamarix aphylla

Athel Pine (*Tamarix aphylla*) (Plate 4.2) was recorded from 13 locations, totalling approximately 81 individuals trees (Figure 4.4 and Appendix F). Athel Pine has been extensively planted throughout the Study Area, including along the western boundary. Individuals were observed flowering, while several thickets were also observed.

Athel Pine is considered to be a significant environmental weed in Central Australia where it has the potential to displace native riparian vegetation and have a cascading impact down the functional system (i.e. loss of hollows, displacement of native vegetation, suppressing native regeneration from fire) (DoEE, 2019b). The current extent within the Study Area is not considered to represent a significant concern as it is highly unlikely for individuals to establish away from the Study Area. Athel Pine seed has a short viability time and it is unlikely individuals will lose limbs that will be washed away to establish new populations (DoEE, 2019b).



Plate 4.2: Athel Pine (*Tamarix aphylla*) recorded within the Study Area

Gomphocarpus fruticosus

Narrowleaf Cottonbush (**Gomphocarpus fruticosus*) (Plate 4.3) was recorded from six locations totalling approximately 14 individuals (Figure 4.4 and Appendix F). The locations Narrowleaf Cottonbush were scattered across the Study Area, concentrated in open disturbed and bare areas. Many individuals observed were fruiting, while several juveniles were also observed suggesting the populations are self-sustaining and expanding.

Narrowleaf Cottonbush is listed as a DPP under the BAM Act across 57 local government areas and has the ability to invade pastures and form dense thickets many hectares in size. Narrowleaf Cottonbush is also toxic to livestock, but is rarely eaten. Although not listed as a DPP for the City of Rockingham and City of Kwinana, it is still a significant environmental weed with the potential to form dense thickets and outcompete native flora.





Plate 4.3: Narrowleaf Cottonbush (Gomphocarpus fruticosus*) recorded within the Study Area**




4.2.4 Vegetation Units

Five vegetation units were described and delineated from the Study Area, however only one unit, EgR, would be described as having a natural structure (Table 4.4). The remaining four units lacked a natural differentiation in the strata and generally consisted of scattered native trees or planted non-native trees over introduced grasses and herbs. Vegetation unit EgR coincided with the historic rehabilitated area in the north of the Study Area (Figure 4.5). The rehabilitation is approximately 20 years old and consisted of a defined upper, middle and lower stratum.

Vegetation unit *Ta consisted mainly of **Tamarix aphylla* over introduced grasses and herbs and occurred along the western boundary and scattered throughout the Study Area. In addition to the planting of **Tamarix aphylla* and the rehabilitated area, numerous non-native and naturalised trees have also been planted across the Study Area. These areas have been mapped as Esp and EgAf (Figure 4.5). The areas of vegetation occupied approximately 10.55 ha (or 27.8%) of the 38 ha Study Area.

Table 4.4: Vegetation Unit Descriptions

Code	Description	Extent (ha)	Features	Photo
Eg	<i>Eucalyptus gomphocephala</i> low to mid trees over disturbed understorey consisting of introduced grasses, herbs and managed lawns/ gardens	3.21	<ul style="list-style-type: none"> Potential black cockatoo breeding trees 	
EgAf	<i>Eucalyptus gomphocephala</i> mid trees over <i>Agonis flexuosa</i> low trees over introduced grasses and herbs	0.36	<ul style="list-style-type: none"> Potential black cockatoo breeding trees 	

Code	Description	Extent (ha)	Features	Photo
EgR	<i>Eucalyptus gomphocephala</i> mid open woodland over <i>Acacia cyclops</i> , <i>Acacia xanthina</i> and <i>Spyridium globulosum</i> scattered tall over <i>Rhagodia baccata</i> low open chenopod shrubland with introduced grasses and herbs	2.87	<ul style="list-style-type: none"> • Potential black cockatoo breeding trees • WoNS present 	
Esp	<i>Eucalyptus gomphocephala</i> , <i>Eucalyptus camaldulensis</i> and other naturalised low to mid trees over varying understorey consisting of native (<i>Melaleuca lanceolata</i> , <i>Callitris preissii</i>) and non-native (<i>Schinus terebinthifolia</i>) shrubs and introduced grasses and herbs	1.50	<ul style="list-style-type: none"> • Potential clack cockatoo breeding trees • WoNS present 	
*Ta	* <i>Tamarix aphylla</i> low trees over disturbed understorey dominated by introduced grasses and herbs	2.61	<ul style="list-style-type: none"> • WoNS present 	

383328

383728

384128

6431380

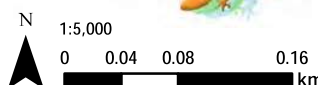
6430930

6430480



Legend

 Study area	 EgAf
Vegetation Unit	 EgR
 *Ta	 Esp
 Eg	 Now cleared



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Vegetation and Fauna Assessment
Fig. 4.5: Vegetation Unit Mapping

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994
Size A4. Created 03/04/2019

The vegetation of the Study Area could not be assigned a Floristic Community Type (FCTs) consistent with flora and vegetation survey work on the Swan Coastal Plain. Gibson *et al.* (1994) completed an analysis of FCTs along the Southern SCP in 1994, with many of these FCTs now considered to be TECs or PECs. The degraded and completely degraded nature of the Study Area and a lack of native flora and vegetation structure ensures that confident assignment to an FCT as described by Gibson *et al.* (1994) is not possible.

4.2.5 Conservation Significant Vegetation

Threatened and Priority Ecological Communities

The vegetation units present within the Study Area do not represent any known TECs or PECs. The vegetation has been highly disturbed from historic clearing and ongoing disturbances, so does not represent native vegetation communities.

Wetlands and Environmentally Sensitive Areas

No wetlands or ESA's occur in the Study Area, while none are expected to occur. A man-made drainage sump occurs in the south-east of the Study Area which collects stormwater drainage from the refinery and nearby roads. The vegetation in association with the man-made drainage sump consists of planted eucalypts (*Eucalyptus erythrocorys*, *Eucalyptus camaldulensis*), native shrubs (*Melaleuca* spp.) and introduced grasses and herbs, including **Asparagus asparagoides*. The man-made drainage sump is not considered to be a natural wetland.

4.2.6 Vegetation Condition

The condition of the vegetation within the Study Area ranged from Degraded (2.87 ha) to Completely Degraded (7.69 ha) (Figure 4.4), while large areas are considered to be cleared (27.45 ha) and are associated with the Nickel Refinery. The vegetation in the north of the Study Area was mapped as Degraded and coincided with the rehabilitated vegetation (vegetation unit EgR). Threatening processes were still prevalent in the degraded vegetation, including a high density of weeds, while the structure resembles a native community, key elements are missing (i.e. understorey shrubs, native herbs and grasses). The remainder of the vegetation present in the Study Area was mapped as Completely Degraded and consisted of isolated native trees, planted lawns and weed dominated units (for example, vegetation unit *Ta).

Three environmental significant weeds, **Asparagus asparagoides*, **Tamarix aphylla* and **Gomphocarpus fruticosus*, occur across the Study Area with **Tamarix aphylla* extensively planted as boundary trees and throughout the Study Area. Rubbish and litter were also prevalent throughout the vegetation units, as was the dumping of green waste and stockpiling of soil.

4.3 Vertebrate Fauna


4.3.1 Fauna Habitat

A single broad fauna habitat was recorded and mapped within the Study Area, rehabilitated woodland habitat, occupying approximately 10.55 ha (27.8%) (Figure 4.6). The habitat comprised a mosaic of scattered eucalypt species, predominantly Tuart (*Eucalyptus gomphocephala*), and Athel Tree (**Tamarix aphylla*) trees over mixed understory, often dominated by sparsely distributed patches of small to medium shrubs or low introduced grasses and herbs on sandy plain. Vegetation within the habitat appears to be dominated by rehabilitated areas, comprising of planted and/or introduce species, with little remnant vegetation present.

The remainder of the Study Area (~27.45 ha) comprised of existing cleared areas and infrastructure for current operations at the site which was not considered fauna habitat (Figure 4.6).

Fauna habitat within the Study Area is heavily degraded as a result of historic and ongoing disturbances. Due to the degraded or completely degraded condition of native vegetation, abundance of non-native or naturalised flora species, evidence of introduced fauna, particularly foxes, and the fragmented nature of the Study Area by existing infrastructure (i.e. roads and buildings), it is deemed to be of low significance. Fauna habitat within the Study Area is also considered to be isolated from surrounding habitats by a fence surrounding the Study Area perimeter. Although some smaller species may be able to freely move though the fence into and out of the Study Area, it is likely to prevent or restrict the movement of many larger species.

Table 4.5: Fauna habitat description

Habitat	Distinguishing habitat characteristics	Extent of the habitat	Conservation Significant Species	Photo
Rehabilitated woodland 10.55 ha 27.8% Significance: Low	<p>This habitat comprises sandy plain supporting a mosaic of scattered eucalypt and other tree species over a mixed patchy understory of small to medium shrubs of varying density or low introduced grasses and herbs.</p> <p>The habitat is largely in a degraded condition throughout the majority of the Study Area and vegetation is not representative of any natural ecological communities.</p>	<p>This habitat was the sole habitat occurring within the Study Area, primarily in the northeast and east of the Study Area. The remaining areas comprised of existing cleared areas or infrastructure.</p> <p>The rehabilitated woodland habitat is not a unique habitat within the broader vicinity of the Study Area and comparable habitats occur more broadly. Areas of similar habitat in better condition (i.e. remnant vegetation) occurs within the broader vicinity of the Study Area.</p>	<p>Suitable for:</p> <ul style="list-style-type: none"> • Black-striped Snake • Perth Lined Skink • Southern Brown Bandicoot • Fork-tailed Swift • Forest Red-tailed Black Cockatoo • Baudin's Cockatoo • Carnaby's Cockatoo • Peregrine Falcon 	



Legend

- Study Area
- ★ Black Cockatoo flyover
- Potential Breeding Trees**
 - Not hollowed
 - Hollowed
- Fauna Habitat**
 - Existing
 - Now cleared



BHP Nickel West
Kwinana Nickel Refinery Flora,
Vegetation and Fauna Assessment
Fig. 4.6: Fauna Habitat, Conservation
Significant Species and Black Cockatoo
Potential Breeding Trees within the Study Area

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994
Size A4. Created 03/04/2019

4.3.2 Fauna Recorded

A total of seven species of vertebrate fauna were recorded during the field survey, from direct and/or secondary evidence (i.e. diggings, scats, burrows). This comprised of on two reptiles, two introduced mammals, Rabbit (*Oryctolagus cuniculus*) and Red Fox (*Vulpes vulpes*) and three birds, including the Carnaby's Cockatoo. All species recorded have previously been recorded within the surrounding area and were identified in the desktop review.

Overall species diversity within the Study Area was low, and introduced or naturalised species were recorded. Red Fox and Rabbit were abundant within the Study Area, with both species recorded multiple times from secondary evidence throughout the majority of the Study Area, including Red Fox dens and Rabbit warrens. Due to a perimeter fence surrounding the Study Area, both Red Fox and Rabbit are likely to be residents and are likely to have had existing impacts on other native species which may have previously resided within or attempted to move into from other areas in the vicinity of the Study Area.

4.3.3 Fauna of Conservation Significance

One conservation significant vertebrate fauna species was recorded during the field survey, Carnaby's Black Cockatoo (Table 4.6; Figure 4.6). No other conservation significant species or evidence of their occurrence was recorded within the Study Area during the field survey. Suitable habitat for a further seven of the 77 conservation significant species identified in the desktop review and may possibly occur within the Study Area (Figure 4.3). Of the eight species recorded or considered to possibly occur within the Study Area, all are considered to only be infrequent or occasional visitors.

Based on species' distribution and ecology, previous records and the habitat present within the Study Area, the remaining 70 species identified in the desktop review are considered unlikely to occur (Table 4.6). Although some conservation significant bird species may infrequently occur in the airspace above the Study Area, they are likely to only be transient movements due to the due to the lack of suitable habitat within the Study Area for them.

Carnaby's Cockatoo

Carnaby's Cockatoo was recorded from direct observation of a small flock of seven individuals flying overhead, although they did not land or use any habitat within the Study Area. No evidence of foraging or nesting by the species was recorded during the field survey and no suitable breeding trees were recorded; however, known foraging species (i.e. Tuart) and potential night roost trees were recorded during the field survey, and the species may occasionally attend these to forage. Carnaby's Cockatoo have previously been recorded multiple times in the broader vicinity of the Study Area (Figure 4.3); however, the Study Area occurs just outside of the species' modelled breeding range. The species occurrence within the Study Area is likely to be infrequent due to the small size and degraded condition of habitat within the Study Area. Existing operations at the site may also deter the species from occurring within the Study Area as no evidence of past occurrence (i.e. evidence of foraging, roosting or nesting) was recorded during the field survey.

Baudin's Cockatoo

The Study Area occurs just outside of the breeding range Baudin's Cockatoo; however, it falls within the non-breeding range of the species and the species may occasionally occur within the Study Area to forage. The species has previously been recorded approximately 3.2 km south of the Study Area (Figure 4.3). Roosting or nesting within the Study Area is unlikely to occur due to the isolated and fragmented nature of habitat and its degraded condition. Existing operations at the site may also deter the species from occurring within the Study Area as no evidence of past occurrence (i.e. evidence of foraging) was recorded during the field survey.

Forest Red-tailed Black Cockatoo

The Study Area occurs within the modelled likely occurrence range of Forest Red-tailed Black Cockatoo which has previously been recorded approximately 3.3 km north of the Study Area (Figure 4.3). The species may occasionally occur within the Study Area to forage or roost; however, its occurrence is likely to be infrequent to occur due to the degraded, as well as isolated and fragmented nature of habitat. Forest Red-tailed Black Cockatoo have previously been recorded roosting approximately 5.4 km east-southeast of the Study Area. Nesting is unlikely to occur due to the absence of suitable breeding trees or habitat (often comprises remnant patches of old Marri trees within the Northern and Southern Jarrah Forest IBRA sub-regions, both of which occur outside the Study Area (DBCA, 2017)) and degraded condition of potential habitat within the Study Area. Existing operations at the site may also deter the species from occurring within the Study Area as no evidence of past occurrence (i.e. evidence of foraging) was recorded during the field survey.

Black-stripe Snake & Perth Lined Skink

The Black-stripe Snake and Perth Lined Skink are both fossorial reptiles, generally occurring in loose sandy substrates or leaf litter within a varied range of vegetation types and may occur within the Study Area where suitable habitat is available. Due to the sparse understory throughout much of the Study Area, the species are most likely to occur in areas where a suitable understory and leaf litter cover is present. Both species have previously been recorded within 5 km of the Study Area, Black-striped Snake approximately 3.5 km southwest of the Study Area and Perth Lined Skink approximately 1.4 km north (Figure 4.3).

Southern Brown Bandicoot

Southern Brown Bandicoot have previously been recorded multiple times in the vicinity of the Study Area, with the nearest record occurring approximately 450 m south of the Study Area (Figure 4.3) and is considered to possibly occur. Due to the degraded condition of habitat occurring in the Study Area and the presence of introduced predators (Fox), it is unlikely the species occurs as a resident or in high abundance. A perimeter fence surrounding the Study Area is also likely to restrict or prevent the movement of individuals into the Study Area from other areas of suitable habitat, particularly adults.

Peregrine Falcon

Peregrine Falcon may occasionally occur within the Study Area as part of a wider foraging range. Nesting may occur where suitable hollows or abandoned nests of other large nest building species may occur; however, the species is likely to utilise other tall infrastructure within and in the vicinity of the Study Area which will provide the species with a better vantage point, as opposed to the tall eucalypts present within the Study Area. The species has previously been recorded approximately 950 m south-east of the Study Area (Figure 4.3), indicating the species may forage or nest nearby.

Fork-tailed Swift

Fork-tailed Swift may occasionally occur above the Study Area to forage; however, it is a widespread species that occurs over a range of habitats. As the species is almost exclusively aerial, it is unlikely to land or nest within the Study Area. The nearest record of the species is located over 10 km from the Study Area; however, it is an infrequently recorded but wide-ranging species.

Table 4.6: Conservation significant species likelihood assessment

Scientific Name	Common Name	Conservation Status			Likelihood of occurrence	Comments	Nearest record to Study Area
		EPBC Act	BC Act	DBCA			
Reptiles							
<i>Neelaps calonotos</i>	Black-striped Snake			P3	Possible	May occur where suitable sandy substrate, leaf litter and low understory vegetation present.	~3.5 km southwest
<i>Lerista lineata</i>	Perth Lined Skink			P3	Possible	May occur where suitable sandy substrate, leaf litter and low understory vegetation present.	~1.4 km north
Mammals							
<i>Dasyurus geoffroii</i>	Chuditch	VU	VU		Unlikely	Suitable habitat not present. Perimeter fencing around Study Area likely to restrict movement of species into Study Area from other areas and fox abundance within Study Area likely to impact any individuals possibly occurring.	>10 km
<i>Macropus irma</i>	Western Brush Wallaby			P4	Unlikely	Species unlikely to occur within the Study Area due to existing clearing and operations, in addition to fox abundance recorded within Study Area. Species may occur in broader vicinity of Study Area where suitable habitat present; however, perimeter fencing surrounding Study Area is likely to restrict movement of species into Study Area.	>10 km
<i>Hydromys chrysogaster</i>	Water-rat			P4	Unlikely	Suitable habitat not present.	~3.1 km northwest
<i>Isodon fusciventer</i>	Southern Brown Bandicoot	EN		P4	Possible	Species may occur within Study Area, in areas where suitable understory cover is available; however, unlikely to occur or persist in high numbers due to fox abundance recorded within the Study Area. Species may occasionally move into the Study Area from areas outside; however, perimeter fencing is likely to restrict the movement of some individuals, particularly large adults.	~450 m south
<i>Bettongia penicillate</i>	Woylie	EN	CR		Unlikely	Suitable habitat not present. Species considered locally extinct in the vicinity of the Study Area.	>10 km
<i>Phascogale tapoatafa wambenger</i>	Wambenger Brush-tailed Phascogale		CD		Unlikely	Suitable habitat not present.	>10 km

Scientific Name	Common Name	Conservation Status			Likelihood of occurrence	Comments	Nearest record to Study Area
		EPBC Act	BC Act	DBCA			
<i>Pseudocheirus occidentalis</i>	Western Ringtail Possum	CR	VU		Unlikely	Suitable habitat not present or heavily degraded throughout most of the Study Area.	>10 km
Birds							
<i>Pandion haliaetus</i>	Osprey	MI	MI		Unlikely	Suitable habitat not present.	>10 km
<i>Oxyra australis</i>	Blue-billed Duck			P4	Unlikely	Suitable habitat not present.	>10 km
<i>Botaurus poiciloptilus</i>	Australasian Bittern	EN	EN		Unlikely	Suitable habitat not present.	>10 km
<i>Apus pacificus</i>	Fork-tailed Swift	MI	MI		Possible	May occasionally occur to forage in the airspace above the Study Area; however, unlikely to land or nest as the species is almost exclusively aerial.	>10 km
<i>Calyptrorhynchus banksia naso</i>	Forest Red-tailed Black Cockatoo	VU	VU		Possible	May occasionally occur within Study Area to forage or roost in suitable trees. No currently suitable nesting hollows recorded within the Study Area. Current operations within the Study Area may deter species from occurring regularly.	~3.3 km north (species record) ~5.4 km east-southeast (roost)
<i>Calyptrorhynchus baudinii</i>	Baudin's Cockatoo	EN	EN		Possible	Species may occasionally forage within Study Area, unlikely to roost or nest. Current operations within the Study Area may deter species from occurring occasionally.	~3.2 km south
<i>Calyptrorhynchus latirostris</i>	Carnaby's Cockatoo	EN	EN		Confirmed	Small flock of seven individuals flying over Study Area recorded during the field survey. May occasionally occur within Study Area to forage or roost, though unlikely to nest. No suitable nesting hollows recorded within the Study Area. Current operations within the Study Area may deter species from occurring regularly.	~950 m southwest (species record) ~4.4 km east-southeast (roost)
<i>Charadrius dubius</i>	Little Ringed Plover	MI	MI		Unlikely	Suitable habitat not present.	>10 km
<i>Charadrius leschenaultia</i>	Greater Sand Plover	VU/MI	VU		Unlikely	Suitable habitat not present.	>10 km

Scientific Name	Common Name	Conservation Status			Likelihood of occurrence	Comments	Nearest record to Study Area
		EPBC Act	BC Act	DBCA			
<i>Charadrius mongolus</i>	Lesser Sand Plover	EN/MI	EN		Unlikely	Suitable habitat not present.	>10 km
<i>Pluvialis squatarola</i>	Grey Plover	MI	MI		Unlikely	Suitable habitat not present.	>10 km
<i>Thinornis rubricollis</i>	Hooded Plover			P4	Unlikely	Suitable habitat not present.	>10 km
<i>Diomedea dabbenena</i>	Northern Royal Albatross	EN/MI	EN		Unlikely	Suitable habitat not present.	>10 km
<i>Diomedea exulans</i>	Wandering Albatross	VU/MI	VU		Unlikely	Suitable habitat not present.	>10 km
<i>Diomedea exulans amsterdamensis</i>	Amsterdam Albatross	EN/MI	CR		Unlikely	Suitable habitat not present.	>10 km
<i>Diomedea exulans dabbenena</i>	Tristan Albatross	EN/MI	CR		Unlikely	Suitable habitat not present.	>10 km
<i>Diomedea epomophora</i>	Royal Albatross	VU/MI	VU		Unlikely	Suitable habitat not present.	>10 km
<i>Phoebastria fusca</i>	Sooty Albatross	VU/MI	EN		Unlikely	Suitable habitat not present.	>10 km
<i>Thalassarche carteri</i>	Indian Yellow-nosed Albatross	VU/MI	EN		Unlikely	Suitable habitat not present.	>10 km
<i>Thalassarche chlororhynchos</i>	Yellow-nosed Albatross	MI	VU		Unlikely	Suitable habitat not present.	>10 km
<i>Thalassarche chrysostoma</i>	Grey-headed Albatross	EN/MI	VU		Unlikely	Suitable habitat not present.	~1.5 km north
<i>Thalassarche cauta</i>	Shy Albatross	VU/MI	VU		Unlikely	Suitable habitat not present.	>10 km
<i>Thalassarche cauta steadi</i>	White-capped Albatross	VU/MI	VU		Unlikely	Suitable habitat not present.	>10 km
<i>Thalassarche melanophris</i>	Black-browed Albatross	VU/MI	EN		Unlikely	Suitable habitat not present.	>10 km
<i>Thalassarche melanophris impavida</i>	Campbell Albatross	VU/MI	VU		Unlikely	Suitable habitat not present.	>10 km
<i>Falco peregrinus</i>	Peregrine Falcon		OS		Possible	Species may occasionally occur within Study Area to forage and nesting may occur in areas where suitable tall trees or infrastructure present. Current operations within the Study Area may deter species from occurring regularly.	~950 m southeast
<i>Glareola maldivarum</i>	Oriental Pratincole	MI	MI		Unlikely	Suitable habitat not present.	>10 km
<i>Oceanites oceanicus</i>	Wilson's Storm-petrel	MI	MI		Unlikely	Suitable habitat not present.	>10 km
<i>Anous stolidus</i>	Common Noddy	MI	MI		Unlikely	Suitable habitat not present.	>10 km
<i>Anous tenuirostris melanops</i>	Australian Lesser Noddy	VU	EN		Unlikely	Suitable habitat not present.	>10 km

Scientific Name	Common Name	Conservation Status			Likelihood of occurrence	Comments	Nearest record to Study Area
		EPBC Act	BC Act	DBCA			
<i>Hydroprogne caspia</i>	Caspian Tern	MI	MI		Unlikely	Suitable habitat not present.	>10 km
<i>Sterna abaethetus</i>	Bridled Tern	MI	MI		Unlikely	Suitable habitat not present.	>10 km
<i>Sterna dougallii</i>	Roseate Tern	MI	MI		Unlikely	Suitable habitat not present.	>10 km
<i>Sterna hirundo</i>	Common Tern	MI	MI		Unlikely	Suitable habitat not present.	>10 km
<i>Sterna leucopetra</i>	White-winged Black Tern	MI	MI		Unlikely	Suitable habitat not present.	>10 km
<i>Stercorarius antarcticus</i>	Brown Skua			P4	Unlikely	Suitable habitat not present.	>10 km
<i>Stercorarius parasiticus</i>	Arctic Jaeger	MI	MI		Unlikely	Suitable habitat not present.	>10 km
<i>Sternum nereis nereis</i>	Australian Fairy Tern	VU	VU		Unlikely	Suitable habitat not present.	>10 km
<i>Thalasseus bergii</i>	Crested Tern	MI	MI		Unlikely	Suitable habitat not present.	~1.2 km west
<i>Leipoa ocellata</i>	Mallefowl	VU	VU		Unlikely	Suitable habitat not present.	>10 km
<i>Motacilla cinerea</i>	Grey Wagtail	MI	MI		Unlikely	Suitable habitat not present.	>10 km
<i>Phaethon rubricauda</i>	Red-tailed Tropicbird	MI	MI	P4	Unlikely	Suitable habitat not present.	>10 km
<i>Halobaena caerulea</i>	Blue Petrel	VU			Unlikely	Suitable habitat not present.	>10 km
<i>Macronectes giganteus</i>	Southern Giant Petrel	EN/MI	MI		Unlikely	Suitable habitat not present.	>10 km
<i>Macronectes halli</i>	Northern Giant Petrel	MI	MI		Unlikely	Suitable habitat not present.	>10 km
<i>Puffinus carneipes</i>	Fleshy-footed Shearwater	MI	VU		Unlikely	Suitable habitat not present.	>10 km
<i>Pterodroma mollis</i>	Soft-plumage Petrel	VU			Unlikely	Suitable habitat not present.	>10 km
<i>Pachyptila turtur</i>	Fairy Prion	VU			Unlikely	Suitable habitat not present.	>10 km
<i>Rostratula australis</i>	Australian Painted Snipe	EN	EN		Unlikely	Suitable habitat not present.	>10 km
<i>Areharia interpres</i>	Ruddy Turnstone	MI	MI		Unlikely	Suitable habitat not present.	~3.3 km southwest
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	MI	MI		Unlikely	Suitable habitat not present.	~4 km southeast
<i>Calidris alba</i>	Sanderling	MI	MI		Unlikely	Suitable habitat not present.	>10 km
<i>Calidris canutus</i>	Red Knot	EN/MI	EN		Unlikely	Suitable habitat not present.	>10 km

Scientific Name	Common Name	Conservation Status			Likelihood of occurrence	Comments	Nearest record to Study Area
		EPBC Act	BC Act	DBCA			
<i>Calidris ferruginea</i>	Curlew Sandpiper	CR/MI	CR		Unlikely	Suitable habitat not present.	~4 km southeast
<i>Calidris melanotos</i>	Pectoral Sandpiper	MI	MI		Unlikely	Suitable habitat not present.	>10 km
<i>Calidris ruficollis</i>	Red-necked Stint	MI	MI		Unlikely	Suitable habitat not present.	~3.7 km southeast
<i>Calidris subminuta</i>	Long-toed Stint	MI	MI		Unlikely	Suitable habitat not present.	>10 km
<i>Calidris tenuirostris</i>	Great Knot	CR/MI	CR		Unlikely	Suitable habitat not present.	>10 km
<i>Limosa lapponica baueri</i>	Bar-tailed Godwit (Western Alaskan)	VU/MI	VU/MI		Unlikely	Suitable habitat not present.	>10 km
<i>Limosa lapponica menzbieri</i>	Bar-tailed Godwit (Northern Siberian)	CR/MI	CR/MI		Unlikely	Suitable habitat not present.	>10 km
<i>Limosa limosa</i>	Black-tailed Godwit	MI	MI		Unlikely	Suitable habitat not present.	>10 km
<i>Numenius madagascariensis</i>	Eastern Curlew	CR/MI	CR		Unlikely	Suitable habitat not present.	>10 km
<i>Philomachus pugnax</i>	Ruff	MI	MI		Unlikely	Suitable habitat not present.	>10 km
<i>Tringa brevipes</i>	Grey-tailed Tattler	MI	MI	P4	Unlikely	Suitable habitat not present.	>10 km
<i>Tringa glareola</i>	Wood Sandpiper	MI	MI		Unlikely	Suitable habitat not present.	>10 km
<i>Tringa hypoleucos</i>	Common sandpiper	MI	MI		Unlikely	Suitable habitat not present.	>10 km
<i>Tringa nebularia</i>	Common Greenshank	MI	MI		Unlikely	Suitable habitat not present.	~4.1 km southeast
<i>Tringa stagnatilis</i>	Marsh Sandpiper	MI	MI		Unlikely	Suitable habitat not present.	>10 km

4.3.4 Black Cockatoo Habitat Assessment

The black cockatoo field survey combined with data from the flora survey allowed an accurate representation of the potential black cockatoo breeding, night roosting and foraging habitat to be identified. The assessment took into account the current guidelines (DSEWPaC, 2012) and the draft referral guidelines (DoEE, 2017a). The most current distributional information (DoEE, 2017a; DSEWPaC, 2012) for each species of black cockatoo in relation to the Study Area is summarised as follows:

- Carnaby's Black Cockatoo: Study Area occurs within the modelled non-breeding range for the species, just outside the breeding range.
- Baudin's Black Cockatoo: Study Area occurs just outside of the modelled likely occurrence range and breeding range of the species.
- Forest Red-tailed Black Cockatoo: Study Area occurs within the modelled likely occurrence range for the species.

The Study Area occurs within the modelled likely range for the Forest Red-tailed Black Cockatoo; however, no further information on species' breeding range is provided by DSEWPaC (2012) or DoEE (2017b). The DBCA Fauna Profile on the species states that critical breeding habitat for this species is within remnant patches of old Marri (*Corymbia calophylla*) trees within the Northern and Southern Jarrah Forest IBRA sub-regions, both of which occur outside the Study Area (DBCA, 2017).

Potential Breeding Habitat

The Study Area occurs outside of the modelled breeding range of Baudin's and Carnaby's Black Cockatoos or areas of critical breeding habitat for the Forest Red-tailed Black Cockatoo (DBCA, 2017; DoEE, 2017a).

Potential breeding trees were recorded where they met the criteria of either having a suitable nest hollow or are of a suitable diameter at breast height (DBH) to develop a nest hollow (DoEE, 2017b). For most potential breeding trees, suitable DBH is 500 mm, except for Salmon Gum and Wandoo, which is 300 mm (DoEE, 2017a). A total of 48 potential breeding trees were recorded within the Study Area, comprising 37 Tuart, nine introduced *Eucalyptus* sp. and two Red Gum (Figure 4.6). Of the 37 potential breeding trees, five trees contained a total of six hollows, four Tuart (including one with two hollows) and one *Eucalyptus* sp. (Figure 4.6). Of the six hollows, none were currently considered suitable for black cockatoo species (i.e. hollow entrance too small, orientation of hollow); however, hollows may develop into suitable nesting hollows in the future. No evidence of current or previous nesting activity was recorded at any of the recorded hollows during the field survey.

Potential Roosting Habitat

Black cockatoo roosting habitat is defined by DSEWPaC (2012) or DoEE (2017b) as a communal site used by black cockatoo species during the evening. Night roosts are generally located in the tallest trees in an area. The species of tree is often not critical for night roosting and a suite of species are commonly used by black cockatoos including species recorded within the Study Area. Numerous tall trees providing

potential roosting habitat were recorded within the Study Area; however, no evidence of roosting was observed during the survey.

Although all three black cockatoo species have previously been recorded within 5 km of the Study Area, not confirmed roosts are known to occur within 4 km of the Study Area. Two Carnaby's Black Cockatoo roost sites have been recorded within 5 km of the Study Area, approximately 4.4 km west-southwest (Peck *et al.*, 2018). The nearest Forest Red-Tailed Black Cockatoo recorded roost site is located approximately 5.4 km (Peck *et al.*, 2018). No known Baudin's Black Cockatoo roost sites are known to occur in the vicinity of the Study Area.

Potential Foraging Habitat

Applying the foraging habitat assessment criteria to the Study Area, the foraging habitat score ranges from one (Low quality) to four (Quality) for each of the three species (Table 4.7). Although the Study Area scores 'Quality' foraging habitat for Carnaby's Black Cockatoo, assessment criteria for foraging habitat do not consider the overall quality of vegetation and habitat, or other factors such as disturbance. With consideration of vegetation condition and other disturbance factors, habitat within the Study Area is considered to be low value and not of significant value for the species.

Due to the degraded condition and scarcity of habitat within the Study Area, in addition to current operations which may deter the species from occurring within the Study Area at times, foraging habitat within the Study Area is considered to be Low quality for the species. This consideration is not included in the assessment criteria for foraging habitat assessments; and is supported by the absence of any foraging records of any black cockatoo species recorded within the Study Area during the field survey.

Table 4.7: Summary of foraging habitat quality assessment for the Study Area

	Carnaby's Cockatoo		Baudin's Cockatoo		Forest Red-tailed Black Cockatoo	
Starting score	1	Low quality: Individual foraging plants of small stand of foraging plants	1	Low quality: Individual foraging plants of small stand of foraging plants	1	Low quality: Individual foraging plants of small stand of foraging plants
Additions	+3	Is within the Swan Coastal Plain (important foraging area).	+2	Contains trees with potential to be used for breeding (dbh \geq 500 mm).	+2	Contains trees with potential to be used for breeding (dbh \geq 500 mm).
	+2	Contains trees with potential to be used for breeding (dbh \geq 500 mm).				
Subtractions	-2	No clear evidence of feeding debris	-2	No clear evidence of feeding debris	-2	No clear evidence of feeding debris
Total score	4	Quality	1	Low quality	1	Low quality

5 CONCLUSION

A Reconnaissance flora and vegetation survey, Level 1 vertebrate fauna survey and a black cockatoo habitat assessment was undertaken within the Kwinana Nickel Refinery premises for BHP Nickel West. The field survey was conducted on 8 March 2019 with all areas supporting vegetation traversed. The field survey was completed by a senior ecologist with over 12 years' experience on the Swan Coastal Plain.

A total of 50 vascular flora taxa, including 22 native and 28 non-native taxa, were recorded from the Study Area. The floristic diversity of the Study Area is considered to be low and is representative of the degraded and completely degraded condition of the vegetation. The SCP is known for its high biological diversity; however, this is not represented in the Study Area.

No threatened or priority listed flora occur or potential occur in the Study Area. Of the 28 non-native taxa recorded from the Study Area, three are considered to be significant environmental weeds, **Asparagus asparagoides*, **Tamarix aphylla* and **Gomphocarpus fruticosus*. Of the three significant environmental weeds, two (**Asparagus asparagoides* and **Tamarix aphylla*) are listed as Weeds of National Significance, while also being listed as Declared Plant Pests under Section 22(2) of the BAM Act. The remaining significant environmental weed is listed as a Declared Plant Pest, however not for the local government areas of the City of Kwinana and the City of Rockingham.

Five vegetation units were described and delineated from the Study Area with only one unit, EgR, consisting of a natural structural differentiation with an upper, middle and lower stratum. The remaining vegetation units mainly consisted of an upper stratum and a lower stratum of introduced grasses and herbs. In addition to the introduced herbs and grasses, many of the upper storey species are non-native or naturalised. The condition of the vegetation units ranged from degraded to completely degraded, with the majority completely degraded. Vegetation unit EgR was considered to be degraded, while the remainder were completely degraded. Excluding the areas of vegetation, the remainder of the Study Area is considered to be cleared and consists of the infrastructure associated with the Nickel Refinery.

The vegetation units mapped in the Study Area are not representative of any known TECs or PECs identified in the desktop review, although the Study Area occurs within the buffer zone of one TEC occurring to the southeast of the Study Area. This is mostly due to the highly altered structure and composition of the vegetation units and the fact they do not represent native vegetation units in good or better condition. No wetlands or environmentally sensitive areas occur within or in close proximity to the Study Area.

A single broad fauna habitat was mapped within the Study Area, rehabilitated woodland, which occupied approximately 27.8% (10.55 ha) of the Study Area. The remainder of the Study Area comprised cleared areas and/or infrastructure not considered fauna habitat. Fauna habitat within the Study Area was largely degraded and deemed low significance based on the condition of vegetation, abundance of non-native flora and fauna species and the fragmented or isolated condition of the habitat. A perimeter fence surrounding the Study Area was also considered to influence the low value of the fauna habitat due to its influence on the exclusion of species moving into the area from outside and containment of fauna within the Study Area.

Seven fauna species were recorded during field survey, including Carnaby's Cockatoo, a species listed as Endangered under the EPBC Act and BC Act. The species was recorded from direct observation of seven individuals flying over the Study Area; none of the birds were observed landing within the Study Area. Two introduced species likely to have impacted native fauna previously and/or currently occurring within the Study Area, the Red Fox and Rabbit. Evidence of these species was recorded from numerous locations during the field survey.

Potential habitat was recorded for a further seven of the 77 conservation significant species identified in the desktop review and may possibly occur within the Study Area (Figure 4.3). Of the species recorded or considered to possibly occur within the Study Area, all are considered to only be infrequent or occasional visitors due to the degraded condition of fauna habitat within the Study Area as a result of past and current operations and associated impacts.

The Study Area occurs outside of the modelled breeding range of both Baudin's and Carnaby's Black Cockatoos or areas of critical breeding habitat for the Forest Red-tailed Black Cockatoo; however, it occurs only just outside the breeding range for Baudin's and Carnaby's. A total of 48 potential breeding trees were recorded, including five containing hollows; however, none were current considered suitable for black cockatoo species. Based on DoEE foraging habitat assessment criteria and further consideration of other factors which do not form part of the standard assessment criteria for foraging habitat, such as vegetation condition, habitat quality and other disturbance, habitat within the Study Area is considered 'Low' for all three black cockatoo species. Although, the Study Area scored 'Quality' for Carnaby's Cockatoo, the actual value foraging score is considered to be lower given the degraded condition of habitat observed and lack of past or recent foraging evidence. All three black cockatoo species may occasionally occur within the Study Area to forage and possibly roost; however, nesting is unlikely to occur.

Of the eight conservation significant species recorded or deemed possible to occur in the Study Area, it is unlikely the Study Area would support the majority as residents or on a permanent basis, or that any species would be dependent on the habitats present at a broad scale. Due to the low significance of fauna habitat, the Study Area is not considered to be critical to the survival of any conservation significant species that may potentially occur.

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7 APPENDICES

Appendix A – Conservation Codes

International Union for Conservation of Nature

Category	Definition
Extinct (EX)	A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Extinct in the Wild (EW)	A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Critically Endangered (CR)	A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Section V), and it is therefore considered to be facing an extremely high risk of extinction in the wild.
Endangered (EN)	A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild.
Vulnerable (VU)	A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see Section V), and it is therefore considered to be facing a high risk of extinction in the wild.
Near Threatened (NT)	A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.
Least Concern (LTC)	A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.
Data Deficient (DD)	A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.
Not Evaluated (NE)	A taxon is Not Evaluated when it has not yet been evaluated against the criteria.

Environment Protection and Biodiversity Conservation Act 1999

Category	Definition
Threatened Flora Species	
Extinct (EX)	A native species is eligible to be included in the Extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
Extinct in the Wild (EW)	A native species is eligible to be included in the Extinct in the Wild category at a particular time if, at that time: <ul style="list-style-type: none"> (a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or (b) it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered (CR)	A native species is eligible to be included in the critically endangered category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered (EN)	A native species is eligible to be included in the endangered category at a particular time if, at that time: <ul style="list-style-type: none"> (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable (VU)	A native species is eligible to be included in the vulnerable category at a particular time if, at that time: <ul style="list-style-type: none"> (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
Conservation Dependent (CD)	A native species is eligible to be included in the Conservation Dependent category at a particular time if, at that time: <ul style="list-style-type: none"> (a) the species is the focus of a specific conservation program the cessation of which would result in the species becoming Vulnerable, Endangered or Critically Endangered; or (b) the following subparagraphs are satisfied: <ul style="list-style-type: none"> (i) the species is a species of fish; (ii) the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised; (iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory; (iv) cessation of the plan of management would adversely affect the conservation status of the species.

Category	Definition
Threatened Ecological Communities (TEC)	
Critically Endangered	An ecological community is eligible to be included in the critically endangered category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered	An ecological community is eligible to be included in the endangered category at a particular time if, at that time: <ul style="list-style-type: none"> (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable	An ecological community is eligible to be included in the vulnerable category at a particular time if, at that time: <ul style="list-style-type: none"> (a) it is not critically endangered nor endangered; and (b) it is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
Threatened Fauna Species	
Extinct (Ex)	Taxa not definitely located in the wild during the past 50 years.
Extinct in the Wild (EW)	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 (En)	Taxa facing a very high risk of extinction in the wild in the near future.
Vulnerable (Vu)	Taxa facing a high risk of extinction in the wild in the medium-term future.
Migratory (Mi)	Consists of species listed under the following International Conventions: Japan-Australia Migratory Bird Agreement (JAMBA); China-Australia Migratory Bird Agreement (CAMBA); Convention on the Conservation of Migratory Species of Wild animals (Bonn Convention)

Biodiversity Conservation Act 2016

Category	Definition
Threatened Flora Species	
Critically Endangered (CR)	Threatened species considered to be “facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines”. Published under schedule 1 of the <i>Wildlife Conservation (Rare Flora) Notice 2018</i> for critically endangered flora.
Endangered (EN)	Threatened species considered to be “facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines”. Published under schedule 2 of the <i>Wildlife Conservation (Rare Flora) Notice 2018</i> for endangered flora.
Vulnerable (VU)	Threatened species considered to be “facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines”. Published under schedule 3 of the <i>Wildlife Conservation (Rare Flora) Notice 2018</i> for vulnerable flora.
Extinct (EX)	Species where “there is no reasonable doubt that the last member of the species has died”, and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act). Published as presumed extinct under schedule 4 of the <i>Wildlife Conservation (Rare Flora) Notice 2018</i> for extinct flora.
Extinct in the Wild (EW)	Species that “is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form”, and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act). Currently there are no threatened flora species listed as extinct in the wild.
Threatened Ecological Communities (TEC)	
Critically Endangered (CR)	An ecological community is eligible for listing in the category of critically endangered ecological community at a particular time if, at that time — (a) it is facing an extremely high risk of becoming eligible for listing as a collapsed ecological community in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines; and (b) listing in that category is otherwise in accordance with the ministerial guidelines.
Endangered (EN)	An ecological community is eligible for listing in the category of endangered ecological community at a particular time if, at that time — (a) it is not a critically endangered ecological community; and (b) it is facing a very high risk of becoming eligible for listing as a collapsed ecological community in the near future, as determined in accordance with criteria set out in the ministerial guidelines; and (c) listing in that category is otherwise in accordance with the ministerial guidelines.

Category	Definition
Vulnerable (VU)	<p>An ecological community is eligible for listing in the category of vulnerable ecological community at a particular time if, at that time —</p> <p>(a) it is not a critically endangered ecological community or an endangered ecological community; and</p> <p>(b) it is facing a high risk of becoming eligible for listing as a collapsed ecological community in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines; and</p> <p>(c) listing in that category is otherwise in accordance with the ministerial guidelines.</p>
Collapsed	<p>An ecological community is eligible for listing as a collapsed ecological community at a particular time if, at that time —</p> <p>(a) there is no reasonable doubt that the last occurrence of the ecological community has collapsed; or</p> <p>(b) the ecological community has been so extensively modified throughout its range that no occurrence of it is likely to recover —</p> <p>(i) its species composition or structure; or</p> <p>(ii) its species composition and structure.</p>
Threatened Fauna Species	
Critically Endangered (Cr)	Rare or likely to become extinct, as <i>critically endangered</i> fauna.
Endangered (En)	Rare or likely to become extinct, as <i>endangered</i> fauna.
Vulnerable (Vu)	Rare or likely to become extinct, as <i>vulnerable</i> fauna.
Extinct (Ex)	Being fauna that is presumed to be extinct.
Migratory (Mi)	Birds that are subject to international agreements relating to the protection of migratory birds.
Conservation Dependent (CD)	Special conservation need being species dependent on ongoing conservation intervention. (Conservation Dependent)
Other Specially Protected Species (OS)	In need of special protection, otherwise than for the reasons pertaining to Schedule 1 through to Schedule 6 Fauna. (Other specially protected species)

Department of Biodiversity, Conservation and Attractions Priority Definitions

Category	Definition
Priority Flora and Fauna Species	
Priority 1 (P1)	<p>Poorly-known Species</p> <p>Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.</p>
Priority 2 (P2)	<p>Poorly-known Species</p> <p>Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.</p>
Priority 3 (P3)	<p>Poorly-known Species</p> <p>Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.</p>
Priority 4 (P4)	<p>Rare, Near Threatened and other species in need of monitoring</p> <p>(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands.</p> <p>(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent.</p> <p>(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.</p>

Category	Definition
Priority Ecological Communities (PEC)	
Priority 1 (P1)	<p>Poorly-known ecological communities</p> <p>Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤ 5 occurrences or a total area of ≤ 100ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.</p>
Priority 2 (P2)	<p>Poorly-known Ecological Communities</p> <p>Communities that are known from few occurrences with a restricted distribution (generally ≤ 10 occurrences or a total area of ≤ 200ha). At least some occurrences are not believed to be under immediate threat (within approximately 10 years) of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.</p>
Priority 3 (P3)	<p>Poorly-known Ecological Communities</p> <p>(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or:</p> <p>(ii) communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat (within approximately 10 years), or;</p> <p>(iii) communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, inappropriate fire regimes, clearing, hydrological change etc.</p> <p>Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.</p>

Category	Definition
Priority 4 (P4)	<p>Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.</p> <p>(i) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands.</p> <p>(ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for a higher threat category.</p> <p>(iii) Ecological communities that have been removed from the list of threatened communities during the past five years.</p>
Priority 5 (P5)	<p>Conservation Dependent Ecological Communities</p> <p>Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.</p>

Appendix B – Vegetation Condition Rating Scale

Vegetation Condition	Definition
Pristine	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.
Very Good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees and shrubs.

Appendix C – Vegetation Structural Definition

NVIS Vegetation Structural Classifications

Cover Characteristics							
Foliage cover *	70-100	30-70	10-30	<10	≈0	0-5	unknown
Crown cover **	>80	50-80	20-50	0.25-20	<0.25	0-5	unknown
% Crown cover ***	>80	50-80	20-50	0.25-20	<0.25	0-5	unknown
Cover code	d	c	i	r	bi	bc	unknown

Growth Form	Height ranges (m)	Structural Formation Classes						
tree, palm	>30 Tall	closed forest	open forest	woodland	open woodland	isolated trees	isolated clumps of trees	trees
	10-30 Mid							
	<10 Low							
tree mallee	10-30 Tall	closed forest	open forest	mallee woodland	open woodland	isolated trees	isolated clumps of mallee trees	mallee trees
	<10 Mid							
	<3 Low							
shrub, cycad, grass-tree, fern	>2 Tall	closed shrubland	shrubland	open shrubland	sparse shrubland	isolated shrubs	isolated clumps of shrubs	shrubs
	1-2 Mid							
	<1 Low							
mallee shrub	10-30 Tall	closed shrubland	mallee shrubland	open shrubland	sparse shrubland	isolated shrubs	isolated clumps of mallee shrubs	mallee shrubs
	<10 Mid							
	<3 Low							

Growth Form	Height ranges (m)	Structural Formation Classes						
heath shrub	>2 Tall	closed heathland	heathland	open heathland	sparse heathland	isolated heath shrubs	isolated clumps of heath shrubs	heath shrubs
	1-2 Mid							
	<1 Low							
chenopod shrub	>2 Tall	closed chenopod shrubland	chenopod shrubland	open chenopod shrubland	sparse chenopod shrubland	isolated chenopod shrubs	isolated clumps of chenopod shrubs	chenopod shrubs
	1-2 Mid							
	<1 Low							
samphire shrub	>0.5 Low	closed samphire shrubland	samphire shrubland	open samphire shrubland	sparse samphire shrubland	isolated samphire shrubs	isolated clumps of samphire shrubs	samphire shrubs
	<0.5 Low							
hummock grass	>2 Tall	closed hummock grassland	hummock grassland	open hummock grassland	sparse hummock grassland	isolated hummock grasses	isolated clumps of hummock grasses	hummock grasses
	<2 Tall							
tussock grass	>0.5 Mid	closed tussock grassland	tussock grassland	open tussock grassland	sparse tussock grassland	isolated tussock grasses	isolated clumps of tussock grasses	tussock grasses
	<0.5 Low							
other grass	>0.5 Mid	closed grassland	grassland	open grassland	sparse grassland	isolated grasses	isolated clumps of grasses	other grasses
	<0.5 Low							
sedge	>0.5 Mid	closed sedgeland	sedgeland	open sedgeland	sparse sedgeland	isolated sedges	isolated clumps of sedges	sedges
	<0.5 Low							
rush	>0.5 Mid	closed rushland	rushland	open rushland	sparse rushland	isolated rushes	isolated clumps of rushes	rushes
	<0.5 Low							
forb	>0.5 Mid	closed forbland	forbland	open forbland	sparse forbland	isolated forbs	isolated clumps of forbs	forbs
	<0.5 Low							

Growth Form	Height ranges (m)	Structural Formation Classes						
fern	>2 Tall	closed fernland	fernland	open fernland	sparse fernland	isolated ferns	isolated clumps of ferns	ferns
	1-2 Tall							
	<1 Low							
bryophyte	<0.5	closed bryophyte land	bryophyte land	open bryophyte land	sparse bryophyte land	isolated bryophytes	isolated clumps of bryophytes	bryophytes
lichen	<0.5	closed lichenland	lichenland	open lichenland	sparse lichenland	isolated lichens	isolated clumps of lichens	lichens
vine	>30 Tall	closed vineland	vineland	open vineland	sparse vineland	isolated vines	isolated clumps of vines	vines
	10-30 Med							
	<10 Low							
aquatic	<1 Tall	closed aquatic bed	aquatic bed	open aquatic bed	sparse aquatics	isolated aquatics	isolated clumps of aquatics	aquatics
	0-0.5 Low							
seagrass	<1 Tall	closed seagrass bed	Seagrass bed	open seagrass bed	sparse seagrass bed	isolated seagrasses	isolated clumps of seagrasses	seagrasses
	0-0.5 Low							

From: NVIS Structural Formation Terminology (Australian Vegetation Attribute Manual Version 7.0 November 2017 <https://www.environment.gov.au/land/publications/australian-vegetation-attribute-manual-version-7>)

* Foliage Cover is defined for each stratum as 'the proportion of the ground, which would be shaded if sunshine came from directly overhead'. It includes branches and leaves and is obtained by multiplying Crown Cover with Crown type (Hnatiuk *et al.*, 2009). It is applied to a stratum in a plot, rather than an individual crown, with the NVIS measure for a vegetation type ideally being a summary of several plots. Foliage Projective Cover, which considers only the vertical projection of photosynthetic components (generally leaves), can be measured by line interception methods for tree, shrub and ground layer vegetation (Specht & Specht, 1999).

** Crown Cover (canopy cover) as per Hnatiuk *et al.* (2009). Although relationships between this attribute and Foliage Cover are dependent on season, species, species age etc., the crown cover category classes have been adopted as the defining measure.

*** The percentage cover is defined as the percentage of a strictly defined plot area, covered by vegetation. This can be an estimate and is a less precise measure than using, for example, a point intercept transect method on ground layer, or overstorey vegetative cover. That is, for precisely measured values (e.g. crown densitometer or point intercept transects) the value measured would be 'foliage' cover. Where less precise or qualitative measures are used these will most probably be recorded as 'percentage' cover.

Appendix D – Relevé Data

Site ID	Date	Type	Landform	Aspect	Slope	Rock Cover (%)	Bare Soil Cover (%)	Leaf Litter Cover (%)	Vegetation Cover (%)	Rock Type	Soil Type	Soil Colour	Condition	Disturbance	Since Last Fire	Evidence of Fire	Broad Floristic Formation	Vegetation Description	Comments
KWI-01	8/03/2019	Releve	Sand Plain	Flat	Flat	0	0	75	25	none	Loamy Sand	Grey	Degraded	Clearing, weeds & rehab	>10 yrs	No evidence	Tuart mid woodland	<i>Eucalyptus gomphocephala</i> mid woodland over <i>Acacia xanthina</i> and <i>Acacia cyclops</i> tall to mid sparse shrubland over <i>Rhagodia baccata</i> low chenopod shrubland over introduced grasses	Rehab area with open understorey
KWI-02	8/03/2019	Releve	Sand Plain	Flat	Flat	0	0	95	5	none	Loamy Sand	Grey	Degraded	Clearing & weeds	>10 yrs	No evidence	Eucalyptus mid woodland	<i>Eucalyptus</i> spp., <i>Casuarina obesa</i> , <i>Callistemon</i> sp., <i>Callitris preissii</i> and <i>Melaleuca lanceolata</i> mid to low open woodland	Open grassy understorey

Appendix E – Assessment of Conservation Significant Flora Likelihood

Family	Taxon	Current Conservation Status			Habit and Habitat\	Habitat in Study Area	Current Known Distribution	Distance to nearest Record	Recorded in Study Area	Likelihood of Occurrence
		EPBC Act	BC Act	DBCA						
Proteaceae	<i>Synaphea</i> sp. Fairbridge Farm (D. Papenfus 696)	CR	CR	T	Dense, clumped shrub, to 0.3 m high, to 0.4 m wide. Fl. yellow, Oct. Sandy with lateritic pebbles. Near winter-wet flats, in low woodland with weedy grasses.	No	No	21 km SE	No	Highly Unlikely
Proteaceae	<i>Synaphea</i> sp. Serpentine (G.R. Brand 103)	CR	CR	T	Small clumped shrub. Long, undulating inflorescences, peduncles red. Flowers in September, October or November. Winter wet areas and adjacent to wetlands	No	No	13 km ESE	No	Highly Unlikely
Orchidaceae	<i>Caladenia huegelii</i>	EN	CR	T	Tuberous, perennial, herb, 0.25-0.6 m high. Fl. green & cream & red, Sep to Oct. Grey or brown sand, clay loam.	No	Yes	7.3 km ENE	No	Highly Unlikely
Orchidaceae	<i>Drakaea elastica</i>	EN	CR	T	Tuberous, perennial, herb, 0.12-0.3 m high. Fl. red & green & yellow, Oct to Nov. White or grey sand. Low-lying situations adjoining winter-wet swamps.	No	Yes	6.3 km NE	No	Highly Unlikely
Myrtaceae	<i>Eucalyptus balanites</i> x	EN	CR	T	(Mallee), to 5 m high, bark rough, flaky. Fl. white, Oct to Dec or Jan to Feb. Sandy soils with lateritic gravel.	No	No	22 km ENE	No	Highly Unlikely
Orchidaceae	<i>Diuris purdiei</i>	EN	EN	T	Tuberous, perennial, herb, 0.15-0.35 m high. Fl. yellow, Sep to Oct. Grey-black sand, moist. Winter-wet swamps.	No	No	13 km NE	No	Highly Unlikely
Cyperaceae	<i>Lepidosperma rostratum</i>	EN	EN	T	Rhizomatous, tufted perennial, grass-like or herb (sedge), 0.5 m high. Fl. brown. Peaty sand, clay.	No	No	23 km ESE	No	Highly Unlikely
Ericaceae	<i>Andersonia gracilis</i>	EN	EN	T	Slender erect or open straggly shrub, 0.1-0.5(-1) m high. Fl. white-pink-purple, Sep to Nov. White/grey sand, sandy clay, gravelly loam. Winter-wet areas, near swamps.	No	No	31 km NE	No	Highly Unlikely

Family	Taxon	Current Conservation Status			Habit and Habitat\	Habitat in Study Area	Current Known Distribution	Distance to nearest Record	Recorded in Study Area	Likelihood of Occurrence
		EPBC Act	BC Act	DBCA						
Orchidaceae	<i>Drakaea micrantha</i>	VU	EN	T	Tuberous, perennial, herb, 0.15-0.3 m high. Fl. red & yellow, Sep to Oct. White-grey sand.	No	No	8.6 km NE	No	Highly Unlikely
Orchidaceae	<i>Diuris micrantha</i>	VU	VU	T	Tuberous, perennial, herb, 0.3-0.6 m high. Fl. yellow & brown, Sep to Oct. Brown loamy clay. Winter-wet swamps, in shallow water.	No	Yes	4.1 km NE	No	Highly Unlikely
Cyperaceae	<i>Eleocharis keigheryi</i>	VU	VU	T	Rhizomatous, clumped perennial, grass-like or herb (sedge), to 0.4 m high. Fl. green, Aug to Nov. Clay, sandy loam. Emergent in freshwater: creeks, claypans.	No	No	27 km NE	No	Highly Unlikely
Fabaceae	<i>Acacia</i> sp. Binningup (G. Cockerton et al. WB 37784)			P1	Upright shrub. Grey sand	Yes	Yes	5.4 km SSE	No	Highly Unlikely
Poaceae	<i>Lachnagrostis nesomytica</i> subsp. <i>paralia</i>			P1	Loosely tufted, weakly ascending, short-lived perennial or annual, herb (grass), to 0.5 m high. Fl. purple-green. Calcareous sands. Coastal dunes and swales.	Yes	Yes	6.4 km NW	No	Unlikely
Poaceae	<i>Austrostipa mundula</i>			P3	Perennial grass to 0.5m. Grey sand over limestone	Yes	No	7.3 km N	No	Unlikely
Cyperaceae	<i>Cyathochaeta teretifolia</i>			P3	Rhizomatous, clumped, robust perennial, grass-like or herb (sedge), to 2 m high, to 1.0 m wide. Fl. brown. Grey sand, sandy clay. Swamps, creek edges.	No	No	8.8 km E	No	Highly Unlikely
Dilleniaceae	<i>Hibbertia spicata</i> subsp. <i>leptotheca</i>			P3	Erect or spreading shrub, 0.2-0.5 m high. Fl. yellow, Jul to Oct. Sand. Near-coastal limestone ridges, outcrops & cliffs.	No	No	17 km N	No	Highly Unlikely
Thymelaeaceae	<i>Pimelea calcicola</i>			P3	Erect to spreading shrub, 0.2-1 m high. Fl. pink, Sep to Nov. Sand. Coastal limestone ridges.	No	Yes	5.2 km N	No	Unlikely

Family	Taxon	Current Conservation Status			Habit and Habitat\	Habitat in Study Area	Current Known Distribution	Distance to nearest Record	Recorded in Study Area	Likelihood of Occurrence
		EPBC Act	BC Act	DBCA						
Fabaceae	<i>Sphaerolobium calcicola</i>			P3	Slender, multi-stemmed, scandent or erect shrub, to 1.5 m high. Fl. orange-red, Jun or Sep to Nov. White-grey-brown sand, sandy clay over limestone, black peaty sandy clay. Tall dunes, winter-wet flats, interdunal swamps, low-lying areas.	No	Yes	7.1 km S	No	Unlikely
Aponogetonaceae	<i>Aponogeton hexatepalus</i>			P4	Rhizomatous or cormous, aquatic perennial, herb, leaves floating. Fl. green-white, Jul to Oct. Mud. Freshwater: ponds, rivers, claypans.	No	No	7.3 km E	No	Highly Unlikely
Sapindaceae	<i>Dodonaea hackettiana</i>			P4	Erect shrub or tree, 1-5 m high. Fl. yellow-green/red, mainly Jul to Oct. Sand. Outcropping limestone.	Yes	Yes	3.3 km NE	No	Unlikely
Fabaceae	<i>Jacksonia sericea</i>			P4	Low spreading shrub, to 0.6 m high. Fl. orange, usually Dec or Jan to Feb. Calcareous & sandy soils.	Yes	Yes	1.2 km W	No	Unlikely
Stylidiaceae	<i>Stylidium ireneae</i>			P4	Lax perennial, herb, (0.06-)0.1-0.28 m high, Leaves oblanceolate, 0.4-2 cm long, 1-3 (-5) mm wide, apex subacute to acuminate, margin entire, glandular. Scape glandular. Inflorescence racemose. Fl. pink, Oct to Dec. Sandy loam. Valleys near creek lines, woodland, often with Agonis.	No	Yes	6 km E	No	Highly Unlikely