



mainroads
WESTERN AUSTRALIA

Offsets Strategy

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Tonkin Highway Extension

April 2021

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Amendments

Report Compilation & Review	Name and Position	Document Revision	Date
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EXECUTIVE SUMMARY

Main Roads Western Australia (Main Roads) is proposing to extend Tonkin Highway from Thomas Road in Oakford to South Western Highway in Mundijong (the Project). The Proposed Action encompasses approximately 305 ha of road reserve, with a disturbance footprint of 230 ha. The Proposed Action is located within the Shire of Serpentine-Jarrahdale on the Swan Coastal Plain in Western Australia. The Project is approximately 30 km south-east of the Perth Central Business District and approximately 3.5 km west of Byford. The Project spans approximately 14 km in length.

In December 2019, Main Roads submitted a Referral of the Proposed Action in accordance with Section 68 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (C'th) (EPBC Act) due to potential impacts on Matters of National Environmental Significance (MNES). In April 2020, the Commonwealth Department of Agriculture, Water and the Environment (DAWE) (on behalf of the Commonwealth Minister for the Environment) determined the Proposed Action to be a 'Controlled Action' which required assessment and approval under the EPBC Act, with the assessment to be undertaken at the level of 'Preliminary Documentation' (EPBC 2019/8608). The DAWE requested Main Roads to provide additional information in accordance with Section 95A of the EPBC Act to further inform its environmental assessment.

The Proposed Action will result in the following significant residual impacts to Matters of National Environmental Significance (MNES):

- clearing of 0.13 ha of *Corymbia-Kingia* TEC (SCP 3a);
- clearing of 3.94 ha *Corymbia-Xanthorrhoea* TEC (SCP 3c);
- loss of up to 165 individuals of *Tetraria australiensis*; and
- loss of Black Cockatoo habitat including:
 - clearing of up to 346 potential breeding trees for Black Cockatoos, including two trees with potentially suitable hollows for Black Cockatoo nesting;
 - clearing of up to 20.93 ha of foraging habitat for Carnaby's Cockatoo;
 - clearing of up to 20.61 ha of foraging habitat and for Baudin's Cockatoo and Forest Red-tailed Black Cockatoo;

This draft Offset Strategy has been prepared to support the Preliminary Documentation (Strategen-JBS&G 2021), to demonstrate Main Roads' commitment to offset the Proposed Action's significant residual impacts to TECs, Black Cockatoos and threatened flora.

The draft Offset Strategy comprises Main Roads pursuing a number of offset packages, in the form of land acquisition of third party freehold land or transfer of Main Roads owned land to the conservation estate, to counterbalance the potential significant impacts of the Proposed Action. Identification and acquisition of land to counterbalance significant residual environmental impacts associated with Main Roads infrastructure projects is now being managed through a Memorandum of Understanding (MoU) between Main Roads and the Department of Biodiversity, Conservation and Attractions (DBCA). The MoU commits Main Roads funding to assist DBCA in identifying and acquiring suitable land offsets to be added to the conservation estate. Once suitable offset land is acquired, Main Roads will reimburse DBCA the land acquisition costs. Acquisition of suitable offset land aims to satisfy Commonwealth and State environmental compliance requirements.

Details of Offsets 1-4 (including locality) remain commercial in confidence at this time and will be provided upon the outcome of commercial negotiations.

Overview of offset package

The table below provides a summary of the potential for the offset package to counterbalance the potential significant residual impacts to *Corymbia-Kingia* TEC (SCP 3a), *Corymbia-Xanthorrhoea* TEC (SCP 3c), Carnaby's Cockatoo, Forest Red-tailed Black Cockatoo, Baudin's Cockatoo and *Tetraria australiensis*.

The draft Offset Strategy will be refined subject to commercial negotiations with property owners, and consultation with the DBCA. Once the strategy is agreed with DBCA, Main Roads will develop a detailed Offset Proposal for submission and approval under the EPBC Act.

Table ES1 Summary of Proposed offset packages.

Offset Site	Offset Description	Property location	Existing tenure
Nirimba	14.2 ha of ha of Black Cockatoo habitat suitable for all three species within the "banked" portion of the Lake Clifton offset site	Lots 1262, 295 and 842 Carrabungup Road, Nirimba	Freehold owned by the State of WA managed by DBCA (acquired in 2016 with funding provided by Main Roads)
Lake Clifton	23.13 ha of ha of Black Cockatoo habitat suitable for all three species within the "banked" portion of the Lake Clifton offset site	Lots 1000, 2240, 2275, 2657 & 3045 Preston Beach Road, Lake Clifton	Freehold owned by the State of WA managed by DBCA (acquired in 2016 with funding provided by Main Roads)
Offset 1	Acquisition of 71 ha of Black Cockatoo habitat suitable for all three species	To be confirmed	To be confirmed
Offset 2	Acquisition of land with 26.2 ha of <i>Corymbia-Xanthorrhoea</i> TEC (SCP 3c)	Confidential pending survey and negotiation with property owners Swan Coastal Plain	Freehold owned by third parties
Offset 3	Acquisition of land with <ul style="list-style-type: none"> At least 350 individuals of <i>Tetraria australiensis</i> 27.2ha of suitable habitat for the species 	To be confirmed	To be confirmed
Offset 4	Restoration and management activities for 1.13 ha of <i>Corymbia-Kingia</i> TEC (SCP 3a)	DBCA managed conservation area	Reserve managed by DBCA
Artificial Hollows	Installation of 9 artificial hollows	To be confirmed in discussion with DBCA	Reserve managed by DBCA or other secure tenure

Offset Site	Offset Description	Property location	Existing tenure
Indirect Offset	<p>Research projects are appropriate as an offset for the Proposed Action as there was a high degree of uncertainty regarding impacts of a Proposed Action and new science was required to develop better mitigation measures or predictive tools to avoid and minimise the particular type of impact.</p> <p>Main Roads is providing a funding contribution to Murdoch University to finance Black Cockatoo research. Murdoch’s research proposal (Warren et al. 2019) is being funded by Main Roads. Funding for research is intended to comprise 10% of the total Carnaby’s, Baudin’s and Forest Red-tailed Black Cockatoo offset requirement.</p> <p>Quantum of indirect offset is currently estimated at \$100,000. The final figure will be determined once the direct offsets are finalised.</p>		

Preliminary offset calculations

Preliminary offset calculations were completed using the EPBC Act Offset Assessment Guide to determine the counterbalance of the offset packages being considered. As presented in the below table, the offset package is expected to provide adequate compensation for significant residual impacts to MNES from this Proposed Action.

Table ES2: Summary of preliminary offset calculations

Attribute	Carnaby’s Cockatoo		FRTBC		Baudin’s Cockatoo		SCP 3c		SCP 3a		Tetraria australiensis		Artificial Hollows
	Area (ha)	% offset	Area (ha)	% offset	Area (ha)	% offset	Area (ha)	% offset	Area (ha)	% offset	Area (ha)	% offset	
Nirimba	14.2	9.85	14.2	11.08	14.2	9.09	-	-	-	-	-	-	-
Lake Clifton	23.13	19.19	23.13	23.41	23.13	19.19	-	-	-	-	-	-	-
Offset 1	71	50.81	71	61.97	71	50.81	-	-	-	-	-	-	-
Offset 2	26.2	12.64	26.2	15.42	26.2	12.64	26.2	100.6	-	-	-	-	-
Offset 3	-	-	-	-	-	-	-	-	-	-	27.2	100.6	-
Offset 4	1.13	0.57	1.13	0.70	1.13	0.57	-	-	1.13	100.4	-	-	-
Total	135.7	93.06	135.7	112.38	135.7	93.06	26.2	100.6	1.13	100.4	27.2	100.6	9

1 INTRODUCTION

1.1 Proposed Action background

Main Roads Western Australia (Main Roads) is proposing to extend Tonkin Highway from Thomas Road in Oakford to South Western Highway in Mundijong (the Project). The Proposed Action encompasses approximately 315 ha of road reserve, with a disturbance footprint of 230 ha.

The Proposed Action is located within the Shire of Serpentine-Jarrahdale on the Swan Coastal Plain in Western Australia. The Project is approximately 30 km south-east of the Perth Central Business District and approximately 3.5 km west of Byford. The Project spans approximately 14 km in length.

The south-east corridor is an important and fast-growing area faced with increased congestion, higher travel times for freight vehicles and reduced safety outcomes on the existing road network. Population projections show that by 2031, sustained growth in the south-east sub-region will result in a population increase of approximately 35 per cent (from the 2008 base level). This additional population will put significant pressure on the existing road network with volumes exceeding recommended capacity.

As the Proposed Action may have a significant impact on Matters of National Environmental Significance (MNES), Main Roads was required to prepare Preliminary Documentation to inform the assessment of the relevant impacts of the Proposed Action. The Preliminary Documentation was prepared in response to a request by the Department of Agriculture, Water, and Environment (DAWE) in April 2020 for additional information to support assessment of impacts for the Proposed Action (EPBC 2019/8608) under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act).

1.2 Proposed Action description

Key components of the Proposed Action include:

- approximately 14 kilometres of four lane dual carriageway road from Thomas Road to South Western Highway;
- construction/upgrades of intersections at Thomas Road, Orton Road, Mundijong Road and South Western Highway;
- a grade separated interchange at Bishop Road catering for the Perth to Bunbury rail line and freight line;
- a principal shared path along the corridor; and
- installation of associated road infrastructure, such as lighting, noise and retaining walls, safety barriers, stopping bays and traffic monitoring devices

1.3 Purpose of this strategy

This draft Offset Strategy has been prepared to support the Preliminary Documentation for the Proposed Action, to demonstrate Main Roads' commitment to offset the Proposed Action's significant residual impacts to MNES.

This draft Offset Strategy will be refined subject to commercial negotiations with property owners, and consultation with the WA Department of Biodiversity, Conservation and Attractions (DBCA). Once land has been adequately assessed and/or acquired, Main Roads will develop a detailed Offset Proposal for submission and approval under the EPBC Act. Acquisition of suitable offset land aims to satisfy Commonwealth and State environmental compliance requirements.

1.4 Impact avoidance

The WA Environmental Offsets Policy notes that environmental offsets will only be considered after avoidance and mitigation options have been pursued. Since the referral of the Proposed Action in December 2019, Main Roads has undertaken a comprehensive review of the design and amended the Proposed Action to reduce the potential impacts on key environmental features including:

- Threatened Ecological Communities (TECs):
 - Clay Pans of the Swan Coastal Plain TEC – Critically Endangered;
 - *Corymbia calophylla* – *Kingia australis* woodlands on heavy soils, Swan Coastal Plain TEC – Endangered; and
 - *Corymbia calophylla* - *Xanthorrhoea preissii* woodlands and shrublands of the Swan Coastal Plain – Endangered.
- Threatened Flora:
 - *Synaphea* sp. Serpentine – Critically Endangered;
 - *Synaphea* sp. Pinjarra Plain – Endangered; and
 - *Tetraria australiensis* – Vulnerable.
- Black Cockatoos:
 - Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) – Endangered;
 - Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) – Vulnerable; and
 - Baudin's Black Cockatoo (*Calyptorhynchus baudinii*) – Endangered.

The Proposed Action has been designed to avoid impacts to TECs, Black Cockatoo habitat and threatened flora species and habitat as far as is practicable. Avoidance measures undertaken by Main Roads for the Proposed Action include:

1. Incorporates a predominantly cleared corridor that is reserved for 'Primary regional roads' and 'Other regional roads' under the MRS.
2. Avoiding bisecting patches of native vegetation where possible.
3. Requiring all laydowns, stockpiles and access tracks to be located within existing cleared areas or within the permanent footprint of the works. As such, no native vegetation will be cleared for temporary works outside of the permanent footprint.
4. Steepening batter slopes and installing safety barriers and retaining walls to reduce and minimise the proposed clearing footprint. Earthworks have been reduced in fill height and/or cut depth in areas where native vegetation exists.
5. The crossing for the interchange at Mundijong has shifted further to the east to completely avoid impacts to *Synaphea* sp. Pinjarra Plain, minimise the impacts to *Synaphea* sp. Serpentine and *Tetraria australiensis*, completely avoid Clay Pan TEC and significantly minimise impacts to the *Corymbia calophylla* – *Kingia australis* and *Corymbia calophylla* – *Xanthorrhoea preissii* TECs.

Further opportunity to reduce the impact to species and their habitat and communities may be possible during the design phase and construction works for the Proposed Action where construction methodology allows (e.g. through localised steepening of fill batter slopes).

Changes to the design of the Proposed Action have been made since referral to reduce impacts to MNES. A summary of the original impact, and resulting impact post design changes and the net reduction in clearing area of TEC's is presented in Table 1.

Changes to the design have included a range of refinements to minimise the impacts to the environment such as reducing median widths and changing the design of interchanges to reduce clearing requirements. The resulting Proposed Action area reflects the minimum land area required for the road corridor. Impacts to MNES and other environmental values have been reduced to the maximum extent possible and the remaining impact cannot be avoided if the Proposal is to proceed.

Table 1 Summary of design changes to avoid and minimise impacts to MNES

Aspect	Original Proposal as referred	Revised Proposal at Concept Design	Reduction in impact
Clay Pans of the Swan Coastal Plain Threatened Ecological Community (Critically Endangered)	0.05 ha	0 ha	-0.05 ha
<i>Corymbia calophylla</i> – <i>Kingia australis</i> woodlands on heavy soils, Swan Coastal Plain Threatened Ecological Community (Endangered)	1.3 ha	0.13 ha	-1.2 ha
<i>Corymbia calophylla</i> - <i>Xanthorrhoea preissii</i> woodlands and shrublands of the Swan Coastal Plain (Endangered)	5.3 ha	3.94 ha	-1.36 ha
<i>Synaphea</i> sp. Serpentine (Critically Endangered)	538	3	-535
<i>Synaphea</i> sp. Pinjarra Plain (Endangered)	6	0	-6
<i>Tetraria australiensis</i> (Vulnerable)	1,131	165	-966

1.5 Relevant policies and guidelines

This draft Offset Strategy has been developed for the Proposed Action with reference to the following documents:

- Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy (Australian Government 2012a);
- Offset Assessments Guide (Australian Government 2012b); and
- Offset Calculator Guidelines (Australian Government 2012c).

2 SIGNIFICANT RESIDUAL IMPACTS

2.1 Controlling provisions

This Offset Strategy applies to offsets required as a result of potential residual impacts to the following MNES within the Proposed Action Area of the Tonkin Extension Project:

- *Corymbia calophylla* – *Kingia australis* woodlands on heavy soils, Swan Coastal Plain (SCP) TEC (referred to as *Corymbia-Kingia* TEC (SCP 3a));
- *Corymbia calophylla* - *Xanthorrhoea preissii* woodlands and shrublands of the SCP (referred to as *Corymbia-Xanthorrhoea* TEC (SCP 3c));
- *Tetralia australiensis*;
- Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*);
- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*); and
- Baudin's Black Cockatoo (*Calyptorhynchus baudinii*).

The Preliminary Documentation (Strategen-JBS&G 2021) provides details of the predicted impacts of the Proposed Action to the above MNES. This information is summarised below.

2.2 Existing environment

2.2.1 Surveys

The MNES within the Proposed Action area have been determined through biological surveys as follows:

- Woodman Environmental Consulting (Woodman) (2020) Flora and Vegetation Survey over a 362.3 ha Survey Area comprising the Proposed Action area and surrounding land;
- Black Cockatoo Breeding Habitat Surveys (Kirkby 2019 and 2020);
- Black Cockatoo Habitat Quality Assessment (Strategen JBS&G 2020); and
- Dieback Assessment (Glevan 2020).

2.2.2 TECs

2.2.2.1 *Corymbia-Kingia* TEC (SCP 3a)

The biological surveys by Woodman (2020) mapped a total of 2.080 ha of the *Corymbia-Kingia* TEC at one occurrence within the broader Survey Area. Woodman (2020) defined vegetation occurring within vegetation unit VT2 and VT3, to represent the *Corymbia-Kingia* TEC based on statistical similarity to SCP3a. The Proposed Action will impact 0.13 ha of the mapped *Corymbia-Kingia* TEC area.

The location, vegetation type and condition of the *Corymbia-Kingia* TEC is identified by Table 2. The *Corymbia-Kingia* TEC comprises two vegetation types, with the condition ranging from 'Very Good' (1.33 ha) to 'Degraded' (0.75 ha). Of the 0.13 ha of *Corymbia-Kingia* TEC that will be impacted for the Proposed Action, 0.10 ha is in 'Very Good' condition and the remaining 0.02 ha is in 'Degraded' condition.

Table 2 *Corymbia-Kingia* TEC (SCP 3a) locations

Site	Location	TEC Area (patch)	Direct impact	Vegetation description / condition
1	South side Mundijong Rd. near Lampiter Dr. intersection. (previously recorded DBCA 2000a Occurrence 7 at 1.2 ha)	2.82 ha	0.13 ha	<p>Vegetation Description:</p> <p>VT2 (0.511 ha) - Tall sparse shrubland dominated by <i>Jacksonia sternbergiana</i>, <i>Kingia australis</i> and <i>Xanthorrhoea preissii</i> over low sparse shrubland, over low open sedgeland and grassland of mixed species, over low sparse shrubland of mixed species on brown sandy loam on seasonally moist flats</p> <p>VT3 (1.569 ha) - Tall to mid sparse shrubland dominated by <i>J. sternbergiana</i>, <i>K. australis</i> and <i>X. preissii</i> over mid sparse shrubland of mixed species, over shrubland to open shrubland of mixed species, over low open rushland and sedgeland of mixed species on brown sandy clay on seasonally moist flats.</p> <p>Vegetation Condition:</p> <ul style="list-style-type: none"> • 'Very Good' (1.33 ha), • 'Degraded' (0.75 ha)

2.2.2.2 *Corymbia-Xanthorrhoea* TEC (SCP 3c)

A total of 9.75 ha of *Corymbia-Xanthorrhoea* TEC was mapped within the broader Survey Area, across 9 occurrences. Vegetation consistent with the *Corymbia-Xanthorrhoea* TEC were identified as VT4, VT5 and VT6 given their statistical similarity to the TEC. All occurrences of the TEC within the survey area were previously known as per DBCA mapping. There is up to 3.94 ha of *Corymbia-Xanthorrhoea* TEC within one patch to be impacted within the Proposed Action area, of which 1.16 ha is in Very Good condition, 0.29 ha in Good condition 1.92 ha is in Degraded condition and 0.57 ha is in Completely Degraded condition.

The location, vegetation type and condition of each recorded occurrence of the *Corymbia-Xanthorrhoea* TEC is identified by Table 3. The *Corymbia-Xanthorrhoea* TEC comprises three vegetation types within the broader Survey Area, with more than half of the total recorded area for the ecological community being in 'Degraded' to 'Completely Degraded' condition. On the advice of DBCA, where 'Degraded' and 'Completely Degraded' patches are small and isolated, they have been excluded from being assessed as *Corymbia-Xanthorrhoea* TEC. However, where larger patches comprise a portion of the mapped area as 'Degraded' to 'Completely Degraded', these areas have been included as part of the mapped occurrence as they are considered viable and potentially important to maintain the integrity of the patch.

Table 3 *Corymbia-Xanthorrhoea* TEC (SCP 3c) locations

Site	Location	TEC Area (patch)	Direct impact	Vegetation description / condition
1	W side of Hopkinson Rd. between Jersey Rd. and Charolais Ct.	0.13 ha	0.13 ha	Vegetation Description: VT4 (0.13 ha) - Mid open forest of <i>Corymbia calophylla</i> over tall to mid sparse shrubland dominated by <i>Xanthorrhoea preissii</i> and <i>Kingia australis</i> over low sedgeland to open sedgeland over low sparse forbland of mixed species on grey or brown sand or sandy loam on dry flats. Vegetation Condition: <ul style="list-style-type: none"> • 'Good' (0.13 ha)
2	SW corner of Abernethy Rd and Hopkinson Rd intersection	0.90 ha	0.0 ha	Vegetation Description: VT4 (0.9 ha) - Mid open forest of <i>C. calophylla</i> over tall to mid sparse shrubland dominated by <i>X. preissii</i> and <i>K. australis</i> over low sedgeland to open sedgeland over low sparse forbland of mixed species on grey or brown sand or sandy loam on dry flats. Vegetation Condition: <ul style="list-style-type: none"> • 'Very Good' (0.24 ha) • 'Degraded' (0.65 ha)
3	N side of Orton Rd. between Bullock Dr. and Hopkinson Rd	0.48 ha	0.41 ha	Vegetation Description: VT4 (0.36 ha) - Mid open forest of <i>C. calophylla</i> over tall to mid sparse shrubland dominated by <i>X. preissii</i> and <i>K. australis</i> over low sedgeland to open sedgeland over low sparse forbland of mixed species on grey or brown sand or sandy loam on dry flats. Vegetation Condition: <ul style="list-style-type: none"> • 'Degraded' (0.33 ha)
4	W side of Hopkinson Rd. between Cavanagh Cl. and Gossage Rd.	0.56 ha	0.34 ha	Vegetation Description: VT4 (0.56 ha) - Mid open forest of <i>C. calophylla</i> over tall to mid sparse shrubland dominated by <i>X. preissii</i> and <i>K. australis</i> over low sedgeland to open sedgeland over low sparse forbland of mixed species on grey or brown sand or sandy loam on dry flats. Vegetation Condition: <ul style="list-style-type: none"> • 'Degraded' (0.56 ha)
5	N side of Bishop Rd between Kargotich Rd and Hopkinson Rd.	0.30 ha	0.30 ha	Vegetation Description: VT4 (0.38 ha) - Mid open forest of <i>C. calophylla</i> over tall to mid sparse shrubland dominated by <i>X. preissii</i> and <i>K. australis</i> over low sedgeland to open

Site	Location	TEC Area (patch)	Direct impact	Vegetation description / condition
				sedgeland over low sparse forbland of mixed species on grey or brown sand or sandy loam on dry flats. Vegetation Condition: <ul style="list-style-type: none"> • 'Degraded' (0.30 ha)
6	S side of Mundijong Rd. between Lampiter Dr. and Paterson St. (previously recorded DBCA 2000b Occurrence 5 at 3.6 ha)	4.31 ha	1.39 ha	Vegetation Description: VT4 (4.31 ha) - Mid open forest of <i>C. calophylla</i> over tall to mid sparse shrubland dominated by <i>X. preissii</i> and <i>K. australis</i> over low sedgeland to open sedgeland over low sparse forbland of mixed species on grey or brown sand or sandy loam on dry flats. Vegetation Condition: <ul style="list-style-type: none"> • 'Very Good' (1.84 ha) • 'Good' (1.86 ha) • 'Degraded' (0.61 ha)
7	E and W sides of railway line adjacent to Wright Rd between Mundijong Rd and Bilya Ave.	1.45 ha	0.66 ha	Vegetation Description: VT4 (4.31 ha) - Mid open forest of <i>C. calophylla</i> over tall to mid sparse shrubland dominated by <i>X. preissii</i> and <i>K. australis</i> over low sedgeland to open sedgeland over low sparse forbland of mixed species on grey or brown sand or sandy loam on dry flats. Vegetation Condition: <ul style="list-style-type: none"> • 'Degraded' (1.18 ha) • 'Completely Degraded' (0.27 ha)
8	W and N sides of Shanley Rd west of South Western Highway	0.73 ha	0.71 ha	Vegetation Description: VT6 (0.73 ha) – Mid open forest of <i>C. calophylla</i> over mid sparse shrubland of <i>X. preissii</i> and <i>K. australis</i> over low sparse shrubland, low open sedgeland, low open introduced grassland, low open shrubland and forbland on brown sandy loam on mid to lower slopes of foothills. Vegetation Condition: <ul style="list-style-type: none"> • 'Degraded' (0.36 ha) • 'Completely Degraded' (0.37 ha)

2.2.3 Black Cockatoo habitat

2.2.3.1 Breeding habitat

The Preliminary Documentation identified a total of 346 trees (> 500 mm DBH) that comprise native species known to support Black Cockatoo breeding within the Proposed Action area, as summarised in Table 2. Only two marri trees of the 346 trees have potentially suitable hollows (Kirkby 2019, 2020).

Table 4 Black Cockatoo potential breeding trees

Tree species	No. of trees in Survey Area	No. of trees with hollows in Survey area	No. of trees in Proposed Action Area	No. of trees with hollows in Proposed Action Area
Flooded Gum (<i>Eucalyptus rudis</i>)	85	2 (1 hollow)	69	0
Flooded Gum (<i>Eucalyptus rudis</i>) – Stag	2	1 (2 hollows)	1	0
Jarraah (<i>Eucalyptus marginata</i>)	7	1 (2 hollows)	6	1 (2 hollows ¹)
Jarraah (<i>Eucalyptus marginata</i>) - Stag	4	0	4	0
Marri (<i>Corymbia calophylla</i>)	341	1 (2 hollows) 9 (1 hollow)	254	1 (2 hollows) ² 4 (1 hollow) ²
Marri (<i>Corymbia calophylla</i>) - Stag	19	1 (2 hollows)	15	1 (2 hollows)
Wandoo (<i>Eucalyptus wandoo</i>)	1	0	2	0
Unknown Eucalypt species	1	0	0	0
Total	460	4 (2 hollows) 11 (1 hollow)	346	3 (2 hollows) 4 (1 hollow)

¹One hollow has since collapsed

²Two trees contain suitable hollows

2.2.3.2 Foraging habitat

In total, the Proposed Action area contains 20.93 ha of 'Low to Moderate' quality foraging habitat for Carnaby's Cockatoo (Table 5). There is 20.61 ha of 'Moderate to High' to 'Low to Moderate' foraging habitat for Forest Red-tailed Black Cockatoo and Baudin's Cockatoo within the Proposed Action area (Table 5) (Strategen-JBS&G 2021).

Table 5 Black Cockatoo Foraging Habitat Extent and Quality

Habitat quality and score	Carnaby's Cockatoo		Forest Red-tailed Black Cockatoo		Baudin's Cockatoo	
	Extent (ha)	Proportion (%)	Extent (ha)	Proportion (%)	Extent (ha)	Proportion (%)
High (6)	0	0	0.0	0.0	0.0	0.0
Moderate to High (5)	0	0	5.61	2.4	5.61	2.4
Moderate (4)	9.32	4.0	3.70	1.6	3.70	1.6
Low to Moderate (3)	11.61	5.0	11.29	4.8	11.29	4.8
Low (2)	8.69	3.7	13.56	5.8	13.56	5.8
Negligible to low (1)	4.55	2.0	0.0	0.0	0.0	0.0
No (0)	199.33	85.4	199.33	85.4	199.33	85.4
Total	233.50	100	233.50	100	233.50	100

2.2.3.3 Roosting habitat

No known roosting sites were recorded within the Proposed Action area (Kirkby 2019, 2020).

2.2.4 Threatened flora

Woodman (2020) recorded populations of two listed threatened flora species within the Proposed Action area, as summarised below. Impacts to *Synaphea* sp. Serpentine is not significant and therefore an offset is not proposed.

Species	Population within Survey Area	Population within Development Envelope	Area of Habitat within Survey Area (ha)	Area of Habitat within Development Envelope (ha)
<i>Synaphea</i> sp. Serpentine	551	3	3.51	0.13 ha
<i>Tetraria australiensis</i>	1,214	165	8.61 ha	3.44 ha

2.3 Significant residual impacts

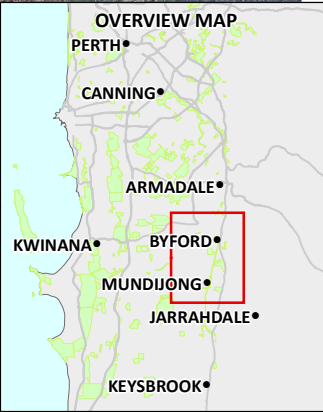
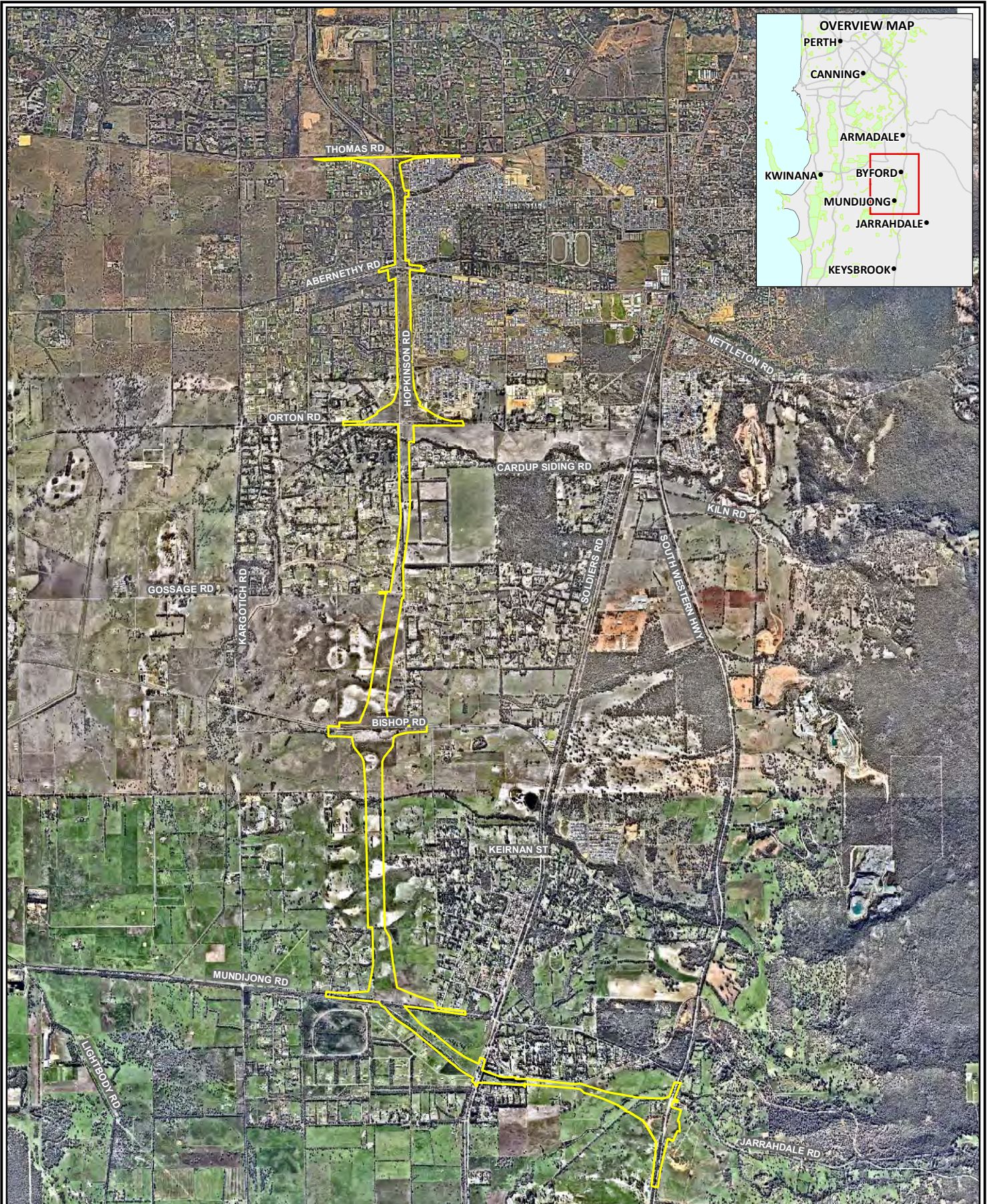
The Proposed Action will result in the following significant residual impacts:

- clearing of 0.13 ha of *Corymbia-Kingia* TEC (SCP 3a);
- clearing of 3.94 ha *Corymbia-Xanthorrhoea* TEC (SCP 3c);
- loss of up to 165 individuals of *Tetraria australiensis* within 3.44 ha of suitable habitat; and
- loss of Black Cockatoo habitat including:
 - clearing of up to 346 potential breeding trees for Black Cockatoos, including two trees with potentially suitable hollows for Black Cockatoo nesting;
 - clearing of up to 20.93 ha of foraging habitat for Carnaby's Cockatoo; and
 - clearing of up to 20.61 ha of foraging habitat and for Baudin's Cockatoo and Forest Red-tailed Black Cockatoo.

The Proposed Action will not result in impacts to known nesting hollows or roosting sites for Carnaby's Cockatoo, Forest Red-tailed Black Cockatoo or Baudin's Cockatoo.

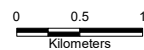
The above estimates are conservative, representing the full extent of MNES values within the 230 ha disturbance footprint. The actual clearing footprint is expected to be less and will be refined through the detailed design and construction planning process.

The Proposed Action is not expected to result in significant indirect impacts to TECs, Threatened flora or the three species of Black Cockatoo.



Legend
 Proposed Action

Scale 1:60,000 at A4



Coord. Sys. GDA 1994 MGA Zone 50



Job No: 58910

Client: Main Roads Western Australia

Version: A

Date: 20-Jan-2021

Drawn By: hsullivan

Checked By: DN

**Tonkin Highway Extension
WA**

PROPOSED ACTION AREA

FIGURE 1



3 PROPOSED OFFSETS

In order to offset the significant residual impacts of the Proposed Action to the listed species and communities, this Draft Environmental Offset Strategy identifies proposed offset actions comprising land acquisition, funding of land management, restoration and research. The proposed environmental offsets will be fully funded and implemented by Main Roads (with the assistance of external technical experts, where appropriate), with the implementation of the environmental offsets to be reported on under the provisions of the EPBC Act.

3.1 Summary of offset package

Main Roads are investigating a number of options to develop a package of offsets to counterbalance the significant residual impacts of the Proposed Action to *Corymbia-Kingia* TEC (SCP 3a), *Corymbia-Xanthorrhoea* TEC (SCP 3c), Carnaby's Cockatoo, Forest Red-tailed Black Cockatoo, Baudin's Cockatoo and *Tetraria australiensis*. Table 6 provides an overview of the offset package under investigation.

Identification and acquisition of land to counterbalance significant residual environmental impacts associated with Main Roads infrastructure projects is now being managed through a Memorandum of Understanding (MoU) between Main Roads and DBCA. The MoU commits Main Roads funding to assist DBCA in identifying and acquiring suitable land offsets to be added to the conservation estate.

Main Roads and DBCA must locate properties that meet the requirements of the project offset as well as meet the criteria of properties which DBCA seek to manage. Following the identification of a suitable offset, the property is surveyed and acquired by the DBCA. Once the land is acquired, Main Roads will reimburse DBCA the land acquisition costs. Acquisition of suitable offset land aims to satisfy Commonwealth and State environmental compliance requirements.

The direct offsets involve acquisition of land by the Crown and land transfer to the conservation estate, which will enable land management by DBCA as the lead agency in WA responsible for conservation management. DBCA will be responsible for vesting the land with the Conservation and Parks Commission of WA, which will provide a conservation mechanism to maintain the offset ecological values in perpetuity. For each of the land offsets acquired, Main Roads will fund seven years of DBCA land management activities. These land management costs are negotiated on a site by site basis, and costs are formalised through a separate Memorandum of Understanding.

Main Roads is liaising with DBCA regarding acquisition of suitable land in order to meet offset requirements and intends to have all required offsets in place within 24 months of commencement of construction. This timing incorporates the all phases of the offset process from land acquisition through to a MoU for land management of the properties.

3.2 Description of offsets

The components of the offset package are described in the following sections and summarised in Table 6. Locations of known offset properties are located in Figure 2.



- Legend**
- Proposed Action
 - Offset sites
 - Nirimba
 - Lake Clifton
 - State roads

Scale 1:300,000 at A4			
Coord. Sys. GCS GDA 1994			
Job No: 58910			
Client: Main Roads Western Australia			
Version: A	Date: 05-May-2021		
Drawn By: hsullivan	Checked By: DN		

Tonkin Highway Extension WA

OFFSET SITES IN RELATION TO THE PROPOSED ACTION

FIGURE 2

Table 6 Overview of offset package proposed under consideration

Offset Site	Offset Description	Property location	Existing tenure
Nirimba	14.2 ha of ha of Black Cockatoo habitat suitable for all three species within the "banked" portion of the Lake Clifton offset site	Lots 1262, 295 and 842 Carrabungup Road, Nirimba	Freehold owned by the State of WA managed by DBCA (acquired in 2016 with funding provided by Main Roads)
Lake Clifton	23.13 ha of ha of Black Cockatoo habitat suitable for all three species within the "banked" portion of the Lake Clifton offset site	Lots 1000, 2240, 2275, 2657 & 3045 Preston Beach Road, Lake Clifton	Freehold owned by the State of WA managed by DBCA (acquired in 2016 with funding provided by Main Roads)
Offset 1	Acquisition of 71 ha of Black Cockatoo habitat suitable for all three species	To be confirmed	To be confirmed
Offset 2	Acquisition of land with 26.2 ha of <i>Corymbia-Xanthorrhoea</i> TEC (SCP 3c)	Confidential pending survey and negotiation with property owners Swan Coastal Plain	Freehold owned by third parties
Offset 3	Acquisition of land with <ul style="list-style-type: none"> At least 350 individuals of <i>Tetraria australiensis</i> 27.2ha of suitable habitat for the species 	To be confirmed	To be confirmed
Offset 4	Restoration and management activities for 1.13 ha of <i>Corymbia-Kingia</i> TEC (SCP 3a)	DBCA managed conservation area	Reserve managed by DBCA
Artificial Hollows	Installation of 9 artificial hollows	To be confirmed in discussion with DBCA	Reserve managed by DBCA or other secure tenure
Indirect Offset	<p>Research projects are appropriate as an offset for the Proposed Action as there was a high degree of uncertainty regarding impacts of a Proposed Action and new science was required to develop better mitigation measures or predictive tools to avoid and minimise the particular type of impact.</p> <p>Main Roads is providing a funding contribution to Murdoch University to finance Black Cockatoo research. Murdoch's research proposal (Warren et al. 2019) is being funded by Main Roads. Funding for research is intended to comprise 10% of the total Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo offset requirement.</p>		

3.2.1 Nirimba Offset Site (Lots 1262, 295 and 842 Carrabungup Road, Nirimba)

Main Roads purchased lots 1262, 295 and 842 Carrabungup Road, Nirimba (referred to collectively as the "Nirimba Offset Site") to offset impacts to previous road projects and has undertaken a biological assessment of the property (Appendix A). A portion of this property is available to be utilised for this offset. The Nirimba site is 257 ha in area and the remaining portion that is available as an offset contains approximately 37.4 ha of vegetation comprising the following broad vegetation types:

- Flooded Gum Woodlands;
- Kunzea Shrubland;
- Melaleuca Woodland; and
- Tuart Woodland.

Of the 37.4 ha available, approximately 14.2 ha this is considered foraging habitat for all three Black Cockatoo species.

3.2.2 Lake Clifton Offset Site (Lots 1000, 2240, 2275, 2657 and 3045 Preston Beach Road, Lake Clifton)

Main Roads purchased Lots 1000, 2240, 2275, 2657 and 3045 Preston Beach Road, Lake Clifton (collectively referred to as the Lake Clifton site) to offset impact to previous road projects and a portion remains available to be utilised as an offset for the significant residual impacts of the Proposed Action. The Lake Clifton property that is available as an offset and contains approximately:

- 632 ha of Carnaby's Cockatoo foraging habitat;
- 214 ha of Forest Red-tailed Black Cockatoo foraging habitat; and
- 45 ha of Baudin's Cockatoo foraging habitat.

Main Roads proposes to allocate a portion of this habitat from this site for the offset. It is proposed to use 23.13 ha of the Lake Clifton site as part of the offset for EPBC 2019/8708. This comprises a mixture of Tuart woodlands, Eucalypt woodlands, Peppermint shrublands, heathlands, *Xanthorrhoea* and *Acacia* shrublands and *Melaleuca* woodland wetland areas (Appendix B).

3.2.3 Offset Property 1

A third offset property (or properties) for Black Cockatoo breeding and foraging values is in a confidential location that is currently under investigation by DBCA and is yet to be negotiated with land owners or subject to surveys. The land area of this property will depend on the presence and distribution of Black Cockatoo foraging and breeding habitat, and Main Roads proposes to acquire and transfer the required portion, to provide the remaining offset following allocation from the other offset sites.

Should the property be suitable for acquisition, Main Roads will arrange for a survey to confirm the ecological values present, including the habitat extent and quality for Carnaby's Cockatoo, FRTBC and Baudin's Cockatoo.

3.2.4 Offsets Properties 2 and 3

Offsets 2 and 3 comprise a number of properties currently under investigation by DBCA in collaboration with Main Roads, and have yet to be negotiated with land owners or subject to surveys. Based on consultation with DBCA, the location and vegetation expected to be present, the properties are expected to comprise the following:

- Offset 2: land containing at least 26.2 ha *Corymbia-Xanthorrhoea* TEC (SCP 3c) (and 8.5 ha of Black Cockatoo foraging and potential breeding habitat); and
- Offset 3: land containing at least 350 individuals of *Tetraria australiensis* and a suitable buffer. Land containing at least 27.2 ha of suitable habitat for the *Tetraria australiensis*. (May potentially contain Black Cockatoo foraging and potential breeding habitat – to be confirmed)

The land area of Offsets 2 and 3 will depend on the presence and distribution of *Corymbia-Xanthorrhoea* TEC (SCP 3c) and *Tetraria australiensis* populations on the properties.

Main Roads are consulting with DBCA to confirm the availability and commercial terms to acquire the properties. Should the properties be suitable for acquisition, Main Roads will arrange for surveys to confirm the ecological values present.

3.2.5 Offset Property 4 – Restoration site for *Corymbia-Kingia* TEC (SCP 3a)

Offset 4 comprises the proposed restoration of a 1.13 ha area of a degraded portion of a conservation area currently managed by the DBCA which is located in the Perth Metropolitan area in the Swan Coastal Plain IBRA sub-region. Main Roads proposes to provide funding for restoration works and management activities in this 1.13 ha portion of the conservation to provide habitat for *Corymbia-Kingia* TEC (SCP 3a). Restoration activities will include weed control, fencing installation/upgrade and dieback management.

The proposed restoration works will be congruent with existing management of the conservation area. The exact location of the 1.13 ha restoration site/s is yet to be agreed with DBCA.

3.2.6 Indirect Offset – Black Cockatoo research funding

Main Roads is providing funding to Murdoch University to finance Black Cockatoo research. Murdoch's research proposal (Warren et al. 2019) is being funded by Main Roads and others. Funding for research is intended to comprise 10% of the total Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo offset requirement, when delivered in addition to the land acquisition component outlined in this Offsets Strategy(Appendix C).

Provision of research funding is classified by the Commonwealth as an 'other compensatory measure' anticipated to lead to benefits for the impacted protected matter, in this instance, to Black Cockatoo species.

Murdoch's research proposal (Warren et. al. 2019) is utilising innovative tracking methodologies to undertake a movement ecology study of Western Australia's three threatened black cockatoo species, to determine habitat use and threatening processes in modified landscapes. This includes tracking the three species of black cockatoos on the Perth-Peel Coastal Plain and tracking Carnaby's Cockatoos at key breeding sites to better understand movement dynamics of this species across its distribution range.

The research proposal commenced in 2019 with the purpose of generating data to identify key habitats and areas for conservation/revegetation, determining threatening processes for Black Cockatoo species across their range, and information decision making in relation to conservation and land management planning at both State and Commonwealth government levels. The research proposal addresses major priority actions in the Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo recovery plans and is fully supported by the chairs of the Carnaby's Cockatoo and FRBC recovery teams.

3.3 Installation of artificial hollows

Main Roads proposes to install nine artificial hollows to offset the loss of three suitable hollows for Black Cockatoo nesting (applying a 3:1 ratio). The hollows will be installed in accordance with the DBCA fauna notes on how to design and place artificial hollows (Appendix D). These hollows will be installed at a site suitable for Black Cockatoo breeding, with the location determined in consultation with DBCA. Note that DBCA, including the Black Cockatoo Recovery Team, have a strong preference for artificial hollows to be placed outside of the Perth Metropolitan Area. They consider the risks to breeding birds and their chicks to be higher in urban areas than in native bushland.

3.3.1 Installation

A suitably qualified person with experience in Black Cockatoos will be engaged to assist with the planning of artificial hollow installation to determine the appropriate installation and location for the hollows. Appropriate trees will be identified taking into consideration the following:

- trees should be within Crown lands (e.g. DBCA-managed lands, Local Government Reserves etc) to facilitate ease of access for monitoring and maintenance;
- located in proximity to impacted potentially suitable hollow, or property identified in consultation with the DBCA.;
- located within or adjacent to foraging habitat;
- located in proximity to water;
- trees should be mature and well shaded; and
- trees should be accessible with a cherry picker, without requiring additional disturbance, to allow installation of the artificial hollows.

Main Roads will fund ten years of monitoring and maintenance activities for artificial hollows.

3.3.2 Monitoring

Artificial hollows will be surveyed during September/October to coincide with the peak of the breeding season for the Black Cockatoo species. Surveys are to be undertaken by a suitably qualified person. Hollows should initially be surveyed from the ground using binoculars to check for signs of use. A drone or remotely operated camera on a pole may also be used. Surveys will identify:

- if hollows are currently in use or show evidence of previous use;
- maintenance requirements for artificial hollows (such as replacement of the sacrificial wooden post or removal of feral bees); and
- if hollows are no longer able to be used by Carnaby's Black Cockatoo, for example they have been invaded by feral bees, the hollow has been damaged or the limb has fallen.

3.3.3 Maintenance

Maintenance of artificial hollows will be scheduled to occur outside of the breeding season.

Maintenance may include:

- replacement of sacrificial chewing post;
- replacement/repair of attachment points;
- repairs to the base of hollows;
- repair of cracks in the artificial hollow. If crack form that are too large to be repaired the hollow may need to be replaced; and
- removal of pest species, such as feral bees.

3.3.4 Completion Criteria

Main Roads is to ensure that the installation of artificial hollows leads to their use by Black Cockatoos. This will be considered to be achieved when:

- at least three artificial nesting hollows have shown evidence of use by Black Cockatoos for three consecutive years; and
- the artificial nesting hollow need not be the same artificial nesting hollow each year, provided at least three are used in any given year.

3.3.5 Adaptive Management

If after three years there is no evidence of use of any of the installed artificial hollows, Main Roads is to implement adaptive management measures including:

- review/modify location selection parameters;
- review artificial hollow locations;
- move the artificial hollows to a new location; and
- install additional hollows in order to increase density.

4 OFFSET INPUTS AND JUSTIFICATION

4.1 Overview and assumptions

Preliminary offset calculations have been based on the Commonwealth DoEE Environmental Offset Calculator and EPBC Offset assessment guide.

The preliminary offset calculations undertaken for the potential offset properties have been based on the available information for the properties/anticipated properties to be acquired. Lake Clifton and Nirimba have been characterised based on the information available from previous surveys and desktop information. Offsets 2-4 have been characterised based on rural freehold properties located near to the Perth Metropolitan Region, with ecological values relating to MNES equivalent or better than those in the Proposed Action area.

The suitability of each offset site for the MNES is detailed in Section 3 and summarised in Table 6. Lake Clifton, Nirimba, Offsets 1, 2 & 4 (direct 90%) and the indirect offset (10%) are suitable for Carnaby's Cockatoo, Baudin's Cockatoo and Forest Red-tailed Black Cockatoo. Offset 2 is suitable for *Corymbia-Xanthorrhoea* TEC (SCP 3c) and Offset 3 is suitable for *Tetraria australiensis*. Offset 4 is suitable for *Corymbia-Kingia* TEC (SCP 3a).

The suitability of Offsets 2 to 4 will be confirmed through survey and/or consultation with DBCA.

4.2 *Corymbia-Xanthorrhoea* TEC (SCP 3c)

Table 7 and Table 8 provide the inputs used in the EPBC Offset Assessment Guide in relation to *Corymbia-Xanthorrhoea* TEC (SCP 3c).

Table 7 Impact Calculator, *Corymbia-Xanthorrhoea* TEC (SCP 3c)

Attribute	Value	Justification
Area of impact	3.94 ha	3.94 ha of TEC mapped within Proposed Action area during ecological survey (Woodman 2020) in one patch.
Quality	4	<p>Moderate score based on an area-weighted scoring of TEC vegetation condition across the Proposed Action area, as follows:</p> <ul style="list-style-type: none"> • 1.16 ha (29.4%) in Very Good condition - Applied Quality score of 7 • 0.29 ha (7.4%) in Good condition – Applied Quality score of 5 • 1.92 ha (48.7%) in Degraded condition – Applied Quality score of 3 • 0.57 ha (14.5%) in Completely Degraded condition – Applied Quality score of 2 <p>The area-weighted score is 4. The Proposed Action area is subject to threatening processes including <i>Phytophthora</i> dieback and weeds.</p>

Table 8 Offset Calculator, *Corymbia-Xanthorrhoea* TEC (SCP 3c) – Offset 2

Attribute	Value	Justification
Offset area	26.2 ha	26.2 ha portion of the Offset 2 property will be acquired to the offset to counterbalance impacts to <i>Corymbia-Xanthorrhoea</i> TEC (3c).
Start quality	5	Expect vegetation condition will be equivalent or better than the TEC condition within the Proposed Action Area.
Future quality without offset	4	Rural freehold land. Vegetation may deteriorate without management and site will benefit from transfer to the conservation estate.
Future quality with offset	5	No rehabilitation proposed. Land will be managed for conservation of existing values.
Confidence in result (Future Quality)	60%	Confidence is dependent on the current land use of Offset 1 once it is identified. Conservative value used to reflect uncertainty of current land use of this unknown offset property.
Time over which loss is averted	20 years	Land will be owned and managed by DBCA so long term protection is afforded. Twenty years is the maximum value that can be input.
Time until ecological benefit	20 year	Any loss in condition (from not offsetting) would be expected to take up to 20 years to be observed (assuming existing agricultural practices continue)
Risk of loss without offset	4.31%	Risk of loss derived from UQ (2017) for the Shire of Serpentine Jarrahdale
Risk of loss with offset	0%	Very low risk through protection of conservation estate.
Confidence in result	90%	High degree of confidence, land will be surveyed to confirm habitat values and then purchased for transfer to the conservation estate.
Output	100.59 %	Of total offset requirement

4.3 *Corymbia-Kingia* TEC (SCP 3a)

Table 9 and Table 10 provide the inputs used in the EPBC Offset Assessment Guide in relation to *Corymbia-Kingia* TEC.

Table 9 Impact Calculator, *Corymbia-Kingia* TEC (3a)

Attribute	Value	Justification
Area of impact	0.13 ha	0.13 ha of TEC mapped within Proposed Action area during ecological survey (Woodman 2020).
Quality	6	<p>Moderate score based on an area-weighted scoring of TEC vegetation condition across the Proposed Action area, as follows:</p> <ul style="list-style-type: none"> • 0.10 ha (79.8%) in 'Very Good' condition – Applied Quality score of 7 and • 0.03 ha (20.2%) of in 'Degraded' condition – Applied Quality score of 3. <p>The area-weighted score is 6.</p> <p>The Proposed Action area is subject to threatening processes including <i>Phytophthora</i> dieback and weeds.</p>

Table 10 Offset Calculator, *Corymbia-Kingia* TEC (3a) – Offset 4 Restoration and management

Attribute	Value	Justification
Offset area	1.13 ha	A 1.13 ha portion of <i>Corymbia-Kingia</i> TEC on DBCA managed land will be allocated for restoration and management activities.
Start quality	5	Expect vegetation condition to be targeted for restoration and management activities will be in Good- Degraded condition (i.e. condition can be improved).
Future quality without offset	5	Freehold land in the conservation estate managed by DBCA. With management by DBCA it is likely that the vegetation would be maintained in condition.
Future quality with offset	6	Restoration and management activities proposed which will improve the condition of the vegetation (targeting Good condition). Land will be managed for conservation of existing values.
Confidence in result (Future Quality)	60%	Confidence is dependent on the current land use of Offset 1 once it is identified. Conservative value used to reflect uncertainty of current land use of this unknown offset property.
Time over which loss is averted	20 years	Land is already within the conservation estate and therefore protected in perpetuity.
Time until ecological benefit	10 year	It is anticipated that the majority of the benefits will be realised within 10 years of commencement of the restoration works.
Risk of loss without offset	4.31%	Risk of loss derived from UQ (2017) for the Shire of Serpentine Jarrahdale
Risk of loss with offset	0%	Very low risk through protection of conservation estate.
Confidence in result	90%	High degree of confidence, land will be surveyed to confirm habitat values and then purchased for transfer to the conservation estate.

Attribute	Value	Justification
Output	100.38 %	Of total offset requirement

4.4 *Tetraria australiensis*

Table 11 and Table 35 provide the impact values for the used in the EPBC Offset Assessment Guide in relation to the direct offset proposed for *Tetraria austaliensis*. Table 34 and Table 36 provide the inputs used in the offset calculation EPBC Offset Assessment Guide in relation to *Tetraria australiensis*.

Table 11 Impact Calculator, *Tetraria australiensis* (individuals)

Attribute	Value	Justification
Count	165	165 individuals recorded within Proposed Action area during ecological survey (Woodman 2020).

Table 12 Offset Calculator, *Tetraria australiensis* – Offset 3 (individuals)

Attribute	Value	Justification
Time horizon	1 year	Land will be transferred to conservation estate so long term protection is afforded.
Start value	350	The portion of land to be allocated to the offset will contain at least 350 <i>Tetraria australiensis</i> plants.
Future value without offset	0	Rural freehold land. Land located within a rural area that is zoned for urban development (e.g. industrial, residential, commercial, road reserve). Plants expected to be lost due to urban development and site will benefit from transfer to the conservation estate.
Future value with offset	350	No rehabilitation / planting proposed. Land will be managed for conservation of existing values.
Confidence in result	50%	Moderate confidence (risk) of loss without offset as land is rural and there is potential for it to be developed in the future. High confidence in protection with offset, as land will be surveyed to confirm flora population and then purchased for transfer to the conservation estate.
Output	104.8%	Of total offset requirement

Table 13 Impact Calculator, *Tetraria australiensis* – Offset 3 (habitat)

Attribute	Value	Justification
Area of impact	3.44 ha	3.44 ha of habitat suitable for <i>Tetraria australiensis</i> is within Proposed Action area (Strategen-JBS&G 2021).
Quality	5	Moderate score based on an area-weighted scoring of vegetation condition quality across the Proposed Action area (Woodman 2020), as follows: <u><i>Tetraria australiensis</i></u> <ul style="list-style-type: none"> • 1.88 ha – degraded- completely degraded condition (Score 3) x 55% of habitat area • 0.29 ha – good condition (Score 5) x 8% of habitat area • 1.27 ha – very good condition (Score 7) x 37% of habitat area <p>The area-weighted score is 5.</p>

		The Proposed Action area is subject to threatening processes including <i>Phytophthora</i> dieback and weeds.
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Table 14 Offset Calculator, *Tetraria australiensis* – Offset 3 (habitat)

Attribute	Value	Justification
Offset area	27.2 ha	27.2 ha portion of the Offset 3 property will be acquired to offset the impacts to <i>Tetraria australiensis</i> .
Start quality	6	Expect vegetation condition will be equivalent or better than the TEC condition within the Proposed Action Area.
Future quality without offset	5	Rural freehold land. Vegetation may deteriorate without management and site will benefit from transfer to the conservation estate.
Future quality with offset	6	No rehabilitation proposed. Land will be managed for conservation of existing values.
Confidence in result (Future Quality)	60%	Confidence is dependent on the current land use of Offset 3 once it is identified. Conservative value used to reflect uncertainty of current land use of this unknown offset property.
Time over which loss is averted	20 years	Land will be owned and managed by DBCA so long term protection is afforded. Twenty years is the maximum value that can be input.
Time until ecological benefit	20 year	Any loss in condition (from not offsetting) would be expected to take up to 20 years to be observed (assuming existing agricultural practices continue)
Risk of loss without offset	4.31%	UQ (2017) value for Shire of Serpentine-Jarrahdale.
Risk of loss with offset	0%	Very low risk through protection of conservation estate.
Confidence in result (risk of loss)	90%	High degree of confidence, land will be surveyed to confirm habitat values and then purchased for transfer to the conservation estate.
Output	100.52 %	Of total offset requirement

4.5 Carnabys Cockatoos – Direct offset

Table 15 provide the impact inputs used in the EPBC Offset Assessment Guide in relation to the direct offset proposed for Carnabys Cockatoo. Tables 16-20 provide the inputs used in the EPBC Offset Assessment Guide and justification for that value for the various offset properties for Carnabys Cockatoo.

4.5.1 Carnaby's Cockatoo Impact Calculator Inputs

Table 15 Impact Calculator, Carnaby's Cockatoo foraging habitat

Attribute	Value	Justification
Area of impact	20.9 ha	21 ha of foraging habitat mapped within Proposed Action area for Carnaby's Cockatoo, Baudin's Cockatoo and Forest Red-tailed Black Cockatoo during the ecological survey (Strategen-JBS&G 2021).
Quality	6	<p>Moderate score based on an area-weighted scoring of foraging habitat quality (Score 0-6) across the Proposed Action area (Woodman 2020), as follows:</p> <p><u>Carnaby's Cockatoo</u></p> <ul style="list-style-type: none"> • 11.61 ha - Low to Moderate foraging value (Score 3) x 55% of habitat area • 9.32 ha - Moderate foraging value (Score 4) x 44% of habitat area <p>The area-weighted score for the species is 3.7 out of 6, using the habitat quality scoring system in Strategen-JBS&G (2021). This corresponds to the input of 6 out of 10 into the impact calculator.</p>

4.5.2 Carnabys Cockatoo Offset Calculator Inputs

Table 16 Offset Calculator, Carnaby's Cockatoo – Nirimba (Direct Offset)

Attribute	Value	Justification
Offset area	14.2 ha	14.2 ha of the Nirimba offset site contains foraging and potential breeding habitat for Carnaby's Cockatoo , Baudin's Cockatoo and Forest Red-tailed Black Cockatoo habitat.
Start quality	8	Habitat quality is better than the habitat within the Proposed Action area.
Future quality without offset	7	Prior to being acquired as an offset this was rural freehold land. Vegetation is likely to deteriorate without management
Future quality with offset	8	Land has been managed for conservation of existing values by DBCA since 2017.
Confidence in result (Future Quality)	80%	Property was previously used for agricultural purposes. Degradation and low level clearing had occurred for fence installation and irrigation. Evidence of pigs on property, likely released by hunters in the area. Lack of maintenance of fences by previous owner allowed illegal access for people, hunters and stock. Management by DBCA has prevented further degradation.
Time over which loss is averted	20 years	Land ownership has been transferred to DBCA so long term protection is afforded. Twenty years is the maximum value that can be input.
Time until ecological benefit	20 year	Any loss in condition (from not offsetting) would be expected to take up to 20 years to be observed (assuming existing agricultural practices continue)
Risk of loss without offset	4.75%	UQ (2017) ROL value for Shire of Murray.
Risk of loss with offset	0%	Very low risk through protection of conservation estate.
Confidence in result (Risk of Loss)	90%	High degree of confidence, land will be surveyed to confirm habitat values and then purchased for transfer to the conservation estate.
Output	9.85%	Of total offset requirement

Table 17 Offset Calculator, Carnaby's Cockatoo – Lake Clifton (Direct Offset)

Attribute	Value	Justification
Offset area	23.13ha	23.13 ha of the Lake Clifton properties is available to the offset, to counterbalance impacts to Carnaby's Cockatoo , Baudin's Cockatoo and Forest Red-tailed Black Cockatoo habitat.
Start quality	8	Habitat quality is better than the habitat within the Proposed Action area.
Future quality without offset	7	Prior to being acquired as an offset, this was rural freehold land, owned by a property developer who was looking to develop the land as rural residential. At the time of sale, the owner had a development application under assessment/appeal for the rural residential sub-division. Vegetation condition would have deteriorated in a rural residential scenario and site will benefit from transfer to the conservation estate.
Future quality with offset	8	Land has been managed for conservation of existing values and maintenance of condition. DBCA has been managing this property since 2017.
Confidence in result (Future Quality)	80%	Land was previously owned by property developer who was seeking to develop land for rural residential lifestyle properties. If this development had gone ahead it is reasonable to expect that vegetated areas would degrade due to clearing for house blocks and activities by owners.
Time over which loss is averted	20 years	Land has been managed by DBCA since 2017. Twenty years is the maximum value that can be input.
Time until ecological benefit	20 year	Any loss in condition (from not offsetting) would be expected to take up to 20 years to be observed (assuming existing agricultural practices continue)
Risk of loss without offset	8.14%	UQ (2017) ROL value for Shire of Mandurah. Given that the land was facing development as a rural residential subdivision, this is a conservative figure.
Risk of loss with offset	0%	Very low risk through protection of conservation estate.
Confidence in result (Risk of Loss)	90%	High degree of confidence, land will be surveyed to confirm habitat values and then purchased for transfer to the conservation estate.
Output	19.19 %	Of total offset requirement

Table 18 **Offset Calculator, Carnaby's Cockatoo – Offset 1 (Direct Offset)**

Attribute	Value	Justification
Offset area	71 ha	It is estimated that an additional 71 ha will be required to offset Black Cockatoo habitat above the offsets proposed within Nirimba, Lake Clifton and Offsets 2 & 4. This amount may vary depending on the size and quality of the eventual Offset 1.
Start quality	8	Habitat quality will be equivalent or better than the habitat within the Proposed Action area. It is anticipated that Offset 1 will contain high value Black Cockatoo habitat.
Future quality without offset	7	Anticipated that current land uses in Offset 1 will continue to degrade vegetation quality over the period of the offset.
Future quality with offset	8	Land will be managed for conservation of existing values and maintenance of condition.
Confidence in result (Future Quality)	60%	Confidence is dependent on the current land use of Offset 1 once it is identified. Conservative value used to reflect uncertainty of current land use of this unknown offset property.
Time over which loss is averted	20 years	Land will be owned and managed by DBCA so long term protection is afforded. Twenty years is the maximum value that can be input.
Time until ecological benefit	20 year	Any loss in condition (from not offsetting) would be expected to take up to 20 years to be observed (assuming existing agricultural practices continue)
Risk of loss without offset	8.17%	UQ (2017) value for Shire of Gingin. The offset is as likely to be acquired within the Shire of Gingin as within any other LGA.
Risk of loss with offset	0%	Very low risk through protection of conservation estate.
Confidence in result (Risk of Loss)	90%	High degree of confidence, land will be surveyed to confirm habitat values and then purchased for transfer to the conservation estate.
Output	50.81 %	Of total offset requirement

Table 19 Offset Calculator, Carnaby's Cockatoo – Offset 2 (Direct Offset)

Attribute	Value	Justification
Offset area	26.2 ha	All of the offset aimed at offsetting the impacts for SCP 3c will also contribute habitat to Black Cockatoo offsets.
Start quality	5	Habitat quality will be equivalent or better than the habitat within the Proposed Action area. Further survey will be required to determine the start quality for this Black Cockatoo offset.
Future quality without offset	4	Anticipated that current land uses in Offset 1 will continue to degrade vegetation quality over the period of the offset.
Future quality with offset	5	Land will be managed for conservation of existing values and maintenance of condition.
Confidence in result (Future Quality)	60%	Confidence is dependent on the current land use of Offset 1 once it is identified. Conservative value used to reflect uncertainty of current land use of this unknown offset property.
Time over which loss is averted	20 years	Land will be owned and managed by DBCA so long term protection is afforded. Twenty years is the maximum value that can be input.
Time until ecological benefit	20 year	Any loss in condition (from not offsetting) would be expected to take up to 20 years to be observed (assuming existing agricultural practices continue)
Risk of loss without offset	4.31%	UQ (2017) value for Shire of Serpentine-Jarrahdale.
Risk of loss with offset	0%	Very low risk through protection of conservation estate.
Confidence in result (Risk of Loss)	90%	High degree of confidence, land will be surveyed to confirm habitat values and then purchased for transfer to the conservation estate.
Output	12.64 %	Of total offset requirement

Table 20 **Offset Calculator, Carnaby's Cockatoo – Offset 4 (Direct Offset)**

Attribute	Value	Justification
Offset area	1.13 ha	The SCP 3a restoration offset will also provide habitat for Carnaby's Cockatoo
Start quality	5	Habitat quality will be equivalent or better than the habitat within the Proposed Action area. Further survey will be required to determine the start quality for this Black Cockatoo offset.
Future quality without offset	5	Anticipated that current land uses in Offset 4 will continue to degrade vegetation quality over the period of the offset.
Future quality with offset	6	Land will be managed for conservation of existing values and maintenance of condition.
Confidence in result (Future Quality)	60%	Confidence is dependent on the current land use of Offset 4 once it is identified. Conservative value used to reflect uncertainty of current land use of this unknown offset property.
Time over which loss is averted	20 years	Land will be owned and managed by DBCA so long term protection is afforded. Twenty years is the maximum value that can be input.
Time until ecological benefit	20 year	Any loss in condition (from not offsetting) would be expected to take up to 20 years to be observed (assuming existing agricultural practices continue)
Risk of loss without offset	4.31%	UQ (2017) value for Shire of Serpentine-Jarrahdale.
Risk of loss with offset	0%	Very low risk through protection of conservation estate.
Confidence in result (Risk of Loss)	90%	High degree of confidence, land will be surveyed to confirm habitat values and then purchased for transfer to the conservation estate.
Output	0.57 %	Of total offset requirement

4.6 Forest Red-tailed Black Cockatoos – Direct offset

Table 15 provide the impact inputs used in the EPBC Offset Assessment Guide in relation to the direct offset proposed for Forest Red-tailed Black Cockatoo. Tables 22-26 provide the inputs used in the EPBC Offset Assessment Guide and justification for that value for the various offset properties for Forest Red-tailed Black Cockatoo.

4.6.1 Forest Red-tailed Black Cockatoo Impact Calculator Inputs

Table 21 Impact Calculator, Forest Red-tailed Black Cockatoo foraging habitat

Attribute	Value	Justification
Area of impact	20.9 ha	21 ha of foraging habitat mapped within Proposed Action area for Carnaby's Cockatoo, Baudin's Cockatoo and Forest Red-tailed Black Cockatoo during the ecological survey (Strategen-JBS&G 2021).
Quality	6	<p>Moderate score based on an area-weighted scoring of foraging habitat quality (Score 0-6) across the Proposed Action area (Woodman 2020), as follows:</p> <p><u>Forest Red-tailed Black Cockatoo</u></p> <ul style="list-style-type: none"> • 11.29 ha - Low to Moderate foraging value (Score 3) x 55% of habitat area • 3.70 ha - Moderate foraging value (Score 4) x 18% of habitat area • 5.61 ha of Moderate to High foraging value (Score 5) x 27% of habitat area <p>The area-weighted score for the species is 3.7 out of 6, using the habitat quality scoring system in Strategen-JBS&G (2021). This corresponds to the input of 6 out of 10 into the impact calculator.</p>

4.6.2 Forest Red-tailed Black Cockatoo Offset Calculator Inputs

Table 22 Offset Calculator, Forest Red-tailed Black Cockatoo – Nirimba (Direct Offset)

Attribute	Value	Justification
Offset area	14.2 ha	14.2 ha of the Nirimba offset site contains foraging and potential breeding habitat for Carnaby's Cockatoo , Baudin's Cockatoo and Forest Red-tailed Black Cockatoo habitat.
Start quality	6	Habitat quality will be equivalent or better than the habitat within the Proposed Action area.
Future quality without offset	5	Prior to being acquired as an offset this was rural freehold land. Vegetation is likely to deteriorate without management
Future quality with offset	6	Land has been managed for conservation of existing values by DBCA since 2017.
Confidence in result (Future Quality)	80%	Property was previously used for agricultural purposes. Degradation and low level clearing had occurred for fence installation and irrigation. Evidence of pigs on property, likely released by hunters in the area. Lack of maintenance of fences by previous owner allowed illegal access for people, hunters and stock. Management by DBCA has prevented further degradation.
Time over which loss is averted	20 years	Land ownership has been transferred to DBCA so long term protection is afforded. Twenty years is the maximum value that can be input.
Time until ecological benefit	20 year	Any loss in condition (from not offsetting) would be expected to take up to 20 years to be observed (assuming existing agricultural practices continue)
Risk of loss without offset	4.75%	UQ (2017) ROL value for Shire of Murray.
Risk of loss with offset	0%	Very low risk through protection of conservation estate.
Confidence in result (Risk of Loss)	90%	High degree of confidence, land will be surveyed to confirm habitat values and then purchased for transfer to the conservation estate.
Output	11.08 %	Of total offset requirement

Table 23 Offset Calculator, Forest Red-tailed Black Cockatoo – Lake Clifton (Direct Offset)

Attribute	Value	Justification
Offset area	23.13 ha	23.13 ha of the Lake Clifton properties will be allocated to the offset, to counterbalance impacts to Carnaby's Cockatoo , Baudin's Cockatoo and Forest Red-tailed Black Cockatoo habitat.
Start quality	8	Habitat quality will be equivalent or better than the habitat within the Proposed Action area.
Future quality without offset	7	Prior to being acquired as an offset, this was rural freehold land, owned by a property developer who was looking to develop the land as rural residential. At the time of sale, the owner had a development application under assessment/appeal for the rural residential sub-division. Vegetation condition would have deteriorated in a rural residential scenario and site will benefit from transfer to the conservation estate.
Future quality with offset	8	Land has been managed for conservation of existing values and maintenance of condition. DBCA has been managing this property since 2017.
Confidence in result (Future Quality)	80%	Land was previously owned by property developer who was seeking to develop land for rural residential lifestyle properties. If this development had gone ahead it is reasonable to expect that vegetated areas would degrade due to clearing for house blocks and activities by owners.
Time over which loss is averted	20 years	Land has been managed by DBCA since 2017. Twenty years is the maximum value that can be input.
Time until ecological benefit	20 year	Any loss in condition (from not offsetting) would be expected to take up to 20 years to be observed (assuming existing agricultural practices continue)
Risk of loss without offset	8.14%	UQ (2017) ROL value for Shire of Mandurah. Given that the land was facing development as a rural residential subdivision, this is a conservative figure.
Risk of loss with offset	0%	Very low risk through protection of conservation estate.
Confidence in result (Risk of Loss)	90%	High degree of confidence, land will be surveyed to confirm habitat values and then purchased for transfer to the conservation estate.
Output	23.41 %	Of total offset requirement

Table 24 Offset Calculator, Forest Red-tailed Black Cockatoo – Offset 1 (Direct Offset)

Attribute	Value	Justification
Offset area	71 ha	It is estimated that an additional 71 ha will be required to offset Black Cockatoo habitat above the offsets proposed within Nirimba, Carrabungup, Lake Clifton and Offsets 2 & 4. This amount may vary depending on the size and quality of the eventual Offset 1.
Start quality	8	Habitat quality will be equivalent or better than the habitat within the Proposed Action area. It is anticipated that Offset 1 will contain high value Black Cockatoo habitat.
Future quality without offset	7	Anticipated that current land uses in Offset 1 will continue to degrade vegetation quality over the period of the offset.
Future quality with offset	8	Land will be managed for conservation of existing values and maintenance of condition.
Confidence in result (Future Quality)	60%	Confidence is dependent on the current land use of Offset 1 once it is identified. Conservative value used to reflect uncertainty of current land use of this unknown offset property.
Time over which loss is averted	20 years	Land will be owned and managed by DBCA so long term protection is afforded. Twenty years is the maximum value that can be input.
Time until ecological benefit	20 year	Any loss in condition (from not offsetting) would be expected to take up to 20 years to be observed (assuming existing agricultural practices continue)
Risk of loss without offset	8.17%	UQ (2017) value for Shire of Gingin. The offset is as likely to be acquired within the Shire of Gingin as within any other LGA.
Risk of loss with offset	0%	Very low risk through protection of conservation estate.
Confidence in result (Risk of Loss)	90%	High degree of confidence, land will be surveyed to confirm habitat values and then purchased for transfer to the conservation estate.
Output	61.97 %	Of total offset requirement

Table 25 Offset Calculator, Forest Red-tailed Black Cockatoo – Offset 2 (Direct Offset)

Attribute	Value	Justification
Offset area	26.2 ha	All of the offset aimed at offsetting the impacts for SCP 3c will also contribute habitat to Black Cockatoo offsets.
Start quality	5	Habitat quality will be equivalent or better than the habitat within the Proposed Action area. Further survey will be required to determine the start quality for this Black Cockatoo offset.
Future quality without offset	4	Anticipated that current land uses in Offset 1 will continue to degrade vegetation quality over the period of the offset.
Future quality with offset	5	Land will be managed for conservation of existing values and maintenance of condition.
Confidence in result (Future Quality)	60%	Confidence is dependent on the current land use of Offset 1 once it is identified. Conservative value used to reflect uncertainty of current land use of this unknown offset property.
Time over which loss is averted	20 years	Land will be owned and managed by DBCA so long term protection is afforded. Twenty years is the maximum value that can be input.
Time until ecological benefit	20 year	Any loss in condition (from not offsetting) would be expected to take up to 20 years to be observed (assuming existing agricultural practices continue)
Risk of loss without offset	4.31%	UQ (2017) value for Shire of Serpentine-Jarrahdale.
Risk of loss with offset	0%	Very low risk through protection of conservation estate.
Confidence in result (Risk of Loss)	90%	High degree of confidence, land will be surveyed to confirm habitat values and then purchased for transfer to the conservation estate.
Output	15.42 %	Of total offset requirement

Table 26 Offset Calculator, Forest Red-tailed Black Cockatoo – Offset 4 (Direct Offset)

Attribute	Value	Justification
Offset area	1.13 ha	The SCP 3a restoration offset will also provide habitat for Forest Red-tailed Black Cockatoo
Start quality	6	Habitat quality will be equivalent or better than the habitat within the Proposed Action area. Further survey will be required to determine the start quality for this Black Cockatoo offset.
Future quality without offset	5	Anticipated that current land uses in Offset 4 will continue to degrade vegetation quality over the period of the offset.
Future quality with offset	6	Land will be managed for conservation of existing values and maintenance of condition.
Confidence in result (Future Quality)	60%	Confidence is dependent on the current land use of Offset 4 once it is identified. Conservative value used to reflect uncertainty of current land use of this unknown offset property.
Time over which loss is averted	20 years	Land will be owned and managed by DBCA so long term protection is afforded. Twenty years is the maximum value that can be input.
Time until ecological benefit	20 year	Any loss in condition (from not offsetting) would be expected to take up to 20 years to be observed (assuming existing agricultural practices continue)
Risk of loss without offset	4.31%	UQ (2017) value for Shire of Serpentine-Jarrahdale.
Risk of loss with offset	0%	Very low risk through protection of conservation estate.
Confidence in result (Risk of Loss)	90%	High degree of confidence, land will be surveyed to confirm habitat values and then purchased for transfer to the conservation estate.
Output	0.70 %	Of total offset requirement

4.7 Baudins Cockatoos – Direct offset

Table 11 provide the impact inputs used in the EPBC Offset Assessment Guide in relation to the direct offset proposed for Baudin’s Cockatoo. Tables 28-33 provide the inputs used in the EPBC Offset Assessment Guide and justification for that value for the various offset properties for Baudin’s Cockatoo.

4.7.1 Baudin’s Cockatoo Impact Calculator Inputs

Table 27 Impact Calculator, Baudin’s Cockatoo foraging habitat

Attribute	Value	Justification
Area of impact	20.9 ha	21 ha of foraging habitat mapped within Proposed Action area for Carnaby’s Cockatoo, Baudin’s Cockatoo and Forest Red-tailed Black Cockatoo during the ecological survey (Strategen-JBS&G 2021).
Quality	6	<p>Moderate score based on an area-weighted scoring of foraging habitat quality (Score 0-6) across the Proposed Action area (Woodman 2020), as follows:</p> <p><u>Baudin’s Cockatoo</u></p> <ul style="list-style-type: none"> • 11.29 ha - Low to Moderate foraging value (Score 3) x 55% of habitat area • 3.70 ha - Moderate foraging value (Score 4) x 18% of habitat area • 5.61 ha of Moderate to High foraging value (Score 5) x 27% of habitat area <p>The area-weighted score for the three species is 3.7 out of 6, using the habitat quality scoring system in Strategen-JBS&G (2021). This corresponds to the input of 6 out of 10 into the impact calculator.</p>

4.7.2 Baudin’s Cockatoo Offset Calculator Inputs

Table 28 Offset Calculator, Baudin’s Cockatoos – Nirimba (Direct Offset)

Attribute	Value	Justification
Offset area	14.2 ha	14.2 ha of the Nirimba offset site contains foraging and potential breeding habitat for Carnaby’s Cockatoo , Baudin’s Cockatoo and Forest Red-tailed Black Cockatoo habitat.
Start quality	6	Habitat quality will be equivalent or better than the habitat within the Proposed Action area.
Future quality without offset	5	Prior to being acquired as an offset this was rural freehold land. Vegetation is likely to deteriorate without management
Future quality with offset	6	Land has been managed for conservation of existing values by DBCA since 2017.
Confidence in result (Future Quality)	80%	Property was previously used for agricultural purposes. Degradation and low level clearing had occurred for fence installation and irrigation. Evidence of pigs on property, likely released by hunters in the area. Lack of maintenance of fences by previous owner allowed illegal access for people, hunters and stock. Management by DBCA has prevented further degradation.
Time over which loss is averted	20 years	Land ownership has been transferred to DBCA so long term protection is afforded. Twenty years is the maximum value that can be input.
Time until ecological benefit	20 year	Any loss in condition (from not offsetting) would be expected to take up to 20 years to be observed (assuming existing agricultural practices continue)
Risk of loss without offset	4.75%	UQ (2017) ROL value for Shire of Murray.
Risk of loss with offset	0%	Very low risk through protection of conservation estate.
Confidence in result (Risk of Loss)	90%	High degree of confidence, land will be surveyed to confirm habitat values and then purchased for transfer to the conservation estate.
Output	9.09 %	Of total offset requirement

Table 29 Offset Calculator, Baudin’s Cockatoos – Lake Clifton (Direct Offset)

Attribute	Value	Justification
Offset area	23.13 ha	23.13 ha of these properties will be allocated to the offset, to counterbalance impacts to Carnaby’s Cockatoo , Baudin’s Cockatoo and Forest Red-tailed Black Cockatoo habitat.
Start quality	8	Habitat quality will be equivalent or better than the habitat within the Proposed Action area.
Future quality without offset	7	Prior to being acquired as an offset, this was rural freehold land, owned by a property developer who was looking to develop the land as rural residential. At the time of sale, the owner had a development application under assessment/appeal for the rural residential sub-division. Vegetation condition would have deteriorated in a rural residential scenario and site will benefit from transfer to the conservation estate.
Future quality with offset	8	Land has been managed for conservation of existing values and maintenance of condition. DBCA has been managing this property since 2017.
Confidence in result (Future Quality)	80%	Land was previously owned by property developer who was seeking to develop land for rural residential lifestyle properties. If this development had gone ahead it is reasonable to expect that vegetated areas would degrade due to clearing for house blocks and activities by owners.
Time over which loss is averted	20 years	Land has been managed by DBCA since 2017. Twenty years is the maximum value that can be input.
Time until ecological benefit	20 year	Any loss in condition (from not offsetting) would be expected to take up to 20 years to be observed (assuming existing agricultural practices continue)
Risk of loss without offset	8.14%	UQ (2017) ROL value for Shire of Mandurah. Given that the land was facing development as a rural residential subdivision, this is a conservative figure.
Risk of loss with offset	0%	Very low risk through protection of conservation estate.
Confidence in result (Risk of Loss)	90%	High degree of confidence, land will be surveyed to confirm habitat values and then purchased for transfer to the conservation estate.
Output	19.19 %	Of total offset requirement

Table 30 Offset Calculator, Baudin’s Cockatoos – Offset 1 (Direct Offset)

Attribute	Value	Justification
Offset area	71 ha	It is estimated that an additional 71 ha will be required to offset Black Cockatoo habitat above the offsets proposed within Nirimba, Carrabungup, Lake Clifton and Offsets 2 & 4. This amount may vary depending on the size and quality of the eventual Offset 1.
Start quality	8	Habitat quality will be equivalent or better than the habitat within the Proposed Action area. It is anticipated that Offset 1 will contain high value Black Cockatoo habitat.
Future quality without offset	7	Anticipated that current land uses in Offset 1 will continue to degrade vegetation quality over the period of the offset.
Future quality with offset	8	Land will be managed for conservation of existing values and maintenance of condition.
Confidence in result (Future Quality)	60%	Confidence is dependent on the current land use of Offset 1 once it is identified. Conservative value used to reflect uncertainty of current land use of this unknown offset property.
Time over which loss is averted	20 years	Land will be owned and managed by DBCA so long term protection is afforded. Twenty years is the maximum value that can be input.
Time until ecological benefit	20 year	Any loss in condition (from not offsetting) would be expected to take up to 20 years to be observed (assuming existing agricultural practices continue)
Risk of loss without offset	8.17%	UQ (2017) value for Shire of Gingin. The offset is as likely to be acquired within the Shire of Gingin as within any other LGA.
Risk of loss with offset	0%	Very low risk through protection of conservation estate.
Confidence in result (Risk of Loss)	90%	High degree of confidence, land will be surveyed to confirm habitat values and then purchased for transfer to the conservation estate.
Output	50.81 %	Of total offset requirement

Table 31 Offset Calculator, Baudin’s Cockatoos – Offset 2 (Direct Offset)

Attribute	Value	Justification
Offset area	26.2 ha	All of the offset aimed at offsetting the impacts for SCP 3c will also contribute habitat to Black Cockatoo offsets.
Start quality	5	Habitat quality will be equivalent or better than the habitat within the Proposed Action area. Further survey will be required to determine the start quality for this Black Cockatoo offset.
Future quality without offset	4	Anticipated that current land uses in Offset 1 will continue to degrade vegetation quality over the period of the offset.
Future quality with offset	5	Land will be managed for conservation of existing values and maintenance of condition.
Confidence in result (Future Quality)	60%	Confidence is dependent on the current land use of Offset 1 once it is identified. Conservative value used to reflect uncertainty of current land use of this unknown offset property.
Time over which loss is averted	20 years	Land will be owned and managed by DBCA so long term protection is afforded. Twenty years is the maximum value that can be input.
Time until ecological benefit	20 year	Any loss in condition (from not offsetting) would be expected to take up to 20 years to be observed (assuming existing agricultural practices continue)
Risk of loss without offset	4.31%	UQ (2017) value for Shire of Serpentine-Jarrahdale.
Risk of loss with offset	0%	Very low risk through protection of conservation estate.
Confidence in result (Risk of Loss)	90%	High degree of confidence, land will be surveyed to confirm habitat values and then purchased for transfer to the conservation estate.
Output	12.64 %	Of total offset requirement

Table 32 Offset Calculator, Baudin's Cockatoos – Offset 4 (Direct Offset)

Attribute	Value	Justification
Offset area	1.13 ha	The SCP 3a restoration offset will also provide habitat for Baudin's Cockatoo
Start quality	6	Habitat quality will be equivalent or better than the habitat within the Proposed Action area. Further survey will be required to determine the start quality for this Black Cockatoo offset.
Future quality without offset	5	Anticipated that current land uses in Offset 4 will continue to degrade vegetation quality over the period of the offset.
Future quality with offset	6	Land will be managed for conservation of existing values and maintenance of condition.
Confidence in result (Future Quality)	60%	Confidence is dependent on the current land use of Offset 4 once it is identified. Conservative value used to reflect uncertainty of current land use of this unknown offset property.
Time over which loss is averted	20 years	Land will be owned and managed by DBCA so long term protection is afforded. Twenty years is the maximum value that can be input.
Time until ecological benefit	20 year	Any loss in condition (from not offsetting) would be expected to take up to 20 years to be observed (assuming existing agricultural practices continue)
Risk of loss without offset	4.31%	UQ (2017) value for Shire of Serpentine-Jarrahdale.
Risk of loss with offset	0%	Very low risk through protection of conservation estate.
Confidence in result (Risk of Loss)	90%	High degree of confidence, land will be surveyed to confirm habitat values and then purchased for transfer to the conservation estate.
Output	0.57 %	Of total offset requirement

4.8 Black Cockatoos – Indirect offset

4.8.1 Quantum of Indirect Offset

The direct offsets described above are intended to amount to 90% of the total offset requirement for the Tonkin Highway Extension controlled action. The remaining 10% of the offset is proposed to be implemented through the partial funding of the Murdoch University Black Cockatoo research proposal described in 3.2.6.

Main Roads has estimated that the total value of the direct offset is in the order of \$900,000. As this is contributing 90% of the offset value, the contribution to the Murdoch University research will be in the order of \$100,000.

A detailed calculation of the direct offset value will be determined once the offsets are in place, in order to determine the final quantum of the indirect offset.

4.8.2 Application of Commonwealth Criteria for Research

Application of Commonwealth criteria for research (Australian Government 2012a) to the research proposal (Warren et. al. 2019) is summarised in Table 36.

Table 33 Consideration of Commonwealth criteria for research (Australian Government 2012a) with respect to the Murdoch University research proposal

Commonwealth criteria for research	Application of criteria to Murdoch University research proposal
A suitable research program must endeavour to improve the viability of the impacted protected matter.	The objectives of the research proposal are summarised in Section 3.2.4 and endeavour to improve the viability of Black Cockatoos and inform future Black Cockatoo offset options.
A suitable research program must be targeted toward key research as identified in the relevant Commonwealth approved recovery plan, threat abatement plan, conservation advice, ecological character description, management plan or listing document. Where Commonwealth approved guidance documents are not available or are insufficient in detail, the department will consider additional information sources such as state management plans or peer reviewed scientific literature to inform priority offset activities.	The proposal has been developed in collaboration with DBCA to meet the requirements of the EPBC Act referral guidelines for three black cockatoo species (Australian Government 2012c), as well as priority actions and recommendations from the national Carnaby's Cockatoo (<i>Calyptorhynchus latirostris</i>) Recovery Plan (DPaW 2013), Baudin's Cockatoo (<i>Calyptorhynchus baudinii</i>) and Forest Red-tailed Black Cockatoo (<i>Calyptorhynchus banksii naso</i>) Recovery Plan (Chapman 2008), MNES Significant Impact Guidelines (Australian Government 2013) and the Consideration of Matters of National Environmental Significance by the WA land use planning system Discussion Paper (Department of Environment, Water, Heritage and the Arts 2009).
A suitable research program must be undertaken in a transparent and scientifically robust and timely manner.	The research program will be: <ul style="list-style-type: none"> • Transparent as regular reporting will be provided to Main Roads and the results will be published and made publicly accessible. • Scientifically robust as it has been based on similar research programs conducted by the same team since 2015. This includes the successful deployment of 84 tags and production of over 140,000 GPS location fixes, 33,000 km of track movement and over 2.8M

Commonwealth criteria for research	Application of criteria to Murdoch University research proposal
	<p>accelerometer records. The methodology is proven and facilitates individual and flock movement characterisation at spatial and temporal scales previously unattainable.</p> <ul style="list-style-type: none"> • Conducted over a period of five years.
<p>A suitable research program must be undertaken by a suitably qualified individual or organisation in a manner approved by the department</p>	<p>The research program will be undertaken by suitably qualified and experienced Murdoch University research scientists and has been developed in collaboration with DBCA to meet the requirements of the EPBC Act referral guidelines for three black cockatoo species (Australian Government 2012c), as well as priority actions and recommendations from the national Carnaby's Cockatoo (<i>Calyptorhynchus latirostris</i>) Recovery Plan (DPaW 2013), Baudin's Cockatoo (<i>Calyptorhynchus baudinii</i>) and Forest Red-tailed Black Cockatoo (<i>Calyptorhynchus banksii naso</i>) Recovery Plan (Chapman 2008), MNES Significant Impact Guidelines (Australian Government 2013) and the Consideration of Matters of National Environmental Significance by the WA land use planning system Discussion Paper (Department of Environment, Water, Heritage and the Arts 2009).</p>
<p>A suitable research program must consider best practice research approaches.</p>	<p>The research proposal will consider best practice research approaches. Main Roads will not be using an open market tender to award this work; instead, it will award funding direct to Murdoch University based on its existing successful Black Cockatoo research prior experience undertaking similar research and proposal.</p>
<p>The proponent is required to select an institution through an internationally available open tender process or provide evidence that the program can be undertaken in-house. Where appropriate, the tender should complement an existing research institution's work program as it relates to the MNES. This will be the responsibility of the proponent; however, the department will require that the proponents follow the department's guidelines.</p>	<p>Main Roads will not be using an open market tender to award this work; instead, it will award funding direct to Murdoch University based on its existing successful Black Cockatoo research program, prior experience undertaking similar research and proposal.</p>
<p>The proponent is required to provide updates on progress and key findings to the department through periodic reporting.</p>	<p>Main Roads requires regular progress reports to be submitted to track research progress, with annual progress reports provided to regulators.</p>
<p>The proponent is required to ensure that funds are managed appropriately and that auditable financial records are kept and maintained.</p>	<p>Main Roads will require that annual progress reports include tracking of funding and that auditable financial records are kept and maintained.</p>
<p>The proponent is required to apply a 'no surprises' policy to the publication, whereby research publications and outputs are provided to the department at least five working days before release.</p>	<p>Research publications and outputs will be provided to the department at least five working days before release.</p>

Commonwealth criteria for research	Application of criteria to Murdoch University research proposal
<p>Research programs will be tailored to at least a postgraduate level; however, there will be scope to engage other educational levels in educational programs.</p>	<p>The research proposal is tailored to at least a postgraduate level.</p>
<p>Research programs will present findings that can be peer reviewed.</p>	<p>The research proposal will present findings that can be peer reviewed.</p>
<p>Research programs will publish findings in an internationally recognised peer-reviewed scientific journal or be of a standard that would be acceptable for publication in such a journal. Publications should be submitted to free open access journals. Data and information collected should have creative commons licensing and be free and accessible.</p>	<p>The research proposal will publish findings in an internationally recognised peer-reviewed scientific journal or be of a standard that would be acceptable for publication in such a journal. Data and information collected will have creative commons licensing and be free and accessible.</p>
<p>Research outputs should inform future management decisions on the protected matter and, where possible, be readily applicable to other similar matters (species groupings etc.)</p>	<p>Research outputs will inform future management decisions of Black Cockatoos</p>

5 COUNTERBALANCE OF SIGNIFICANT RESIDUAL IMPACTS

Table 34 provides a summary of the offset package to counterbalance the significant residual impacts to *Corymbia-Kingia* TEC (SCP 3a), *Corymbia-Xanthorrhoea* TEC (SCP 3c), Black Cockatoos and *Tetraria australiensis*. Table 34 is based on preliminary offset calculations using the EPBC Act Offset Assessment Guide, as presented in Section 4 and Appendix E. The offset package is expected to provide adequate compensation for significant residual impacts to those environmental attributes noted above.

Table 34 Summary of proposed direct offset for Tonkin Highway Extension

Attribute	Carnaby's Cockatoo		FRTBC		Baudin's Cockatoo		SCP 3c		SCP 3a		Tetraria australiensis		Artificial Hollows
	Area (ha)	% offset	Area (ha)	% offset	Area (ha)	% offset	Area (ha)	% offset	Area (ha)	% offset	Area (ha)	% offset	
Nirimba	14.2	9.85	14.2	10.88	14.2	9.85	-	-	-	-	-	-	-
Lake Clifton	23.13	19.19	23.13	23.41	23.13	19.19	-	-	-	-	-	-	-
Offset 1	71	50.81	71	61.97	71	50.81	-	-	-	-	-	-	-
Offset 2	26.2	12.64	26.2	15.42	26.2	12.64	26.2	100.59	-	-	-	-	-
Offset 3	-	-	-	-	-	-	-	-	-	-	27.2	100.6	-
Offset 4	1.13	0.57	1.13	0.70	1.13	0.57	-	-	1.13	100.4	-	-	-
Total	135.66	93.06	135.66	112.38	135.66	93.06	26.2	100.59	1.13	100.4	27.2	100.6	9

6 APPLICATION OF EPBC ACT ENVIRONMENTAL OFFSETS POLICY

The proposed offset strategy is consistent with the principles of the EPBC Act Environmental Offsets Policy (DSEWPaC 2012) as presented in Table 35.

Table 35 Consistency with EPBC Act Environmental Offsets Policy

Policy overarching principles	Comment
Suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of the protected matter	The offsets will provide a conservation outcome that maintains or improves the viability of the <i>Corymbia-Kingia</i> TEC (SCP 3a), <i>Corymbia-Xanthorrhoea</i> TEC (SCP 3c), Carnaby's Cockatoo, Forest Red-tailed Black Cockatoo, Baudin's Cockatoo and <i>Tetraria australiensis</i> . The offset strategy provides at least 100% offset for all seven protected matters.
Suitable offsets must be built around direct offsets but may include other compensatory measures	The conservation outcome will be achieved through protecting the protected matters through transfer of land containing <i>Corymbia-Kingia</i> TEC (SCP 3a), <i>Corymbia-Xanthorrhoea</i> TEC (SCP 3c), Carnaby's Cockatoo, Forest Red-tailed Black Cockatoo, Baudin's Cockatoo and <i>Tetraria australiensis</i> to DBCA.
Suitable offsets must be in proportion to the level of statutory protection that applies to the protected matter	The offset strategy is built around direct offsets, involving a package of suitable offset properties to provide at least 100% direct offsets for <i>Corymbia-Kingia</i> TEC (SCP 3a), <i>Corymbia-Xanthorrhoea</i> TEC (SCP 3c), Carnaby's Cockatoo, Forest Red-tailed Black Cockatoo, Baudin's Cockatoo and <i>Tetraria australiensis</i> .
Suitable offsets must be of a size and scale proportionate to the residual impacts on the protected matter	All offsets will be transferred to DBCA. DBCA and the Conservation and Parks Commission are then responsible for the management of the land and creation of the conservation reserve, providing in perpetuity protection and management.
Suitable offsets must effectively account for and manage the risks of the offset not succeeding	The quantum of offsets proposed are in proportion to the level of statutory protection applied to the <i>Corymbia-Kingia</i> TEC (SCP 3a) (Endangered), <i>Corymbia-Xanthorrhoea</i> TEC (SCP 3c) (Endangered), Carnaby's Cockatoo (Endangered), Forest Red-tailed Black Cockatoo (Vulnerable), Baudin's Cockatoo (Endangered) and <i>Tetraria australiensis</i> (Vulnerable) as presented in the preliminary offset calculations.
Suitable offsets must be additional to what is already required, determined by law or planning regulations, or agreed to under other schemes or programs	The offsets will be of a size and scale proportional to the residual impacts on <i>Corymbia-Kingia</i> TEC (SCP 3a), <i>Corymbia-Xanthorrhoea</i> TEC (SCP 3c), Carnaby's Cockatoo, Forest Red-tailed Black Cockatoo, Baudin's Cockatoo and <i>Tetraria australiensis</i> . The offset strategy provides at least 100% offset for all three protected matters.
Suitable offsets must be efficient, effective, timely, transparent, scientifically robust and reasonable	The provision of direct offsets is based on completed offset assessment guide calculations, incorporating evidence based justification for all inputs.
Suitable offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced	The estimation of direct offsets is based on completed offset assessment guide calculations, incorporating a conservative assessment of risk of the offset not succeeding.
Suitable offsets must be built around direct offsets but may include other compensatory measures	Main Roads has a history of offset management, including provision of land to DBCA for ongoing management and conservation. The transfer of land to DBCA is expected to have a high chance (90%) of successfully delivering the required conservation outcomes.

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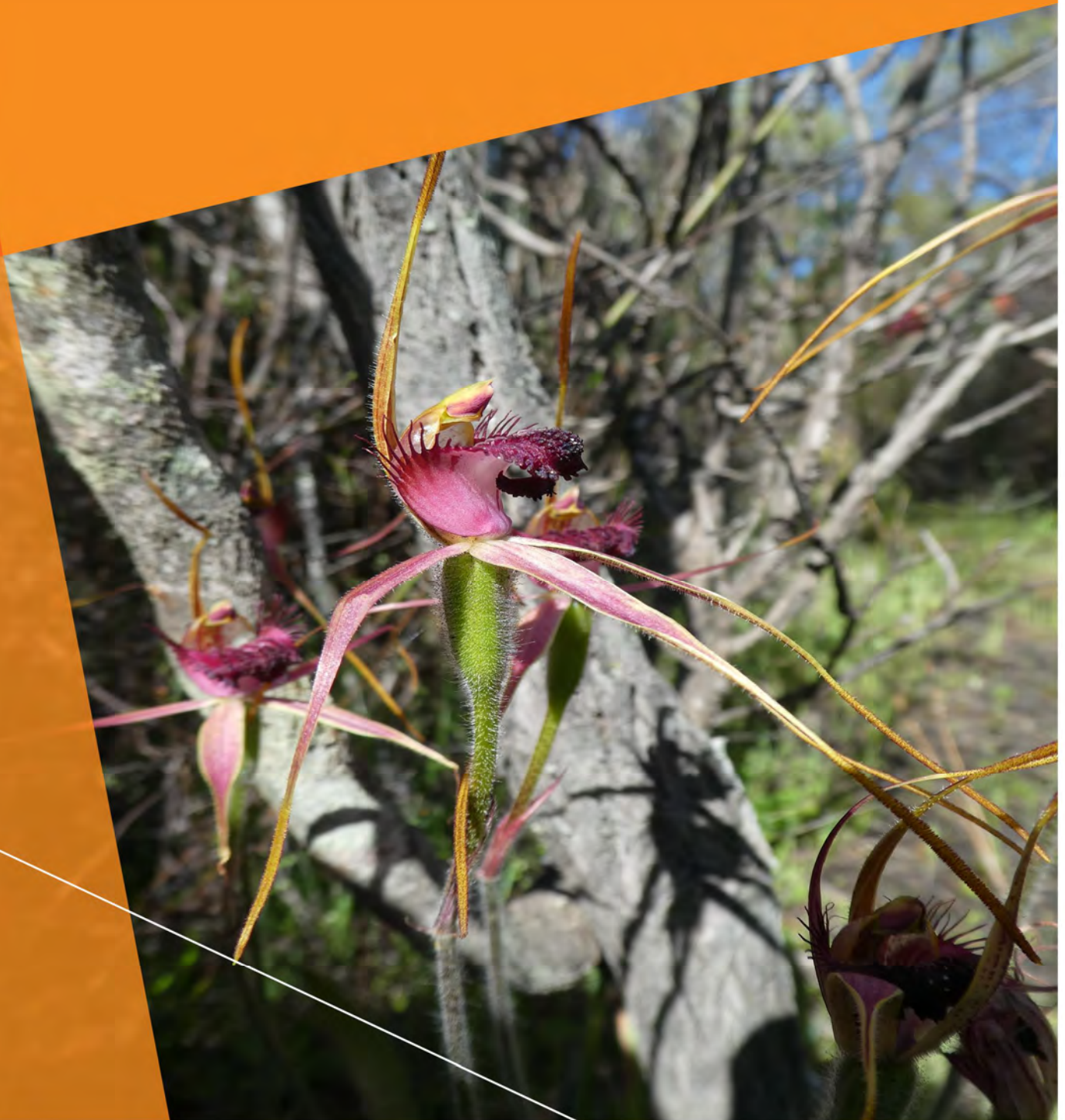
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8 APPENDICES

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Appendix A	Biological Assessment for Lot 295, 842 and 1262 Nirimba
Appendix B	Biological Assessments Lot 1000, 2240, 2275, 2657 & 3045 Preston Beach Road Lake Clifton
Appendix C	Murdoch University Research
Appendix D	DBCA's guide how to design and place artificial hollows
Appendix E	Preliminary offset calculations

Appendix A: Biological Assessment for Lot 295, 842 and 1262 Nirimba

Biological Assessment for Lot 295, 842 and 1262 Nirimba



Biological Assessment for Lot 295, 842 and 1262 Nirimba

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Executive Summary

Main Roads Western Australia (Main Roads) required biological assessments for Lots 295, 842 and 1262, Carrabungup Road in Nirimba (the Survey Area) to determine their suitability as offset sites for current and future projects. The objective of this assessment was to map and quantify environmental values, specifically including flora, vegetation, fauna, wetlands and Black Cockatoo habitat. To meet this objective a level 2 flora and vegetation assessment, level 1 fauna assessment, a Black Cockatoo assessment and a wetland assessment were undertaken.

Field surveys were undertaken between 1 and 2 August 2016, and 10 and 11 October 2016. Flora and vegetation was documented from 18 quadrats and 12 relevés. The fauna assessment was informed by 13 detailed fauna habitat assessments and 13 opportunistic microhabitat searches. Black Cockatoo foraging and breeding habitat was documented at 21 Carnaby's and 22 Forest Red-tail observation points. A wetland assessment was undertaken for three wetlands, including two Conservation Category Wetlands and one group of wetlands of varying classification associated with the Peel-Harvey estuary.

Four Threatened Ecological Communities (TECs) were mapped in the Survey Area. The desktop assessment indicated recorded locations of these communities within the Survey Area, all related to the riparian vegetation of the Peel-Harvey estuary. The TECs include:

- Three TECs listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
 - Subtropical and Temperate Coastal Saltmarsh (Vulnerable)
 - Herb Rich Saline Shrublands in Clay Clay Pans (Critically Endangered)
 - Banksia Woodlands of the Swan Coastal Plain (Endangered)
- One TEC listed under the *Wildlife Conservation Act 1950* (WC Act)
 - Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain (Vulnerable).

A breakdown of the TECs presence within each Lot is shown in Table 1.

Six vegetation communities were mapped, including two wetland communities, and four woodland communities. Of these, MrTpCc is considered regionally significant as it represents the aforementioned TECs and ErXpLh and ErMiLg are considered locally significant as they support populations of Priority flora.

Two Priority flora species were recorded including *Dillwynia dillwynioides* (Priority 3) and *Eucalyptus rudis* subsp. *cratyantha* (Priority 4). *D. dillwynioides* was recorded in one quadrat in wetland vegetation. It was identified as a Priority at the WA Herbarium following the field survey therefore no population extent or size was recorded at the time of collection. There are four populations in close proximity to the Survey Area indicating it could be locally common.

E. rudis subsp. *cratyantha* (Priority 4) was the dominant tree species in community ErXpLh. A sample was collected in August and submitted to the WA Herbarium where it was confirmed as the Priority *E. rudis* species. The population extends for 42.53 ha and supports more than 1000 individuals. This species has not been recorded in the vicinity (<10 km from the Survey Area) and may therefore be considered locally significant.

The Black Cockatoo foraging assessment determined that the Survey Area contains approximately 171 ha of Carnaby's Black Cockatoo foraging habitat and 130 ha of Forest Red-tailed Black Cockatoo foraging habitat. Forest Red-tailed Black Cockatoos were heard during the field survey and evidence of foraging on Marri nuts was observed at three locations. Two Banksia cones were opportunistically recorded showing evidence of Carnaby's foraging on the grub inside the cone.

The breeding habitat assessment identified four vegetation communities that support potential suitable breeding trees for Black Cockatoos. Of these, three were considered low quality, and one was considered valued quality based on the density of suitable potential breeding trees. An estimated 2,527 potential Black Cockatoo breeding trees may be present within the Survey Area based on detailed surveys of 18 representative quadrats.

Wetlands mapped in the Geomorphic Wetlands dataset extend over 74 ha of the Survey Area. This coincides with the wetland vegetation mapping, extending 75 ha. The Wetland Assessment showed that the wetlands subject to a Wetland Assessment met the criteria of a Conservation management category, despite some being mapped in the Resource Enhancement (RE) or Multiple Use (MU) categories.

A summary of the environmental values and their distribution within the Lots is outlined in Table 1.

Table 1 Summary of environmental values recorded within the Survey Area

Environmental Value	Lot 295	Lot 842	Lot 1262	Total
Carnaby's Potential Foraging Habitat	70.05	35.10	66.60	171.75
FRTBC Potential Foraging Habitat	41.60	35.04	52.57	129.22
Black Cockatoo Potential Breeding Habitat	70.05	35.10	66.60	171.75
Conservation Category Wetlands	12.61	0.34	10.50	23.45
Resource Enhancement Wetlands	2.85	18.02	2.94	23.81
Threatened Ecological Communities including: <ul style="list-style-type: none"> · Subtropical and Temperate Coastal Saltmarsh (EPBC Act: VU) · Clay Pans of the Swan Coastal Plain (EPBC Act: CR; WC Act: VU) · Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain (WC Act: Vulnerable) 	0.48	22.41	13.87	36.76
<i>Dillwynia dillwynioides</i> Priority flora records	1	0	0	1
<i>Eucalyptus rudis</i> subsp. <i>cratyantha</i> Priority flora population extent (ha)	28.45	0.05	14.03	42.53

1.0 Introduction

1.1 Background and scope

Main Roads Western Australia (Main Roads) required biological surveys for Lots 295, 842 and 1262, Carrabungup Road in Nirimba to determine their suitability as offset sites for current and future projects. The biological assessments were required to assess the environmental values within the defined Survey Area. The properties were subject to biological investigations including:

- Carnaby's and Forest Red-tailed Black Cockatoo foraging and breeding assessment
- Level 2 flora and vegetation survey
- Level 1 fauna survey
- Wetland assessment and assessment of wetland boundaries.

This technical report documents the methodology utilised and results gained from undertaking the biological surveys to meet the above scope.

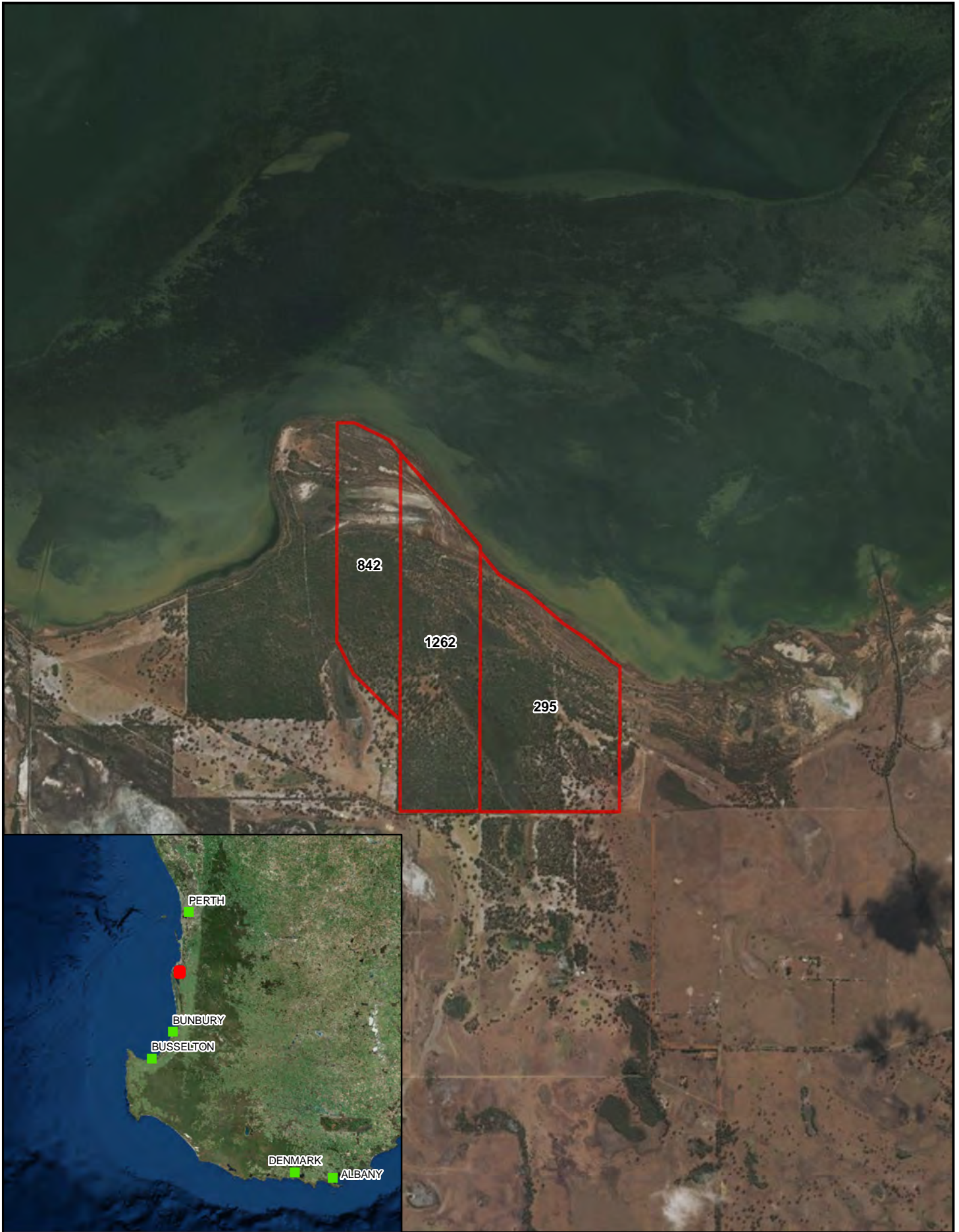
1.2 Location

Lots 295, 842 and 1262 (the Survey Area) are located along Carrabungup Road in Nirimba approximately 80 km south of Perth. The Survey Area lies adjacent to Boggy Bay, in the Shire of Murray (Figure 1).

1.3 Objectives

The primary objective of the biological assessments was to define floristic, vegetation and fauna values within the Survey Area. The biological assessments comprised:

- biological field surveys, in accordance with relevant standards and technical guides
- ecological community mapping and vegetation condition mapping
- surveying and mapping of suitable breeding, roosting and foraging habitat for Black Cockatoos
- defining fauna habitat values and potential for presence of significant fauna species.



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 LAST MODIFIED 29 NOV 2016

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DATUM GDA 1994, PROJECTION MGA ZONE 50

0 230 460 690 920
 metres

1:30,000 when printed at A4

LEGEND
 Survey Area

Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Survey Area

MAIN ROADS
 NIRIMBA BIOLOGICAL ASSESSMENT

Figure
 1

2.0 Existing Environment

2.1 Climate

The Swan Coastal Plain has a warm Mediterranean climate, characterised by hot dry summers and cool to mild wet winters. The closest meteorological recording station with comprehensive data is Pinjarra Refinery (BOM Station 9891), located 20 km east of the Survey Area. The weather station has been collecting data since 1984.

The reconnaissance survey was undertaken in August following dry months of June and July (Figure 2). Some orchid leaves were observed but annual species (i.e. Asteraceae species) were low. The wetlands were dry at this time. The surveys in October followed a higher than average rainfall in August. This led to inundation of one wetland, and extensive inundation of the riparian vegetation of the Peel-Harvey estuary (also influenced by tides). Many annual species were recorded and the majority of flora species were in flower and/or fruit.

Climate is not considered a limitation of the survey.

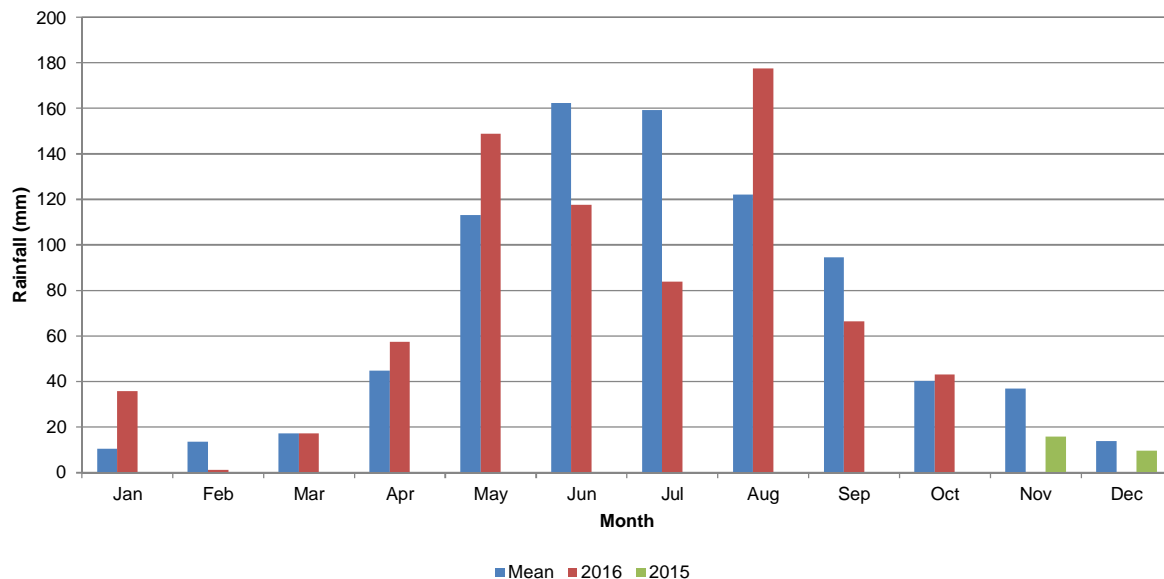


Figure 2 Rainfall received at Pinjarra Refinery Station 9891 showing monthly totals for the twelve months preceding the field surveys (BOM 2016)

2.2 IBRA region

The Survey Area is located on the Swan Coastal Plain bioregion described in CALM (2002), including Perth and the outer suburbs (excluding the Hills suburbs). The Swan Coastal Plain consists of the Dandaragan Plateau and the Perth Coastal Plain and is comprised of a narrow belt less than 30 km wide of Aeolian, alluvial and colluvial deposits of Holocene or Pleistocene age incorporating a complex series of seasonal fresh water wetlands, alluvial river flats, coastal limestone and several offshore islands. Younger sandy areas and limestone are dominated by heath and/or Tuart woodlands, while *Banksia* and *Jarrah-Banksia* woodlands are found on the older dune systems.

The Swan Coastal Plain subregion, described by Mitchell *et al.* (2002), is a low-lying coastal plain covered with woodlands dominated by *Banksia* or Tuart on sandy soils, *Casuarina obesa* on outwash plains, and paperbark in swampy areas. The area includes a complex series of seasonal wetlands and includes Rottneest, Carnac and Garden Islands. Land use is predominantly cultivation, conservation, urban and rural residential. The area contains a number of rare features including Holocene dunes and wetlands and a large number of threatened species and ecological communities.

2.3 Vegetation

2.3.1 Pre-European vegetation

The Environmental Protection Authority's (EPA) objective is to retain at least 30% of all pre-European Heddle *et al.* (1980) vegetation complexes, which is consistent with recognised retention levels (EPA, 2000; EPA, 2015).

There are two Beard (1981) vegetation associations present within the Survey Area (Table 2) including low and medium woodland. Heddle *et al.* (1980) mapped two vegetation complexes within the Survey Areas (Table 3). The Southern River vegetation complex has been reduced to 18.4% of the original extent (EPA, 2015).

Table 2 Beard (1981) vegetation types mapped within the Survey Area

Vegetation Association	Description
27	Low woodland: Paperbark (<i>Melaleuca</i> species)
968	Medium woodland; Jarrah, Marri and Wandoo

Table 3 Heddle *et al.* (1980) vegetation complexes mapped within the Survey Area and the extent remaining using the Perth @ 3.5 million document (EPA, 2015)

Vegetation association	Description	Extent Remaining
Southern River Complex	Open woodland of <i>Corymbia calophylla</i> , <i>Eucalyptus marginata</i> , <i>Banksia</i> species with fringing woodland of <i>E. rudis</i> and <i>Melaleuca raphiophylla</i> along creek beds	18.4%
Vasse Complex	Estuarine and marine deposits	35.9%

2.4 Wetlands

2.4.1 Ramsar Site

The Survey Area is adjacent to the Peel-Yalgorup Ramsar site. The Peel-Yalgorup site comprises the estuarine Peel Inlet and Harvey Estuary, the freshwater wetlands of lakes McLarty and Mealup, and the Yalgorup National Park (including the saline lakes system with sections of fringing upland). This system stretches for 60 km north to south and approximately 10 km east to west.

The Ramsar site was recognised as a wetland of international importance in 1990 and is considered to be representative of wetlands of the Swan Coastal Plain forming a chain of diverse habitat types which in turn support an array of ecologically important species and communities (Peel-Harvey Catchment Council, 2009).

Less than 0.2 ha of the Ramsar site intersects with the Survey Area, representing the estuarine edge of the site.

2.4.2 Geomorphic Wetlands of the Swan Coastal Plain

There are 14 wetlands assigned unique numbers in the Geomorphic Wetlands of the Swan Coastal Plain dataset within the Survey Area. Of these, seven are associated with the Peel-Yalgorup Ramsar site resembling estuarine vegetation and shallow water.

Wetlands comprise 73.72 ha of the Survey Area, shown in Table 4 and Figure 3. This includes:

- 23.49 ha of CCW
- 23.82 ha of RE wetlands
- 26.41 ha of MU wetlands.

Table 4 Wetlands that intersect with the Survey Area including UFI, classification, extent (ha), consanguineous suite

Unique Feature Identifier	Wetland Evaluation	Extent within Survey Area (ha)	Consanguineous Suite	Vegetation Present, Condition and Additional Comments
2987	MU	0.24	Peel-Harvey Estuary	Edge of wetland intersects with Survey Area, represents degraded estuarine vegetation. No access due to inundation.
2991	MU	1.66	Peel-Harvey Estuary	Represents part of the Peel-Harvey estuary group of wetlands. No access due to inundation.
2992	MU	12.8	Peel-Harvey Estuary	Subject to Wetland Assessment as part of the Peel-Harvey estuary group.
2994	RE	0.04	Keysbrook	Edge of wetland intersects with Survey Area. This wetland was not further assessed.
2995	CCW	15.87	Keysbrook	Located entirely within the Survey Area, this wetland was subject to a Wetlands Assessment.
3115	RE	2.85	Peel-Harvey Estuary	Subject to Wetland Assessment as part of the Peel-Harvey estuary group.
3116	CCW	5.55	Keysbrook	Located entirely within the Survey Area, this wetland was subject to a Wetlands Assessment.
3117	MU	7.88	Peel-Harvey Estuary	Represents part of the Peel-Harvey estuary group of wetlands. Condition was not observed to be significantly more degraded than adjacent RE wetland.
3118	MU	0.07	Keysbrook	Edge of wetland intersects with Carrabungup Road and the Survey Area. Forms part of UFI 2995 at this location.
3125	MU	3.74	Keysbrook	Degraded wetland located in a paddock that continues to be used as a private dwelling/pasture. Wetland was not visited due to presence of electric fence and evidence of private residency.
3367	MU	0.02	Keysbrook	Edge of wetland intersects with Survey Area. Not significant enough to warrant further investigation.
14562	RE	20.93	Peel-Harvey Estuary	Subject to Wetland Assessment as part of the Peel-Harvey estuary group.
15229	CCW	2.07	Peel-Harvey Estuary	Peel Inlet Waterbody.

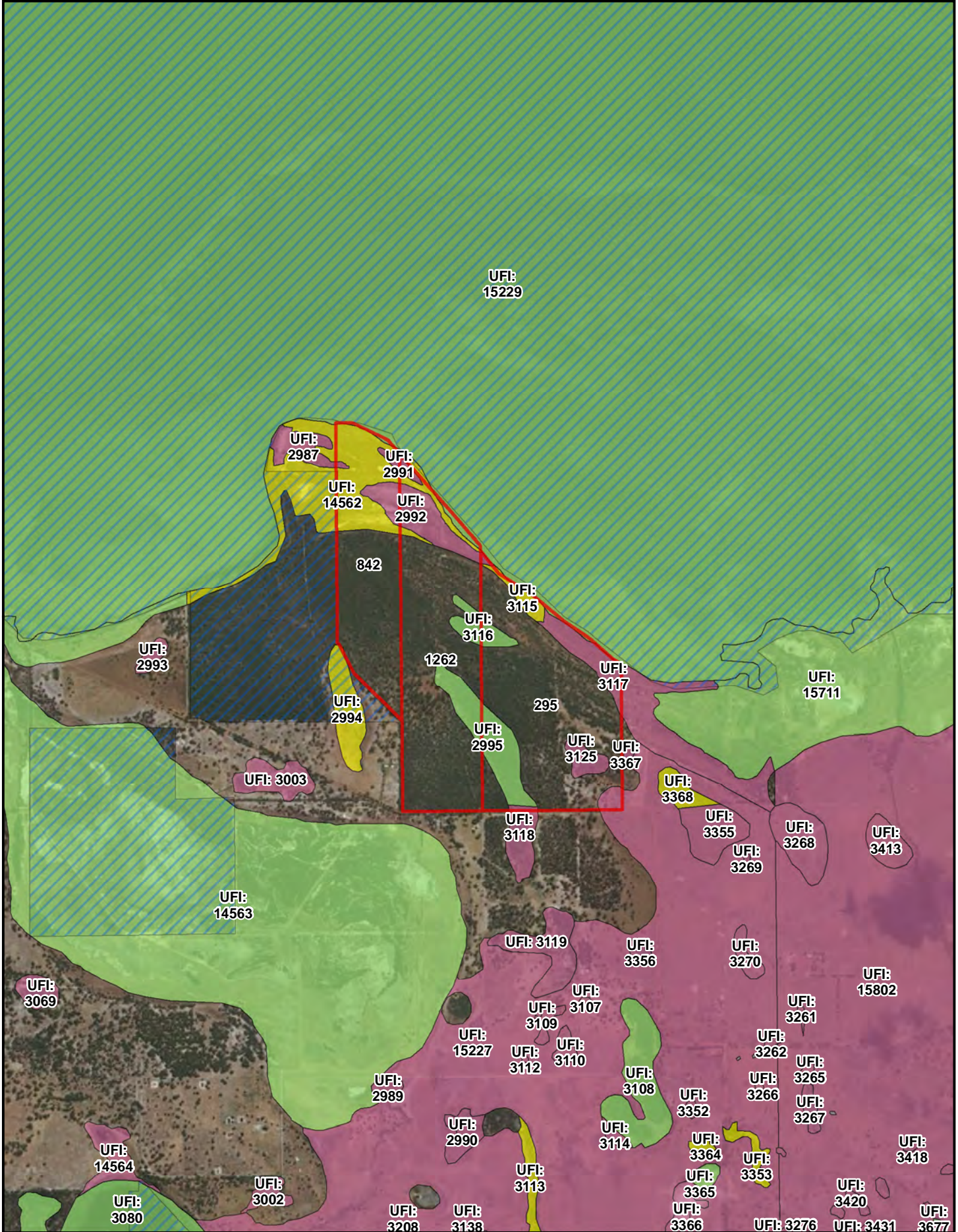
2.5 Conservation estate, Bush Forever and Environmentally Sensitive Areas

The Survey Area adjoins the Austin Bay Nature Reserve on the northeast side and the west side. Austin Bay Nature Reserve is a Class A reserve that encompasses 1,658 ha. The Reserve adjoins the Survey Area along the northeast edge and the western edge. It incorporates open water, wetland vegetation and native terrestrial vegetation.

The entire Survey Area is located within an Environmentally Sensitive Area associated with the Class A nature reserve and the Ramsar site. The Survey Area does not intersect with any Bush Forever Sites.

The Survey Area is currently owned in freehold title by the State of WA and is managed for conservation by DPaW.

Conservation estates and ESAs are show in Figure 4.



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LEGEND

Survey Area
 Peel-Yalgorup System Ramsar

Geomorphic Wetlands

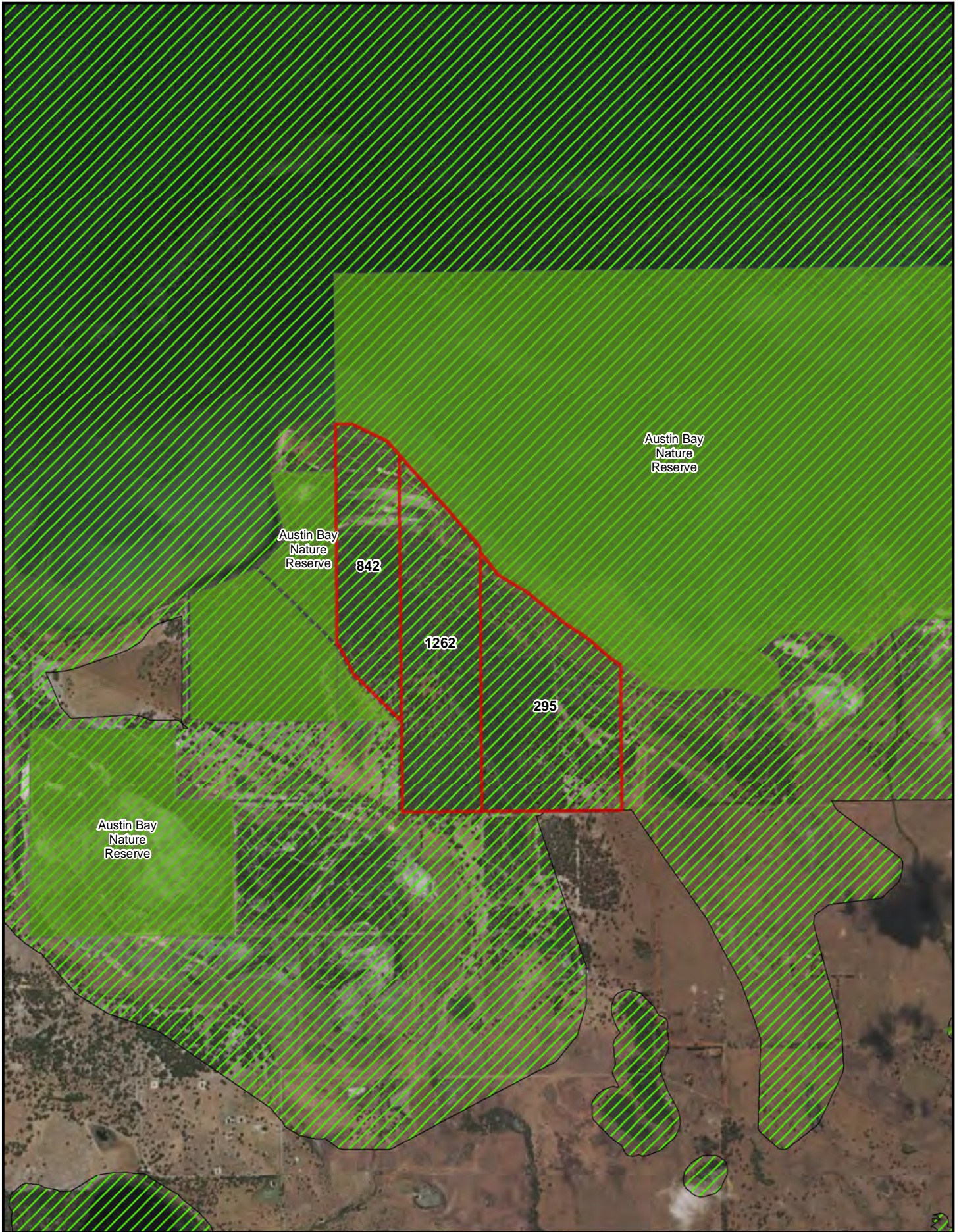
- Conservation
- Multiple Use
- Not Assessed
- Resource Enhancement

Wetlands

MAIN ROADS

NIRIMBA BIOLOGICAL ASSESSMENT

Figure 3



<p>PROJECT ID 60100953 CREATED BY DGF APPROVED BY FDW LAST MODIFIED 29 NOV 2016</p> <p>AECOM www.aecom.com</p> <p>DATUM GDA 1994, PROJECTION MGA ZONE 50</p> <p>0 230 460 690 920 metres</p> <p>1:30,000 when printed at A4</p>	<p>LEGEND</p> <ul style="list-style-type: none"> Survey Area Environmentally Sensitive Areas <p>DPAW Managed Lands and Water</p> <ul style="list-style-type: none"> Nature Reserve <p><small>Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community</small></p>	<p>Conservation Estates and ESAs</p> <hr/> <p>MAIN ROADS</p> <p><i>NIRIMBA BIOLOGICAL ASSESSMENT</i></p>	<p>Figure 4</p>
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3.0 Methodology

3.1 Desktop Assessment

A desktop assessment was undertaken following the August 2016 reconnaissance survey to identify potential significant matters that may be present in the Survey Area. The results were used to provide context for significance of the results, and to tailor methods and sampling to target particular species and communities.

The desktop assessment required undertaking data searches through DPaW (October 2016), and the Protected Matters Search from DotEE (June 2016) and undertaking a likelihood of assessment for species and communities identified in these searches.

Significant values likely to be present in the Survey Area were assessed by reviewing publicly available information including Geological Survey of Western Australia and Geoscience (2008), and WA Atlas (Landgate, 2016), and information on DPaW reserves and national parks. Beard (1981) Swan region mapping was used to identify the pre-European vegetation types present within the Survey Area.

The search results were reviewed to assess the potential presence of conservation significant environmental values including species, suitable habitat or unique compositions of flora and fauna. All conservation significant matters including flora, fauna and communities were reviewed and a likelihood of occurrence was completed based on the categories outlined in Table 10.

Table 5 Categories of likelihood of occurrence for species and communities

Likelihood	Flora	Fauna	Communities
Likely to occur	Habitat is present in the Survey Area and the species has been recorded in close proximity to the Survey Area	Survey Area is within the known distribution of the species, habitat is present in the Survey Area and the species has been recorded in close proximity to the Survey Area	Known occurrences of the community in close proximity to the Survey Area. Vegetation looks the same within the known occurrence and Survey Area based on aerial imagery. Geographic location is similar to the Survey Area
May occur	Habitat may be present and/or the species has been recorded in close proximity to the Survey Area	Survey Area is within the known distribution of the species, marginal habitat may be present and/or the species has been recorded in close proximity to the Survey Area	Known occurrence of the community in the local area, and/or vegetation looks the same within known occurrence and Survey Area based on aerial imagery. Geographic location is similar to the Survey Area
Unlikely to occur	No suitable habitat is present and the species has not been recorded in close proximity to the Survey Area	Survey Area is outside the known distribution for the species, or no suitable habitat is present and the species has not been recorded in close proximity to the Survey Area	Known occurrence of the community in close proximity to the project area however geographic location does not occur in Survey Area

3.2 Flora and Vegetation Assessment

A level 2 flora and vegetation assessment was completed. This included a level 1 survey (viewed as the reconnaissance survey) undertaken between 1 and 2 August 2016, and the level 2 survey undertaken between 10 and 11 October 2016. Field survey methods conformed with those published in EPA (2004a) Guidance Statement 51 (GS51) and the flora survey technical guide (DPaW & EPA, 2015). Field surveys were undertaken by Botanists Floora de Wit (Collection Permit SL011555) and Lyn van Gorp (Collection Permit SL011558).

Twelve sample point locations (relevés) (August 2016) and 18 quadrats (October 2016) were selected to document the floristics, and vegetation composition and structure. At all sample point locations, site characteristics and floristic data were recorded including:

- GPS location
- soil information (colour, type, moisture content)
- landform and topography
- rock types
- vegetation condition
- fire history
- representative photograph
- vascular plant species including height and projected foliage cover.

All quadrat data is provided in Appendix G at the end of this report.

Any species unable to be identified in the field were collected for identification in AECOM's in-house herbarium and the specimens and taxonomic references and keys at the Western Australian Herbarium (WAH). Taxonomy was undertaken by Botanist Sharnya Thomson. Naming of species followed the convention of the WAH as published on florabase (WAH, 1998-).

Quantitative flora species data were used to define the vegetation communities. Vegetation communities were described and mapped based on changes in dominant species composition and landform. Vegetation community descriptions were done to Level VI Sub-Association level in accordance with the National Vegetation Information System (NVIS) framework (Australian Government, 2003).

Vegetation condition was determined using the scale published by the Wildflower Society WA (Keighery, 1994) condition. The scale is based on disturbance (e.g. grazing, erosion), degree of alteration to community and habitat structure and site ecology and is widely accepted as the national standard for condition mapping (EPA & DPaW, 2015).

The TEC assessments were undertaken using available published information from the DotEE published conservation advice notices. Key diagnostic criteria were used where applicable.

3.3 Fauna

A Level 1 fauna survey was conducted in accordance with EPA Guidance Statement No. 56 (EPA, 2004b) and the fauna survey technical guide (EPA & DEC, 2010). The field survey was undertaken by Ecologist Jared Leigh between 10 and 11 October.

The Survey area was traversed on foot and fauna habitat assessments were completed at the same sample point locations as the flora and vegetation assessment. These locations were considered to best represent the fauna habitat in that area. Fauna habitats were assessed for specific habitat components in order to determine the potential for these habitats to support conservation significant species. Information collected included:

- location
- general habitat description
- habitat condition and disturbance types
- dominant / characteristic flora species and vegetation layers
- presences and abundance of hollows, fallen logs, leaf litter, bare ground, grass, stones and boulders, rock crevices, soil cracks, cryptogamic crust, vines, mistletoe, dense shrubs, water bodies etc.
- presence of animal signs (e.g. scats, digging, tracks, burrows, egg shell, bones, feathers etc.)

- fauna observations
- connectivity and potential significance of habitat.

Opportunistic observations (i.e. direct sightings or call identification) of fauna were recorded whilst traversing the Survey Area. Details of indirect evidence such as scats, tracks and diggings were also documented.

The taxonomy and nomenclature of vertebrate species for mammals, reptiles and amphibians used is in accordance with the Checklist of Vertebrates of Western Australia (WAM, 2015), and for bird species the Bird's Australia Checklist of Australian Birds based on Christidis and Boles (2008) was used.

3.4 Black Cockatoo Survey

A Black Cockatoo survey was conducted to identify potential breeding and foraging habitat for the three Threatened Black Cockatoo species that occur in WA. This survey focussed on the two species most likely to be present; the EPBC Act and WC Act listed Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*: Carnaby's), and Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii subsp. naso*: FRTBC). Foraging habitat quality was also quantified Black Cockatoo species. The surveys were undertaken in accordance with:

- Referral guidelines for three species of Western Australian black cockatoos species: Carnaby's Cockatoo (endangered), Baudin's Cockatoo (vulnerable), Forest Red-tailed Black Cockatoo (vulnerable) (Department of Sustainability, Environment, Water, Populations and Communities [DSEWPaC], 2012a)
- Technical Guide - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA & DEC [Department of Environment and Conservation], 2010).

3.4.1 Breeding habitat

The Black Cockatoo breeding habitat assessment focussed on quantifying potential breeding trees and associated habitat. Table 6 defines breeding habitat and identifies those trees that Black Cockatoos will utilise as breeding trees, according to the DSEWPaC (2012). Vegetation communities were assessed for their potential to provide breeding habitat by installing a 50 x 50 m quadrat as a sample point. All trees within this quadrat were then assessed for their suitability as a breeding tree. A total of 22 quadrats were assessed. These quadrats were used to provide a representative sample to determine the total amount of breeding habitat in the Survey Area (and approximate number of trees). The following information was collected for all potential breeding trees with a Diameter at Breast Height (DBH) >500 mm:

- location
- fire scarring present
- tree species
- DBH
- height
- number of hollows
- number of potentially suitable hollows
- photographs.

Breeding habitat quality was determined using the density of potential suitable breeding trees recorded within each vegetation community as follows:

- Low: <15 trees/ha
- Valued: 15-30 trees/ha
- Quality: >30 trees/ha.

Table 6 Potential Breeding Habitat (source: DSEWPaC, 2012)

	Carnaby's	FRTBC
Specific breeding habitat	Nest in hollows in live or dead trees of <i>E. salmonophloia</i> , <i>E. wandoo</i> , <i>E. gomphocephala</i> , <i>E. marginata</i> , <i>E. rudis</i> , <i>E. loxophleba</i> subsp. <i>loxophleba</i> , <i>E. accedens</i> , <i>E. diversicolor</i> and <i>Corymbia calophylla</i> .	Nest in hollows in live or dead trees of <i>E. diversicolor</i> and <i>Corymbia calophylla</i> , <i>E. wandoo</i> , <i>E. megacarpa</i> , <i>E. patens</i> , <i>E. gomphocephala</i> and <i>E. marginata</i> .
Definition of breeding habitat	'Breeding habitat' is defined in these referral guidelines as trees of species known to support breeding within the range of the species which either have a suitable nest hollow OR are of a suitable DBH to develop a nest hollow. For most tree species, suitable DBH is 500 mm. Note that <i>E. wandoo</i> is DBH >300 mm.	

3.4.2 Foraging habitat

The Black Cockatoo foraging habitat assessments focussed on mapping the area of potential foraging habitat within the Survey Area. Table 7 defines the foraging species for the FRTBC and Carnaby's. Vegetation communities were assessed for their potential to provide foraging habitat by installing a 50 x 50 m quadrat as a sample point. Vegetation within this quadrat was then assessed for its suitability as foraging habitat.

Twenty one Carnaby's and 22 FRTBC habitat quality assessments were completed. These quadrats were used to provide a representative sample to determine the total amount of potential foraging habitat within the Survey Area for each Black Cockatoo species.

Table 7 Black Cockatoo suitable foraging species (sources: DSEWPaC, 2012; Johnstone *et al.*, 2013)

Carnaby's	FRTBC
Native shrubland, kwongan heathland and woodland dominated by proteaceous plant species (e.g. <i>Banksia</i> sp., <i>Hakea</i> sp. and <i>Grevillea</i> sp.) as well as eucalypt woodland and forest that is dominated by foraging species. Also will feed on Callistemon, seeds of introduced species such as <i>Pinus</i> species and <i>Erodium</i> species, wild radish, canola, almonds and pecan nuts and occasionally apples and persimmons.	The principal foods of the FRTBC are the seeds of Marri and Jarrah. Other less important foods include Blackbutt <i>E. patens</i> , <i>E. wandoo</i> , Sheoak <i>A. fraseriana</i> , Snottygobble <i>P. longifolia</i> , <i>Hakea</i> spp., also introduced species (including Cape Lilac <i>Melia azedarach</i> , Spotted Gum <i>C. maculata</i> , Lemon-scented Gum <i>C. citriodora</i> , Silver Princess <i>E. caesia</i> , Illyarrie <i>E. erythrocorys</i> and Kaffir Plum <i>Harpephyllum caffrum</i>) and in southern forests Albany Blackbutt <i>E. staeri</i> and Karri <i>E. diversicolor</i> . Rarely observed grubbing for insect larvae on <i>Allocasuarina</i> spp.
Any area within the range of Black Cockatoo species that contains known food or nesting plant species is considered to be potential habitat for the Black Cockatoo species.	

3.5 Wetlands

The vegetation within wetland boundaries, as mapped in the Geomorphic Wetlands dataset, was investigated to determine the extent of wetland vegetation, as well as vegetation condition. A wetland evaluation was completed for wetlands located entirely, or mostly within the Survey Area, inclusive of vegetation, water, and fringing vegetation that grades from wetland to adjacent floodplain woodlands. Wetlands where only a small area intersects with the Survey Area, i.e. slivers and edges, were not considered.

The wetland evaluation methodology for the Swan Coastal Plain is a two-tiered approach. This approach has been adopted to avoid detailed evaluations being undertaken where it may not be necessary. The two tiers of evaluation are as follows:

1. Preliminary Evaluation – if any one of the preliminary evaluation criteria is met the wetland is automatically to be assigned a Conservation management category and no further evaluation is required
2. Secondary Evaluation – if the wetland does not meet the preliminary evaluation criteria the secondary evaluation should be conducted to determine the wetland's management category.

The Preliminary evaluation was undertaken using the information contained in the *Wetland evaluation and desktop and site assessment form*. In accordance with DPaW (2013) methodology, if a wetland met any one of the Preliminary evaluation criteria then it was assigned a Conservation management category.

A number of wetlands associated with the Peel-Harvey inlet were subject to one Wetland Assessment (as a group) in accordance with DPaW (2013) Wetland Assessment methodology. These wetlands included UFI 2992, 3115 and 14562.

3.5.1 Geomorphic Wetlands dataset of the Swan Coastal Plain

The Geomorphic Wetlands of the SCP dataset displays the location, boundary, geomorphic classification (wetland type) and management category of wetlands on the SCP. The mapping, classification and evaluation of wetlands on the SCP was initially conducted by Hill *et al.* in 1996 and then subsequently conducted in accordance with EPA Bulletin 686: *A Guide to Wetland Management in the Perth and Near Perth Swan Coastal Plain Area* (EPA, 1993). These mapping and evaluation results have been digitised into the *Geomorphic Wetlands of the SCP dataset* administered by DPaW. Geomorphic classifications are determined based on the duration of wetland inundation and associated landform.

In addition to geomorphic classifications, evaluation of wetlands is undertaken to assign the relevant management categories. EPA (2008) Guidance Statement 33 outlines the three key management categories which have been applied on the SCP, along with guidance on management objectives for each category (Table 8).

Table 8 Management categories and objectives for the Geomorphic Wetlands of the Swan Coastal Plain

Management Category	General Description	Management Objectives
Conservation (CC or CCW)	Wetlands which support a high level of attributes and functions.	Highest priority wetlands. Objective is to preserve and protect the existing conservation values of the wetlands through various mechanisms including: <ul style="list-style-type: none"> · reservation in national parks, crown reserves and State owned land protection under Environmental Protection Policies · wetland covenanting by landowners. No development or clearing is considered appropriate. These are the most valuable wetlands and any activity that may lead to further loss or degradation is inappropriate.
Resource Enhancement (RE)	Wetlands which may have been partially modified but still support substantial ecological attributes and functions	Priority wetlands. Ultimate objective is to manage, restore and protect towards improving their Conservation value. These wetlands have the potential to be restored to Conservation Category. This can be achieved by restoring wetland function, structure and biodiversity. Protection is recommended through a number of mechanisms.
Multiple Use (MU)	Wetlands with few remaining important attributes and functions	Use, development and management should be considered in the context of ecologically sustainable development and best management practice catchment planning through landcare.

3.6 Limitations

Factors that may have affected the completeness (and therefore the results) of the survey are addressed in Table 9. The EPA published these proposed limitations as a minimum requirement for level 2 flora and vegetation assessments (EPA, 2004a).

One moderate limitation was identified, being the inundation of the riparian vegetation associated with the Peel-Harvey estuary. The DPaW and EPA (2015) technical guide, and DPaW (2015b) advise that wetlands require multiple visits of the same quadrats in order to adequately sample the suite of flora species present at varying levels of inundation. Particularly in the Peel-Harvey estuary, it is known that different suites of species germinate and flower in the spring to summer months, hence making this community so unique. Furthermore, transects crossing the various zones of the wetland may have been useful in capturing more species and allowed for more accurate delineation of the TECs. At the time of the field surveys the level of inundation prevented access to the majority of this vegetation.

Table 9 Consideration of limitations that may affect the biological survey completeness

Limitation	Constraints	
	Flora and Vegetation Assessment	Fauna Assessment
Competency/experience of consultant conducting survey	Nil. The flora and vegetation assessment was led by Floora de Wit who has 8 years' experience addressing similar scopes on the Swan Coastal Plain.	Nil. Jared Leigh is an Ecologist with over 14 years' experience in the environmental industry and has conducted fauna surveys and Black Cockatoo assessments in a range of bioregions within Western Australia.
Scope (i.e. what life forms were sampled)	Minor. The <i>Tecticornia</i> species of the Peel-Harvey estuary lacked identifiable material (flowers) therefore were not able to be confirmed with certainty. None of the <i>Tecticornia</i> 's are likely to be Threatened or Priority species, therefore this limitation is not considered significant.	Nil. The Level 1 fauna survey assessed all fauna habitats within the Survey Area, documented secondary evidence (scats, diggings, burrows etc.) and fauna sightings, and included microhabitat searches at appropriate sites. Sufficient representative quadrats were assessed for breeding and foraging habitat for the targeted Western Australian Threatened Black Cockatoo species.
Proportion of flora/fauna identified, recorded and/or collected (based on sampling, timing and intensity)	Nil. Sampling effort included 12 relevés, 18 formal quadrats and numerous opportunistic observations recorded on field maps. This is considered suitable for meeting the scope and objectives of the assessment.	Minor Information gained for a Level 1 fauna survey was sufficient. Fauna were observed (through direct or indirect evidence) during daylight hours (0700 and 1800hrs). Nocturnal species were predominantly observed through indirect evidence.
Sources of information	Minor. A desktop assessment including DPaW database searches were undertaken with results obtained after the second field survey phase was completed. Lacking this information, no targeted surveys or particular attention was given to species or communities known or considered likely to occur in the Survey Area.	Nil. DPaW Threatened fauna database, Naturemap and EPBC Act PMST were utilised to inform the Level 1 fauna survey and Black Cockatoo assessment. These results were not available until after the field survey was completed. Jared's knowledge of the local area allowed him to anticipate species likely to be present therefore this was not considered a limitation.

Limitation	Constraints	
	Flora and Vegetation Assessment	Fauna Assessment
Completion (is further work needed)	<p>Nil. The objective of describing and mapping the vegetation communities at a fine scale (1:10,000) has been met and a better understanding of floristic value was obtained as a result of completing the two field surveys. Targeted searches were not part of the scope, despite the survey being undertaken at a Level 2 standard. It is likely that more conservation significant flora species occur in the Survey area. Further assessment of the Peel-Harvey riparian vegetation, including multiple sample efforts and using transects to capture the various zones of the wetland would have assisted in the delineation of the TECs and improved Floristic Community Analysis results.</p>	<p>Nil. The objectives of the Level 1 fauna survey and Black Cockatoo assessment for an offset site were met and no further work is required.</p>
Timing, weather, season, cycle	<p>Nil. The level of detail for the survey was considered adequate for meeting the objective of the survey.</p>	<p>Nil. The field survey was undertaken during Spring between 10 and 11 October 2016. The weather was warm. No rainfall was received during the survey. Sufficient rainfall had been received in the preceding months of the survey.</p>
Disturbances (e.g. fire flood, accidental human intervention) which affected results of the survey	<p>Nil. No disturbances were noted that may have affected the results of the survey.</p>	<p>Nil. Neither the Level 1 fauna survey or Black Cockatoo assessment were disrupted or impacted.</p>

Limitation	Constraints	
	Flora and Vegetation Assessment	Fauna Assessment
Intensity (was the intensity adequate)	<p>Moderate. A minimum of three quadrats representing each vegetation community were surveyed as stipulated in the technical guide (DPaW & EPA, 2015).</p>	<p>Nil. The Survey Area was surveyed over a two day period which required the field team to be very efficient. Additional time would have enabled additional microhabitat searches and a more extensive observed fauna species list. However, this did not significantly impact the results of the survey.</p>
Resources (degree of expertise available in plant/animal identification)	<p>Nil. Plant material was collected where specimens were not able to be identified in the field. These were identified by Sharnya Thomson at the WAH.</p>	<p>Nil. The resources (time, equipment and expertise) were sufficient for a Level 1 fauna survey and the Black Cockatoo assessment.</p>
Remoteness and/or access problems	<p>Minor. The Survey area was traversed on foot with the exception of the inundated vegetation adjacent to the Peel-Harvey estuary. This may have limited the identification of some riparian vegetation associated with any of Threatened Ecological Communities known to occur there.</p>	
Availability of contextual information on the region	<p>Nil. For the purpose of this assessment, no additional contextual information was considered. This limits the ability for desktop information to inform the sample plan and survey design. However for the purposes of this assessment, this is not considered a limitation.</p>	

4.0 Desktop Results

4.1 Threatened and Priority Ecological Communities

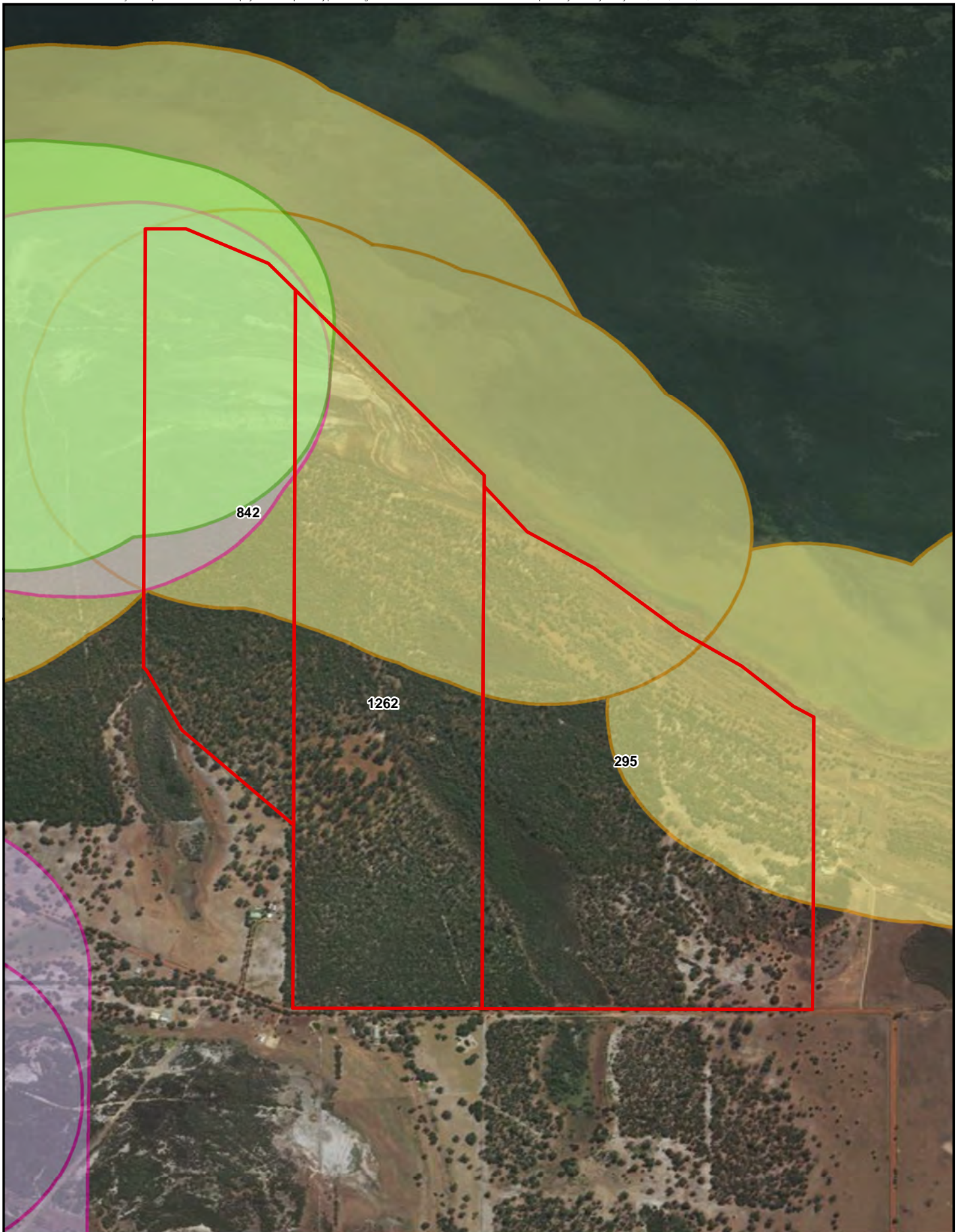
The DPaW database search result shows three Threatened and one Priority ecological community located within and in the vicinity of the Survey Area. All of these communities are associated with the Peel-Harvey estuary. Descriptions of these communities are provided in Table 10.

Table 10 Threatened and Priority Communities identified in the desktop assessment including their conservation status and detailed description

Community	Conservation Status ¹	Description
Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain	WC Act: VU	Captured as FCT SCP15 is described by Gibson <i>et al.</i> (1994) as dominated by <i>Melaleuca raphiophylla</i> or <i>Casuarina obesa</i> , occurring on alluvial sediments at sites which are inundated with saline water for long periods. Includes species such as <i>Atriplex cinerea</i> , <i>Samolus repens</i> , <i>Sarcocornia quinqueflora</i> and <i>Sporobolus virginicus</i> . Species richness is low (mean 17.5 species/plot). This community is restricted to the eastern side of the plain and adjacent to the Peel-Harvey Estuary. This TEC overlaps with the Survey Area.
Herb rich saline shrublands in clay pans	EBPC Act: CE WC Act: VU	This community supports unique suites of geophytes and annual flora that germinates, grows and flowers sequentially as these areas dry over summer, producing a floral display for over three months. Clay pans have a high species richness, a number of local endemics and are the most floristically diverse of the Swan Coastal Plain Wetlands. The community is dependent on the hydrological functioning of the clay pan. Furthermore it supports a diverse array of fauna that dependent on various aspects of the vegetation and surface water to provide shelter, food and suitable breeding conditions. The Australian Government (2012) approved the conservation advice for this community on 6 March 2012 from where this information is derived. This TEC overlaps with the Survey Area.
Southern <i>Eucalyptus gomphocephala</i> – <i>Agonis flexuosa</i> woodlands	DPaW: P3	Listed on the DPaW PEC list version 24 (2016). This PEC occurs south of Woodman Point. It has been recorded from the Karrakatta, Cottesloe and Vasse units. Dominants other than Tuart were occasionally recorded, including <i>Corymbia calophylla</i> at Paganoni block and <i>Eucalyptus decipiens</i> at Kemerton. Tuart formed the overstorey at Nirimba. Located 5 km southwest of the Survey Area. The preliminary field survey suggests this community is not present in the Survey Area.

Community	Conservation Status ¹	Description
Subtropical and Temperate Coastal Saltmarsh	EPBC Act: V	This TEC occurs within a narrow margin of the Australian coastline spanning across six State jurisdictions. The distribution of the TEC is determined by interactions between biota and physical factors, with zonation and mosaics common. The community provides important nursery habitat for fish and prawn species and insects are abundant and an important food source and/or pollinators. Australian Government (2010) published the approved conservation advice from which this information was derived. This TEC overlaps with the Survey Area.
Banksia Woodlands of the Swan Coastal Plain	EPBC Act: E WC Act: various.	Woodland of <i>Banksia</i> species with scattered eucalypts and other tree species over a species rich mix of sclerophyllous shrubs, graminoids, and forbs. The community shows high endemism and considerable local variation in species composition across its range. This TEC was listed under the EPBC Act on 16 September 2016. It was therefore not identified during the desktop assessment. It is considered likely to occur based on the indicative map of locations provided on the DotEE website (2016).

1. Conservation codes are explained in Appendix A



<p>PROJECT ID 60100953 CREATED BY DGF APPROVED BY JL LAST MODIFIED 29 NOV 2016</p> <p>AECOM www.aecom.com</p> <p>DATUM GDA 1994, PROJECTION MGA ZONE 50</p> <p>0 110 220 330 440 metres</p> <p>1:15,000 when printed at A4</p>	<p>LEGEND</p> <p> Survey Area</p> <p>Threatened and Priority Ecological Communities</p> <ul style="list-style-type: none"> Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain, Vulnerable Herb rich saline shrublands in clay pans, Vulnerable Subtropical and Temperate Coastal Saltmarsh, Vulnerable (EPBC) <p><small>Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community</small></p>	<p>Desktop results for Threatened and Priority Ecological Communities</p> <hr/> <p>MAIN ROADS</p> <p><i>NIRIMBA BIOLOGICAL ASSESSMENT</i></p>	<p>Figure 5</p>
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4.2 Threatened and Priority Flora

The database search results showed 20 conservation significant flora species occur in the vicinity of the Survey Area. These include three species listed under the EPBC Act and the WC Act and 17 species listed by DPaW as Priority species.

Of the 20 species, only one species is considered 'unlikely' to occur, three 'may occur' and 16 species are considered likely to occur. The close proximity of the Peel-Harvey estuary, the incorporation of several seasonally-wet wetlands, and riparian vegetation associated with the Peel-Harvey estuary, means there is suitable habitat present for many conservation significant species that prefer winter-wet areas.

Details of all conservation significant species identified in the desktop assessment are outlined in Table 11.

Table 11 Threatened and Priority flora that occur in the vicinity of the Survey Area including their conservation status, habitat and likelihood of occurrence

Taxon	Conservation Status ¹	Habitat ²	Likelihood of Occurrence
<i>Acacia benthamii</i>	DPaW: P2	Typically on limestone breakaways.	May. Records in vicinity but no suitable habitat present.
<i>Blennospora doliiformis</i>	DPaW: P3	Grey or red clay soils over ironstone. Seasonally-wet flats.	Unlikely. One record from 1993 8 km north east and no suitable habitat present.
<i>Dillwynia dillwynioides</i>	DPaW: P3	Grows on sandy soils in winter-wet depressions.	Likely. Known records in vicinity and suitable habitat present.
<i>Diuris drummondii</i>	EPBC Act: V WC Act: VU	Low-lying depressions in peaty and sandy clay swamps. Can be in several centimetres of water during the summer flowering period.	Likely. Known records in vicinity and suitable habitat present.
<i>Drakaea elastica</i>	EPBC Act: E WC Act: CR	White or grey sand. Low-lying situations adjoining winter-wet swamps.	Likely. Known records in vicinity and suitable habitat present.
<i>Eryngium pinnatifidum</i> subsp. <i>Palustre</i> (G.J. Keighery 13)	DPaW: P3	DPaW record from 1995 in close proximity on winter wet flats behind beach on grey sandy clay over clay.	Likely. Known records in vicinity and suitable habitat present.
<i>Eryngium pinnatifidum</i> subsp. <i>Umbraphilum</i> (G.J. Keighery 13967)	DPaW: P2	No habitat information available. Recorded in adjacent native vegetation west of Survey Area.	Likely. Known records in vicinity.
<i>Eryngium</i> sp. <i>Ferox</i> (G.J. Keighery 16034)	DPaW: P3	No habitat information available. Recorded more than 5 km from Survey Area.	Likely. Known records in vicinity.
<i>Gastrolobium</i> sp. <i>Harvey</i> (G.J. Keighery 16821)	DPaW: P2	Black peaty sandy clay, brown sandy clay. Winter-wet flats, margins of billabongs.	May. Records are further inland than Survey Area and suitable habitat partially present.
<i>Hemigenia microphylla</i>	DPaW: P3	Sandy clay, peaty clay, granite. Winter-wet depressions.	Likely. Known records in vicinity and suitable habitat present.

Taxon	Conservation Status ¹	Habitat ²	Likelihood of Occurrence
<i>Meionectes tenuifolia</i>	DPaW: P3	No habitat information available. Recorded in adjacent native vegetation west of Survey Area.	Likely. Known records in vicinity.
<i>Myriophyllum echinatum</i>	DPaW: P3	Clay. Winter-wet flats. One record from 1993.	Likely. Known record in vicinity and suitable habitat present.
<i>Ornduffia submersa</i>	DPaW: P4	No habitat information available. Recorded in adjacent native vegetation west of the Survey Area.	Likely. Known records in vicinity and suitable habitat present.
<i>Phyllangium palustre</i>	DPaW: P2	Clay. Winter-wet claypans, low-lying seasonal wetlands.	Likely. Known records in vicinity and suitable habitat present.
<i>Rumex drummondii</i>	DPaW: P4	Winter-wet disturbed areas.	Likely. Known records in vicinity and suitable habitat present.
<i>Schoenus natans</i>	DPaW: P4	Winter-wet depressions.	Likely. Known records in vicinity and suitable habitat present.
<i>Schoenus</i> sp. Waroona (G.J. Keighery 12235)	DPaW: P3	Clay or sandy clay. Winter-wet flats.	Likely. Known records in vicinity and suitable habitat present.
<i>Synaphea stenoloba</i>	EPBC Act: E WC Act: CR	Loamy soils in low lying areas that are occasionally inundated. Associated with swampy heath vegetation with scattered <i>Nuytsia floribunda</i> . Known from one population in the vicinity on the corner of Greenlands Rd and Paull Rd.	Likely. Known records in vicinity and suitable habitat present.
<i>Tripterococcus</i> sp. Brachylobus (A.S. George 14234)	DPaW: P4	No habitat information available. Record from 2007 was from grey sand over laying clay that was burnt 2 years' prior.	May. One known record however no fire history on site.

1. conservation abbreviations are explained in Appendix A.

2. Information derived from the DOTEE Species Profile and Threats Database (2016) and Florabase (WA Herb 1998-)



<p>PROJECT ID 60100953 CREATED BY DGF APPROVED BY JL LAST MODIFIED 29 NOV 2016</p> <p>AECOM www.aecom.com</p> <p>DATUM GDA 1994, PROJECTION MGA ZONE 50 0 190 380 570 760 metres 1:25,000 when printed at A4</p>	<p>LEGEND</p> <p> Survey Area</p> <p>TPFL</p> <ul style="list-style-type: none"> ▲ T ▲ 1 ▲ 2 ▲ 3 ▲ 4 <p>WA Herb</p> <ul style="list-style-type: none"> ■ T ■ 1 ■ 2 ■ 3 ■ 4 	<p>Desktop results for Threatened and Priority flora species</p> <p>MAIN ROADS</p> <p><i>NIRIMBA BIOLOGICAL ASSESSMENT</i></p>
		<p>Figure 6</p>

4.3 Threatened and Priority Fauna

Forty four Threatened, Priority or Migratory species were identified from the DPaW Threatened and Priority flora, WAHERB database (including WAM records) and EPBC Act Protected Matters search of the Survey Area. Of these, 38 are bird species, four are mammal species and two are invertebrate species. Of the 44 species identified, those that are considered likely to or may occur within the Survey Area are listed in Table 12.

For further descriptions and likelihood analysis refer to Appendix C.

Table 12 Conservation significant fauna species that may or are likely to occur in the Survey Area

Species	Vernacular	Conservation Status ¹		Likelihood
		Commonwealth	State/DPaW	
<i>Calyptorhynchus latirostris</i>	Carnaby's Black Cockatoo	E	EN	Likely to occur
<i>Calyptorhynchus baudinii</i>	Baudin's Black Cockatoo	V	EN	Likely to occur
<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black Cockatoo	V	VU	Likely to occur
<i>Dasyurus geoffroii</i>	Chuditch, Western Quoll	V	VU	Likely to occur
<i>Calidris ferruginea</i>	Curlew Sandpiper	V	IA	May occur
<i>Calidris tenuirostris</i>	Great Knot	V	IA	May occur
<i>Charadrius mongolus</i>	Lesser Sand Plover	E	IA	May occur
<i>Falco peregrinus</i>	Peregrine Falcon	-	IA	May overfly the Survey Area
<i>Ctenotus ora</i>	Coastal Plains Skink	-	P3	May occur
<i>Tyto novaehollandiae novaehollandiae</i>	masked owl (southwestern)	-	P3	May occur
<i>Isoodon obesulus fusciventer</i>	Quenda, Southern Brown Bandicoot	-	P4	Likely to occur
<i>Oxyura australis</i>	Blue-billed Duck	-	Priority 4	May occur

1. Conservation codes are explained in Appendix A

4.3.1 Black Cockatoo Species

Carnaby's Black Cockatoo

Carnaby's Black Cockatoo (Carnaby's) is endemic to the southwest of Western Australia, extending from the Murchison River to Esperance, and inland to Coorow, Kellerberrin and Lake Cronin (DotEE, 2016). This black cockatoo has a white patch on its cheek, white bands on its tail, and a strong curved bill.

Carnaby's feed on seeds, nuts and flowers of a variety of native and exotic plants. Feed plants include various proteaceous species (e.g. *Banksia*, *Grevillea* and *Hakea*), *Corymbia calophylla* (Marri), *Eucalyptus* (e.g. Jarrah [*Eucalyptus marginata*]), and seeds from the cones of Pine trees (*Pinus* sp.).

Carnaby's display strong pair bonds and nest in the hollows of live or dead mature eucalypts including Salmon Gum (*Eucalyptus salmonophloia*), York Gum (*Eucalyptus loxophleba* subsp. *loxophleba*), Flooded Gum (*Eucalyptus rudis*), Karri (*Eucalyptus diversicolor*), Marri (*Corymbia calophylla*), Wandoo (*Eucalyptus wandoo*) and Tuart (*Eucalyptus gomphocephala* [DSEWPaC, 2012]). Nest hollows generally range from 2.5-12 m above ground, size of entrance from 23-30 cm and depth of hollows from 1-2.5 m (Johnstone and Storr, 1998). There are several small resident populations on the northern Swan Coastal Plain at Boonanarring, Mooliabeenee and Yanchep National Park and on the southern Swan Coastal Plain at Lake Clifton (50–100 pairs), also near Bunbury and probably at Baldivis (DotEE, 2016). The species appears to be expanding its current breeding range westward and south into the Jarrah-Marri forests of the Darling Range and into the Tuart forests of the SCP (Johnstone and Kirkby, 2006). After breeding, Carnaby's Black Cockatoo disperse to the higher rainfall coastal areas of the south-west of Western Australia to feed in late December to July (DotEE, 2016). Breeding has been recorded from early July to mid-December.

Carnaby's has undergone a dramatic decline of approximately 50 percent in the past 45 years, with the main contributing factors the clearing of core breeding habitat in the wheatbelt, the deterioration of nesting hollows, and clearing of foraging habitat.

Forest Red-tailed Black Cockatoo

The Forest Red-tailed Black Cockatoo (FRTBC) is endemic to the south-west humid and semi-humid zones of Western Australia, where it inhabits dense Jarrah, Karri and Marri forests which receive more than 600 mm average annual rainfall (DSEWPaC, 2012). The species has a pair of black central tail feathers and a bright red, orange or yellow barring on the tail.

This species predominantly feeds in eucalypt forests, preferring Marri (*Corymbia calophylla*) and Jarrah (*Eucalyptus marginata*) seeds, but also feeding in Blackbutt (*Eucalyptus patens*), Albany Blackbutt (*Eucalyptus staeri*), Karri (*Eucalyptus diversicolor*), Sheoak (*Allocasuarina fraseriana*) and Snottygobble (*Persoonia longifolia*) (Johnstone, 2016 pers. comm.). FRTBC are monogamous and pairs nest in tree hollows from 6.5–33 m above ground. Most nests are in very large and very old, mature Marri (*Corymbia calophylla*) (Johnstone, Kirkby & Sarti, 2013), though they will nest in other eucalypts such as Tuart (Johnstone, 2016 pers. comm.).

Formerly common, but now rare to uncommon and patchily distributed, the FRTBC has disappeared from about 30% of its former range. It has suffered a marked decline in numbers over the past 60 years because of the destruction and fragmentation of habitat (especially Jarrah-Marri forest), the apparent decline in Marri along the eastern side of the Darling Scarp (possibly due to climate change), logging, the impact of competitors for nest hollows, and fire (Chapman, 2008; Garnett *et al.*, 2011).

5.0 Field Results

5.1 Vegetation

5.1.1 Threatened Ecological Communities

Four TECs are known to occur in the Survey Area according to DPaW database records accessed in the desktop review. These communities include:

- Herb Rich Saline Shrublands in Clay Pans – EPBC Act listed as Critically Endangered
- Subtropical and Temperate Coastal Saltmarsh – EPBC Act listed as Vulnerable
- Forests and Woodlands of Deep Seasonal Wetlands of the SCP (FCT15) – State-listed as Vulnerable
- Banksia Woodlands of the Swan Coastal Plain – EPBC Act listed as Endangered. Listed under the EPBC Act on 16 September 2016.

The Herb Rich Saline Shrublands in Clay Pans TEC was not able to be accurately verified lacking key diagnostic characteristics or FCT analysis. Due to the direct overlap of a known occurrence of this TEC, it has been mapped as occurring in the Survey Area.

The Subtropical and Temperate Coastal Saltmarsh TEC was confirmed as present by assessing the quadrat and observational data to key diagnostic characteristics. This community is confirmed to occur in the Survey Area.

The Forests and Woodlands of Deep Seasonal Wetlands TEC corresponds to a Gibson *et al.* (1994) floristic community type (FCT). FCT analysis was undertaken using the more recent Keighery *et al.* (2012) dataset and quadrat data. This TEC has been confirmed as occurring in the Survey Area.

The Banksia Woodlands of the Swan Coastal Plain community has been confirmed as occurring in the Survey Area by assessing quadrat data against the key diagnostic characteristics of this community.

A breakdown of TEC presence within each lots is provided in Table 13 and shown in Figure 8. The detailed assessment results for each TEC are described below.

Table 13 Extent of TEC within the Survey area

TEC	Lot 295	Lot 842	Lot 1262	Total
Herb Rich Saline Shrublands in Clay Pans	0.48	22.41	13.87	36.76
Subtropical and Temperate Coastal Saltmarsh	0.48	22.41	13.87	36.76
Forests and Woodlands of Deep Seasonal Wetlands of the SCP	11.17	22.41	13.87	47.45
Banksia Woodlands of the Swan Coastal Plain	33.03	31.21	42.12	106.36

5.1.1.1 Herb rich saline shrublands in clay pans – EPBC Act Critically Endangered, WC Act Vulnerable

This TEC buffer overlaps with the Survey Area and corresponds to the Subtropical and Temperate Coastal Saltmarsh TEC described further below. The approved conservation advice (Australian Government, 2012) does not provide key diagnostic features and the community is not associated with a Gibson FCT. As the known occurrence of this community directly overlaps with community MrTpCc located in the northwest corner of the Survey Area, it has been assumed that this community in 'Good' or better condition represents the TEC. Representative photographs are provided in Plate 1.

5.1.1.2 Subtropical and Temperate Coastal Saltmarsh – EPBC Act Vulnerable

Community MrTpCc is considered to represent the Subtropical and Temperate Coastal Saltmarsh TEC. The national listing focusses on legal protection on remaining areas or patches of this community that are most functional, relatively natural and in relatively good condition (Australian Government, 2010). For this reason, only the vegetation considered in 'Good' or better condition was considered to represent this TEC.

The key diagnostic features for this community have been addressed in Table 14. Representative photographs are provided in Plate 1.

Table 14 Key diagnostic features of the Subtropical and Temperate Coastal Saltmarsh

Key Diagnostic Feature	Community in Survey Area
Occurs south of 23° 37' S latitude - from the central Mackay coast on the east coast of Australia, southerly around to Shark Bay on the west coast of Australia (26° latitude), and including the Tasmanian coast and islands within the above range	Yes
Occurs on the coastal margin, along estuaries and coastal embayments and on low wave energy coasts	Yes
Occurs on places with at least some tidal connection, including rarely-inundated supratidal areas, intermittently opened or closed lagoons, and groundwater tidal influences, but not areas receiving only aerosol spray	Yes
Occurs on sandy or muddy substrate and may include coastal clay pans (and the like)	Yes
Consists of dense to patchy areas of characteristic coastal saltmarsh plant species (i.e. salt tolerant herbs, succulent shrubs or grasses, that may also include bare sediment as part of the mosaic)	Yes
Proportional cover by tree canopy such as mangroves, Melaleucas or Casuarinas is not greater than 50%, nor is proportional ground cover by seagrass greater than 50%.	Yes
Condition thresholds	
Patch size greater than 0.4 ha	Yes
Ongoing tidal regime	Yes

5.1.1.3 Forests and woodlands of deep seasonal wetlands of the SCP – State-listed TEC Vulnerable

A portion of a woodland community overlaps with the buffer of this TEC within the Survey Area.

FCT analysis was undertaken to determine the presence of this TEC. Using the Keighery *et al.* (2012) dataset, two subsets were derived including:

- sites representing FCT15
- sites that are located in close proximity to the Survey Area.

All three quadrats within community MrTpCc were compared to Keighery *et al.* (2012) sites located in close proximity to the Survey Area. They showed the highest similarity to site CARAB 1 which is classified as SCP15. Furthermore, when analysis was carried out with only FCT15 sites, similarity increased above 15% (Table 15).

The low percentage of similarity is due to the limited species recorded at Nirimba compared to the Keighery *et al.* (2012) dataset where all sites have been 'scored' on more than two occasions. DPaW (2015b) suggest that using FCT analysis for a dataset where no re-sampling has occurred can be potentially misleading. More than two sampling events are generally recommended for wetland communities to capture a comprehensive presence/absence list of species present.

The nearest neighbour cluster analysis shows close clustering with McLart-1, a site that represents FCT13 (Figure 7). FCT13 represents deeper wetlands that commonly occur south from Serpentine (Gibson *et al.* 1994). It can therefore be concluded with reasonable confidence that this community is a representation of FCT15.

Table 15 Floristic Community Type analysis of SCP15 and AECOM quadrats

Quadrat	Percentage Similarity of quadrats to Keighery <i>et al.</i> (2012) Sites in close proximity	Percentage Similarity of FCT15 sites
Q07	24% with CARAB-1 (represents FCT15)	24% with CARAB-1
Q08	16.67% with CARAB-1 (represents FCT15)	16.67% with xpearce0
Q11	18.18% with CARAB-1 (represents FCT15)	19.35% with xpearce0

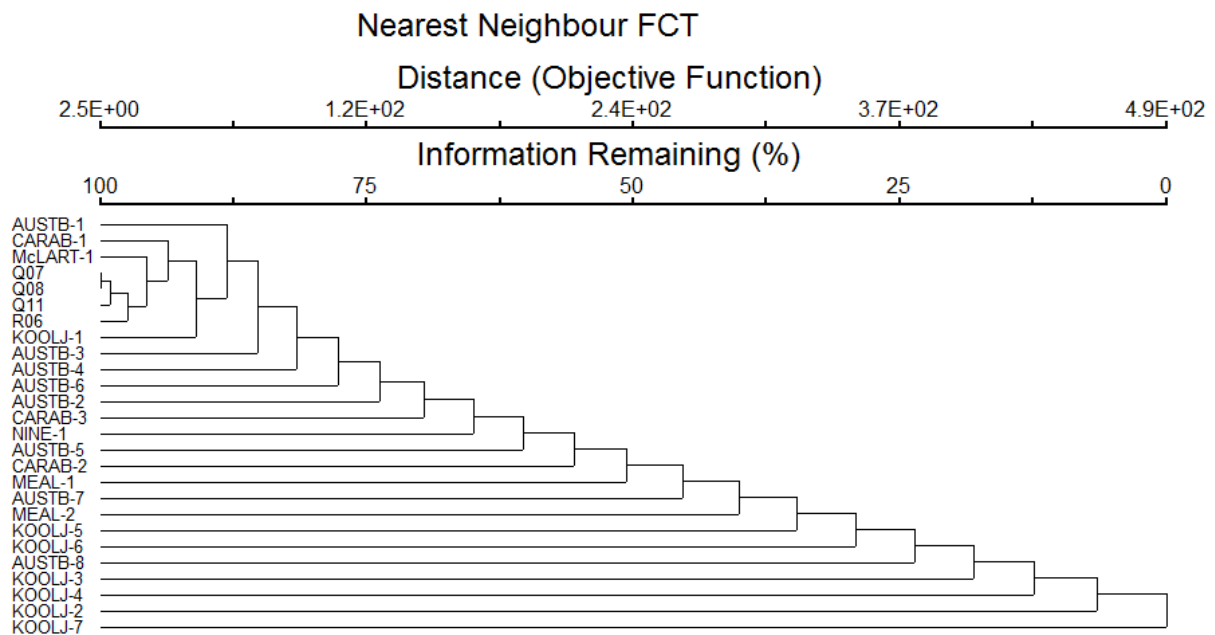


Figure 7 Nearest neighbour cluster dendrogram for AECOM sites located in the TEC compared to Keighery (2012) plots located in close proximity



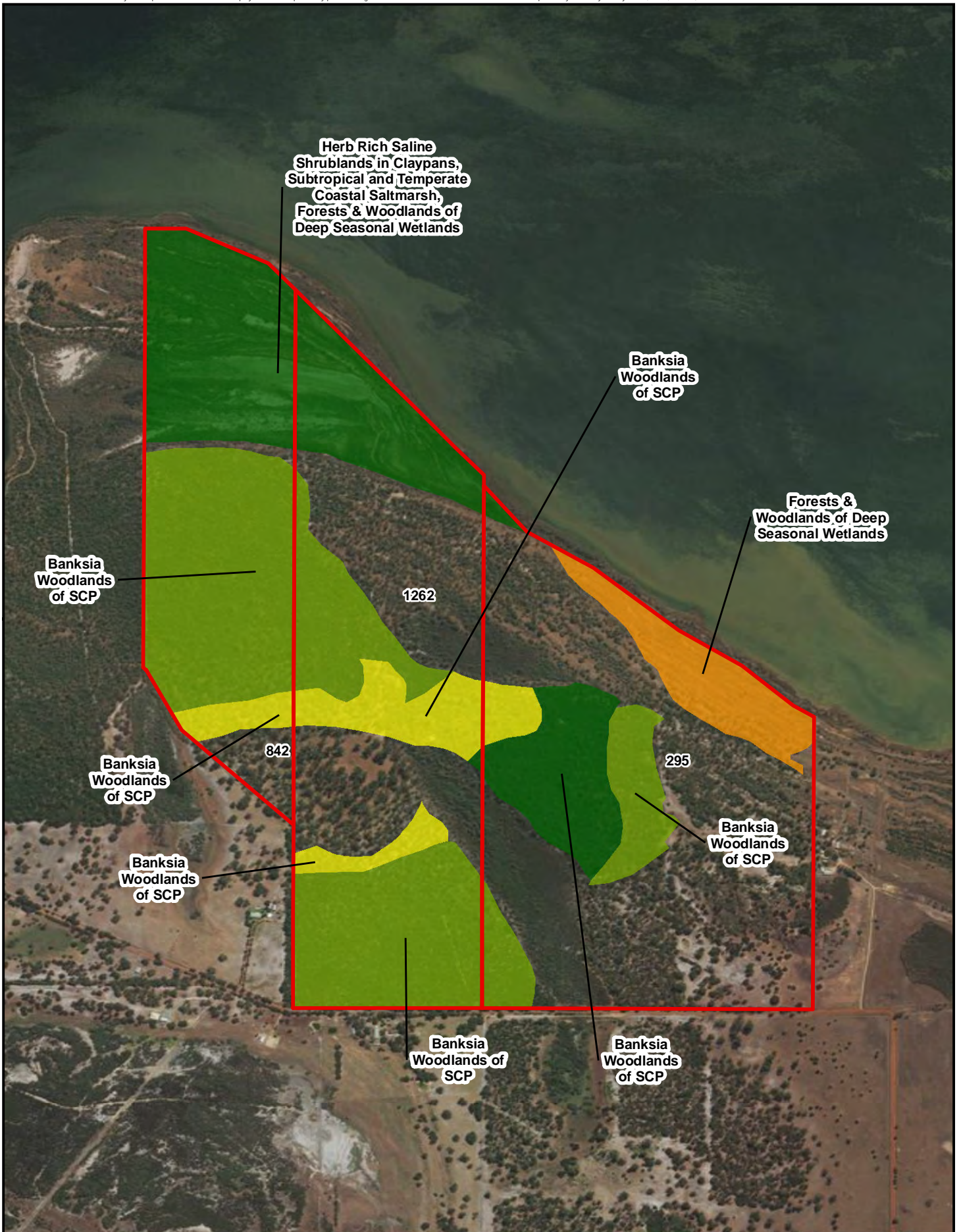
Plate 1 Peel-Harvey riparian vegetation

5.1.1.4 Banksia Woodlands of the Swan Coastal Plain – EPBC Act Endangered

The Nirimba Survey Area supports two patches of native vegetation, as outlined in the vegetation map. This includes patch one, comprising 27.14 ha of BaHhOe. This patch is isolated from the larger patch two, comprising 79.30 ha of BaHhOe and BaKgMr.

Patch one includes quadrats 1 and 2, and relevés 1 and 2. Patch 2 includes quadrats 5, 6, and 14 and relevés 4, 5 and 10. Quadrat data was used to provide responses for species composition and structure. Both patches are confirmed to represent the Banksia Woodlands TEC based on an assessment against the key diagnostic characteristics. The complete assessment is provided in Appendix D.

Patch one was mapped as 'Very Good' condition. This patch is 27.14 ha, thereby far exceeding the minimum patch size. Patch two is of varying condition including Good, Very Good and Excellent. All patches are above 2 ha in size thereby complying to the size requirements as outlined above. The extent of this community and associated condition is shown in Figure 8.




<p>PROJECT ID 60100953 CREATED BY DGF APPROVED BY JL LAST MODIFIED 12 JAN 2017</p> <p>AECOM www.aecom.com</p> <p>DATUM GDA 1994, PROJECTION MGA ZONE 50</p> <p>0 110 220 330 440 metres</p> <p>1:15,000 when printed at A4</p>	<p>LEGEND</p> <p> Survey Area</p> <p>TEC Condition</p> <p> Excellent</p> <p> Very Good</p> <p> Good</p> <p> Degraded</p> <p><small>Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community</small></p>	<p>Threatened Ecological Communities</p> <hr/> <p>MAIN ROADS</p> <p>NIRIMBA BIOLOGICAL ASSESSMENT</p> <p>Figure 8</p>
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5.1.2 Other communities



A total of six vegetation communities were observed and mapped within the Survey Area. These include two wetland communities, three forest communities and one woodland community. The community codes, descriptions and photographs are presented in Table 16 and are spatially presented in Figure 9.

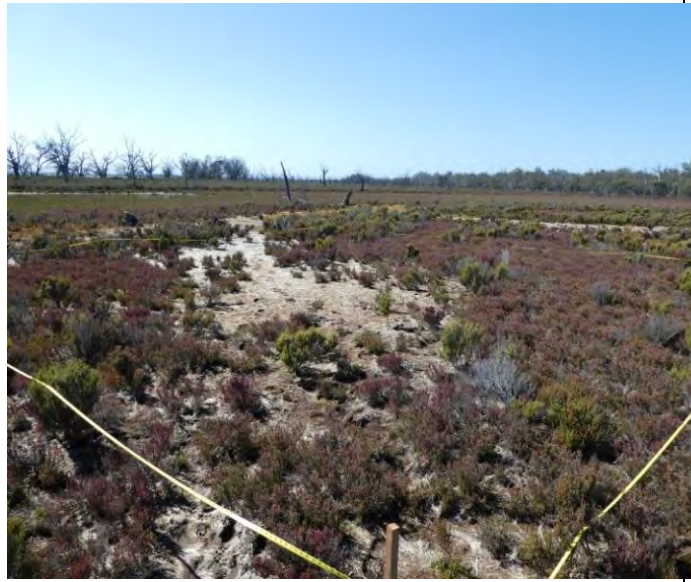
A species by community matrix is presented in Appendix E. Relevè and Quadrat data is provided in Appendix G.

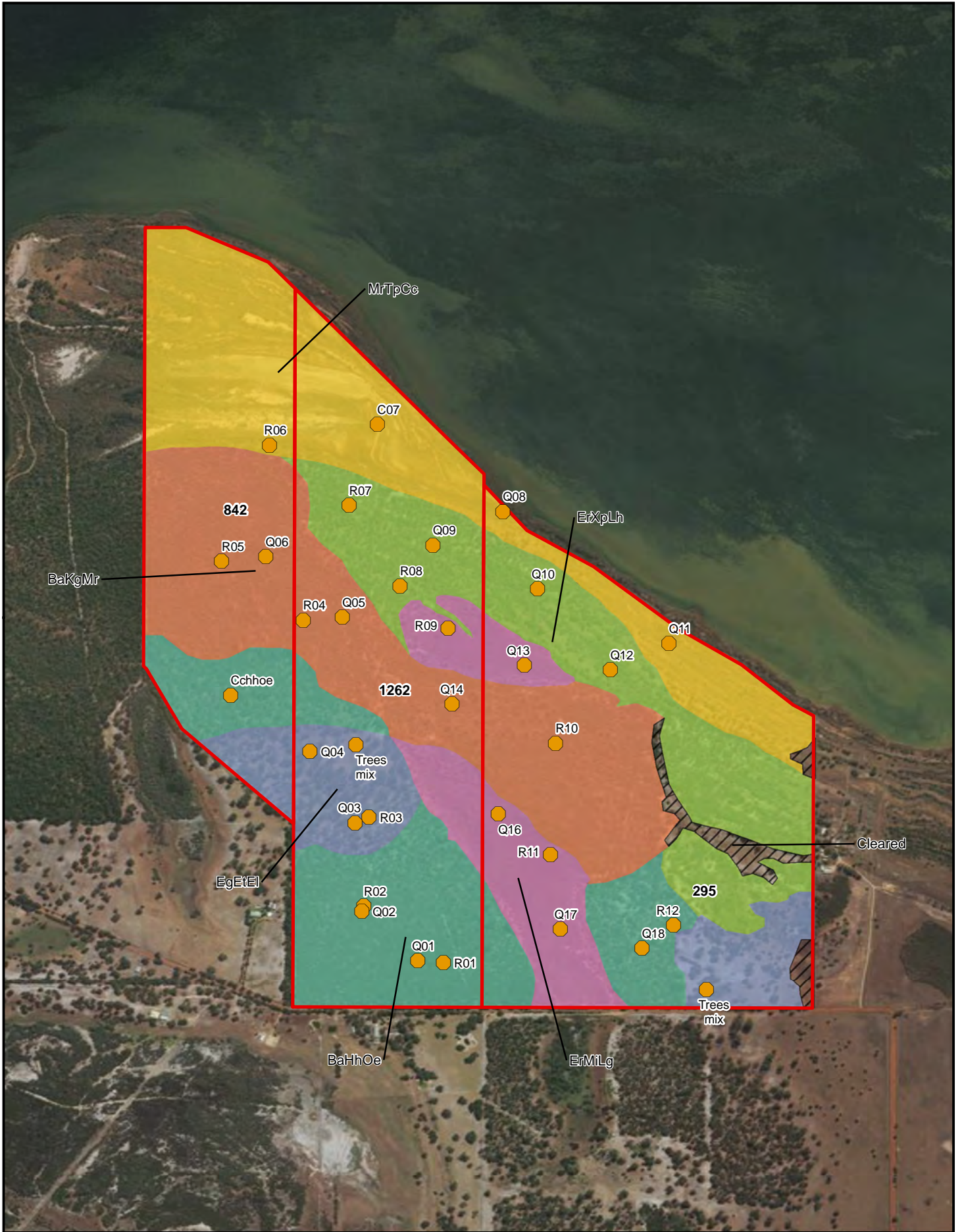
Table 16 Vegetation community codes, descriptions and representative photograph

Code	Description	Photograph
Woodlands		
BaHhOe	<p><i>Corymbia calophylla</i> and <i>Eucalyptus marginata</i> medium woodland over <i>Banksia attenuata</i>, <i>Allocasuarina fraseriana</i> and <i>Banksia grandis</i> low open forest over <i>Hibbertia hypericoides</i>, <i>Xanthorrhoea preissii</i>, <i>Macrozamia riedlei</i> mid shrubland over <i>Opercularia echinocephala</i>, <i>Ursinia anthemoides</i>, <i>Pyrorchis nigricans</i>, <i>Trachymene pilosa</i> and <i>Isotropis cuneifolia</i> subsp. <i>cuneifolia</i> low sparse forbland and *<i>Briza maxima</i>, <i>Tetrarrhena laevis</i> and *<i>Lagurus obovatus</i> low isolated grassland.</p> <p>Community BaHhOe was recorded on grey to brown sandy loam soils on undulating terrain. The vegetation condition varied between Degraded to Very Good.</p> <p>Area: 46.49 ha Lot 295: 11.90 ha Lot 842: 8.34 ha Lot 1262: 26.25 ha Survey effort: three quadrats (Q01, Q02, Q03) and four relevés (R01, R02, R12, R13). Species richness: 58 native and 19 weed species.</p>	

Code	Description	Photograph
BaKgMr	<p><i>Eucalyptus gomphocephala</i> and <i>Eucalyptus rudis</i> subsp. <i>rudis</i> mid open woodland over <i>Banksia attenuata</i>, <i>Allocasuarina fraseriana</i> and <i>Banksia grandis</i> low open forest over <i>Kunzea glabrescens</i> tall shrubland over <i>Macrozamia riedlei</i>, <i>Xanthorrhoea preissii</i> and <i>Acacia pulchella</i> var. <i>pulchella</i> mid open shrubland over <i>Hypochaeris glabra</i>, <i>Pyrorchis nigricans</i>, <i>Ursinia anthemoides</i>, <i>Trachymene pilosa</i>, <i>Drosera erythrorhiza</i> and <i>Isotropic cuneifolia</i> subsp. <i>cuneifolia</i> low open forbland and <i>Briza maxima</i>, <i>Briza minor</i> and <i>Aira caryophyllea</i> low sparse grassland.</p> <p>This community was recorded on flat grey sandy soils ranging from Good to Excellent condition.</p> <p>Area: 59.87 ha Lot 295: 21.14 ha Lot 842: 22.87 ha Lot 1262: 15.87 ha Survey effort: three quadrats (Q05, Q06, Q14) and three relevés (R04, R05, R10). Species richness: 46 native and 18 weed species.</p>	
ErXpLh	<p><i>Eucalyptus rudis</i> subsp. <i>cratyantha</i> (P3) mid woodland over <i>Melaleuca raphiophylla</i> and <i>Melaleuca preissiana</i> low open woodland over <i>Kunzea glabrescens</i>, <i>Melaleuca incana</i> subsp. <i>incana</i> and <i>Jacksonia sternbergiana</i> tall sparse shrubland over <i>Xanthorrhoea preissii</i> and <i>Macrozamia riedlei</i> mid sparse shrubland over <i>Ornithopus pinnatus</i>, <i>Hypochaeris glabra</i>, <i>Arctotheca calendula</i> and <i>Ursinia anthemoides</i> and <i>Chaetanthus aristatus</i>, <i>Juncus kraussii</i> and <i>Juncus pallidus</i> tall sparse rushland</p> <p>Community ErXpLh represents the transition between riparian wetland vegetation and terrestrial vegetation. It is located on flat dark brown sandy loam soils. Condition was recorded as Degraded to Good with evidence of historical clearing, grazing and weed invasion.</p> <p>Area: 42.53 ha Lot 295: 28.45 ha Lot 842: 0.05 ha Lot 1262: 14.03 ha Survey effort: three quadrats (Q09, Q10, Q12) and two relevés (R07, R08). Species richness: 23 native and 12 weed species.</p>	

Code	Description	Photograph
EgEtEI	<p><i>Eucalyptus gomphocephala</i> <i>Corymbia calophylla</i> and <i>Eucalyptus marginata</i> mid open forest over <i>*Euphorbia terracina</i>, <i>*Lupinus cosentinii</i>, <i>*Trifolium campestre</i>, <i>*Arctotheca calendula</i> and <i>*Trachyandra divaricata</i> low forbland and <i>*Ehrharta longiflora</i>, <i>*Bromus diandrus</i> and <i>*Lolium rigidum</i> tall closed grassland</p> <p>This community represents paddocks that support stands of native tree species. Due to long-term grazing and clearing native understorey species were generally lacking. EgEtEI was recorded on undulating terrain on sandy loam soils. Condition ranged from Degraded to Good.</p> <p>Area: 22.86 ha Lot 295: 8.57 ha Lot 842: 3.83 ha Lot 1262: 10.46 ha Survey effort: two quadrats (Q03, Q04), one relevé (R03) and two opportunistic observations. Species richness: eight native and 13 weed species.</p>	
Wetlands		
ErMiLg	<p><i>Eucalyptus rudis</i> subsp. <i>rudis</i> mid open woodland over <i>Melaleuca raphiophylla</i> <i>Melaleuca preissiana</i> and <i>Banksia littoralis</i> low woodland over <i>Melaleuca incana</i> subsp. <i>incana</i>, <i>Calothamnus lateralis</i>, <i>Melaleuca teretifolia</i>, <i>Kunzea glabrescens</i> and <i>Astartea affinis</i> tall shrubland over <i>Lepyrodia glauca</i>, <i>Hypolaena exsulca</i> and <i>Chaetanthus aristatus</i> tall rushland over <i>Pimelea lanata</i>, <i>*Hypochoeris glabra</i>, <i>Hibbertia stellaris</i> and <i>Microtis media</i> low sparse forbland.</p> <p>Community ErMiLg is restricted to two wetlands in the Survey Area. Soils were loamy clays, black in colour and inundated at the time of the field survey. Low impact weeds were recorded in this community, however condition was still considered to be Excellent. This community supports one population of the Priority 3 <i>Dillwynia dillwynioides</i> (Q13) and is therefore considered locally significant.</p> <p>Area: 23.74 ha Lot 295: 15.37 ha Lot 842: 0.00 ha Lot 1262: 8.47 ha Survey effort: three quadrats (Q13, Q16, Q17) two relevés (R09, R11) Species richness: 38 native and nine weed species.</p>	

Code	Description	Photograph
MrTpCc	<p><i>Eucalyptus rudis</i> subsp. <i>rudis</i> and <i>Allocasuarina fraseriana</i> mid isolated trees over <i>Melaleuca raphiophylla</i> and <i>Melaleuca preissiana</i> low open woodland over <i>Hypolaena exsulca</i> and <i>Baumea rubiginosa</i> tall sparse to open rushland with <i>Tecticornia ?pergranulata</i> subsp. <i>pergranulata</i>, <i>Tecticornia ?halocnemoides</i> and <i>Tecticornia ?lepidosperma</i> low samphire shrubland and <i>Juncus pallidus</i>, <i>Triglochin mucronata</i> and <i>Juncus bufonius</i> low sparse sedgeland and <i>*Cotula coronopifolia</i>, <i>*Arctotheca calendula</i>, <i>*Ursinia anthemoides</i> and <i>Apium prostratum</i> var. <i>prostratum</i> low sparse forbland</p> <p>The vegetation along the edge of the Peel-Harvey Inlet has two distinct “zones” including woodland and rushes along the edge between terrestrial and inundated vegetation, grading into the samphire shrubland. Condition varied from Degraded to Excellent. This community is regionally significant as it represents several TECs as discussed in Section 5.1.1.</p> <p>Area: 50.99 ha Lot 295: 12.18 ha Lot 842: 23.43 ha Lot 1262: 15.38 ha Sites: Three quadrats (Q07, Q08, Q11) and one relevé (R06) Species richness: 16 native and nine weed species.</p>	



PROJECT ID 60100953
 CREATED BY DGF
 APPROVED BY JL
 LAST MODIFIED 12 JAN 2017

AECOM
 www.aecom.com

DATUM GDA 1994, PROJECTION MGA ZONE 50

0 110 220 330 440
 metres

1:15,000 when printed at A4

LEGEND

- Sites
- Survey Area

Community

- BaHhOe
- BaKgMr
- Cleared
- EgEtEl
- ErMiLg
- ErXpLh
- MrTpCc

Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Vegetation Community Mapping

MAIN ROADS

NIRIMBA BIOLOGICAL ASSESSMENT

Figure
9

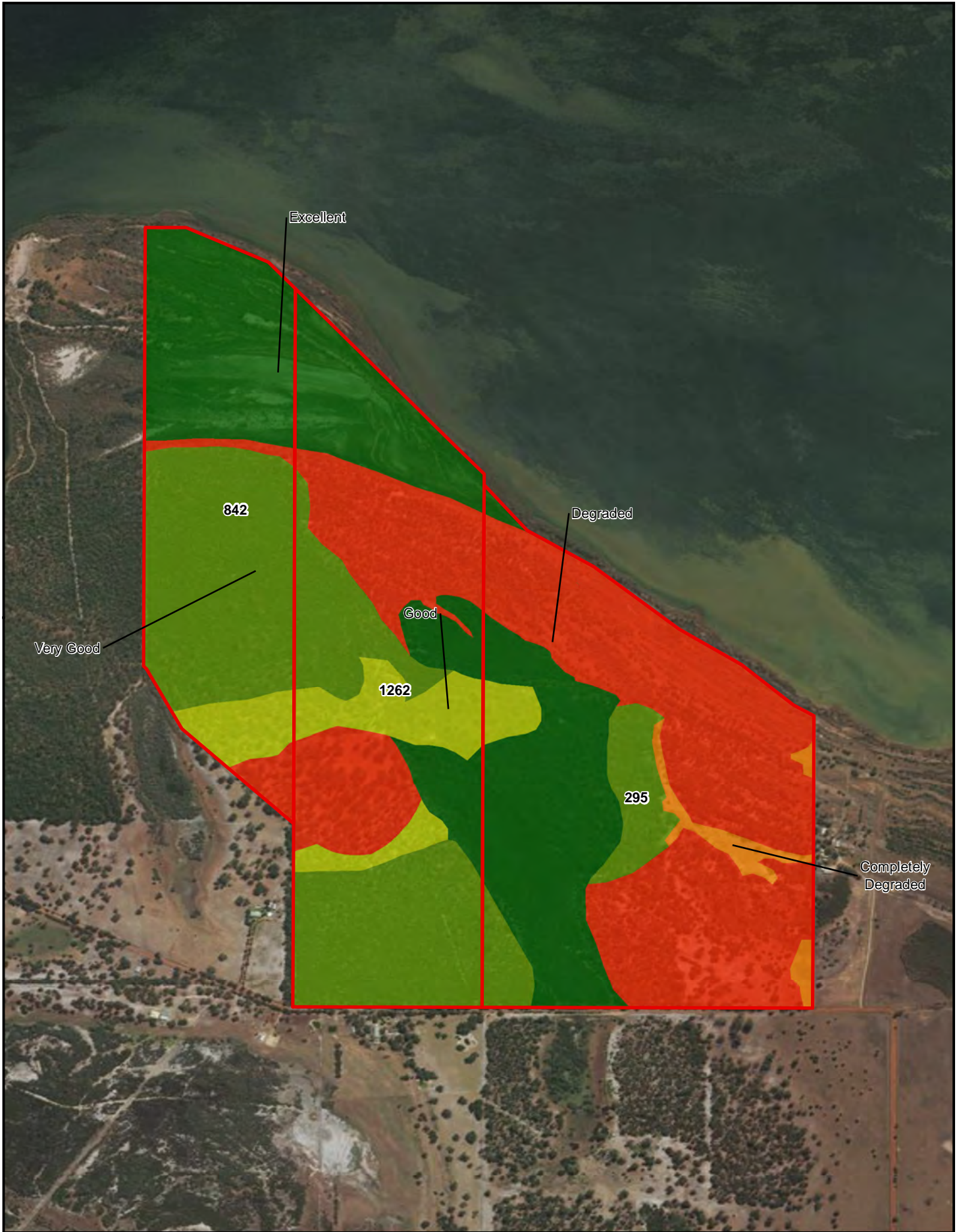
5.1.3 Vegetation condition

The condition of native vegetation in the Survey Area varied from Completely Degraded (cleared) to Excellent condition, with the majority of the Survey Area in Excellent or Very Good condition (57%; Table 17). Areas of Excellent condition included the wetlands (mapped as such on the Geomorphic wetlands database) and a small area adjacent to the wetland.

Weeds were observed regularly as the Survey Area was traversed on foot. Parts of the Survey Area have been cleared in the past. In these areas only the tree species and hardy shrubs such as *Xanthorrhoea* and *Kunzea* remain. Edge effects from adjacent paddocks, and erosion from the Peel-Harvey estuary, are also contributing to the degradation of the site.

Table 17 Extent of varying vegetation condition mapped in the Survey Area

Condition	Extent (ha)				Percentage of Survey Area
	Lot 295	Lot 842	Lot 1262	Total	
Excellent	28.38	22.41	22.51	73.30	29%
Very Good	9.59	28.44	31.26	69.29	28%
Good	2.22	4.64	10.96	17.82	7%
Degraded	57.31	3.04	25.72	86.07	34%
Completely Degraded	4.01	0.00	0.00	4.01	2%
Total	101.51	58.53	90.45	250.48	100%



<p>PROJECT ID 60100953 CREATED BY DGF APPROVED BY JL LAST MODIFIED 12 JAN 2017</p> <p>AECOM www.aecom.com</p> <p>DATUM GDA 1994, PROJECTION MGA ZONE 50</p> <p>0 110 220 330 440 metres</p> <p>1:15,000 when printed at A4</p>	<p>LEGEND</p> <p> Survey Area</p> <p>Condition</p> <ul style="list-style-type: none"> Excellent Very Good Good Completely Degraded Degraded <p><small>Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community</small></p>	<p>Vegetation Condition Mapping</p> <hr/> <p>MAIN ROADS</p> <p><i>NIRIMBA BIOLOGICAL ASSESSMENT</i></p> <p style="text-align: right;">Figure 10</p>
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5.2 Flora

5.2.1 Threatened and Priority flora

Two Priority flora species were recorded during the field survey including the Priority 3 *Dillwynia dillwynioides* and the Priority 4 species *Eucalyptus rudis* subsp. *cratyantha*, discussed below.

Dillwynia dillwynioides – Priority 3

D. dillwynioides is in the pea (Fabaceae) family and commonly grows on sandy soils in winter-wet depressions. It was recorded at one location (Q13) in wetland vegetation. At the time of collecting this specimen it was not known to be a Priority therefore species counts were not obtained. Foliage cover was recorded as 0.2% (of a 10 x 10 m quadrat) indicating less than five specimens given its size (150cm tall).

Table 18 Population information for *Dillwynia dillwynioides* Priority 3

AECOM Population	DPaW and WAHerb Records ¹	WAH Vouchered Specimens
1 Population 1-4 individuals	4 populations Pop 12: 12 individuals (2006) Pop 16: 8 individuals (2007) Pop 22: no count taken (1998) Pop ?: no count taken (2007)	38 records

1. Informed by the database search results, Population numbers are registered by DPaW.

Eucalyptus rudis subsp. *cratyantha* – Priority 4

E. rudis subsp. *cratyantha* was collected during the August and October field surveys. The specimen was submitted to and confirmed by WAH. Its key distinguishing feature is the bigger fruits compared to the common *Eucalyptus rudis*. The habit of the tree in the Survey Area is smaller, and more often mallee growth form rather than the tall *E. rudis* commonly seen along rivers and winter-wet areas (Plate 2).

E. rudis subsp. *cratyantha* is the dominant tree species in community ErXpLh. Within this community this species is widespread, with a population of 1000+ individuals. The species does not appear to spread beyond vegetation community ErXpLh. The population is healthy, with recruitment occurring despite it growing in degraded vegetation impacted by historical clearing and grazing.

Lack of database records for this species indicates the population is locally significant. WAH vouchered specimens are often recorded in areas where the tree is the locally dominant canopy species.

Table 19 Population information for *E. rudis* subsp. *cratyantha* Priority 4

AECOM Population	DPaW and WAHerb Records ¹	WAH Vouchered Specimens
1 Population 1000+ individuals	0	17 records

1. informed by the database search results



Plate 2 *Eucalyptus rudis* subsp. *cratyantha* habit

5.2.2 Diversity

A total of 117 native flora species from 82 genera and 36 families were recorded during the field survey. Families with the highest representation includes Myrtaceae (14 native species), Fabaceae (12 native species), and Orchidaceae (12 native species; Plate 3).

Forty one weed species were recorded. One Declared Pest listed under the BAM Act as a Category 3 species was recorded. This species, *Zantedeschia aethiopica* (Arum Lily) was recorded at two locations in R02 (community BaHhOe) and R07 (community ErXpLh).

A species by community matrix is provided in Appendix E.



Plate 3 Orchids *Caladenia marginata* and *Thelymitra vulgaris*

5.3 Fauna

5.3.1 Fauna species

Thirty nine fauna species were observed or heard during the field survey at Nirimba. This comprised 33 bird species, three mammals (one of which is an introduced species), and three reptiles. The inventory of species recorded is provided in Table 20.

Nine conservation significant fauna species were recorded during the field survey, though eight of these are listed as Marine under the EPBC Act, refer to Appendix A. One species listed as Migratory under the EPBC Act, the Osprey (*Pandion haliaetus*), was recorded, and is discussed further in Section 5.3.1.1.

Despite not being recorded, the Chuditch and the Quenda (aka Western Brown Bandicoot) are considered likely to occur in the Survey Area due to the presence of known records according to the DPaW database and suitable habitat presence. These are discussed in Sections 5.3.1.2 and 5.3.1.3 respectively.

Targeted surveys for Black Cockatoos were also undertaken, these results are discussed in a separate chapter in Section 5.4.

Table 20 Fauna observed in the Survey Area

Name	Common Name	Commonwealth	State
Birds			
<i>Anas superciliosa</i>	Pacific Black Duck	-	-
<i>Anthochaera carunculata</i>	Red Wattlebird	-	-
<i>Ardea pacifica</i>	White-necked Heron	-	-
<i>Artamus cinereus</i>	Black-faced Woodswallow	-	-
<i>Aquila audax</i>	Wedge-tailed Eagle	-	-
<i>Barnardius zonarius semitorquatus</i>	Twenty-eight Parrot	-	-
<i>Cacatua pastinator</i>	Western Corella	-	-
<i>Colluricincla harmonica</i>	Grey Shrikethrush	-	-
<i>Coracina novaehollandiae</i>	Black-faced Cuckooshrike	M	-
<i>Corvus coronoides</i>	Australian Raven	-	-
<i>Cracticus tibicen</i>	Australian Magpie	-	-
<i>Dacelo novaeguineae</i>	Laughing Kookaburra*	-	-
<i>Egretta novaehollandiae</i>	White-faced Heron	-	-
<i>Eolophus roseicapilla</i>	Galah	-	-
<i>Epthianura albifrons</i>	White-fronted Chat	-	-
<i>Falco cenchroides</i>	Nankeen Kestrel	M	-
<i>Gerygone fusca</i>	Western Gerygone	-	-
<i>Grallina cyanoleuca</i>	Magpie-lark	M	-
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	M	-
<i>Haliastur sphenurus</i>	Whistling Kite	M	-
<i>Hirundo neoxena</i>	Welcome Swallow	M	-

Name	Common Name	Commonwealth	State
<i>Malarus sp.</i>	Fairy Wren	-	-
<i>Merops ornatus</i>	Rainbow Bee-eater	M	-
<i>Ocyphaps lophotes</i>	Crested Pigeon	-	-
<i>Pandion haliaetus</i>	Osprey	M / Mig	IA
<i>Pelecanus conspicillatus</i>	Australian Pelican	M	-
<i>Petroica boodang</i>	Scarlet Robin	-	-
<i>Phaps chalcoptera</i>	Common Bronzewing	-	-
<i>Phylidonyris novaehollandiae</i>	New Holland Honeyeater	-	-
<i>Rhipidura albiscapa</i>	Grey Fantail	-	-
<i>Rhipidura leucophrys</i>	Willie Wagtail	-	-
<i>Streptopelia senegalensis</i>	Laughing Turtle-dove*	-	-
<i>Threskiornis moluccus</i>	Australian White Ibis	-	-
Mammals			
<i>Canis lupis familiaris</i>	Dog*	-	-
<i>Macropus fuliginosus</i>	Western Grey Kangaroo	-	-
<i>Oryctolagus cuniculus</i>	European Wild Rabbit*	-	-
Reptiles			
<i>Christinus marmoratus</i>	Western Marbled Gecko	-	-
<i>Pseudonaja affinis</i>	Dugite	-	-
<i>Tiliqua rugosa rugosa</i>	Southwestern Bobtail	-	-

Note: M = Marine, Mig = Migratory, IA = protected under international agreement. More details can be found in Appendix A.

5.3.1.1 Osprey

Also known as the Eastern Osprey (*Pandion cristatus*), there remains some confusion around the taxonomic classification of the three subspecies. In accordance with Christidis and Boles (2008), the Eastern Osprey *Pandion cristatus* is a separate species, listed as Migratory and Marine under the EPBC Act. Other publications such as BirdLife International do not accept this division and classify all the Ospreys as *Pandion haliaetus*. For the purposes of this report, *Pandion haliaetus* has been adopted as the correct name.

Eastern Ospreys are a medium-sized raptor dark-brown to blackish-brown above and white below with a white head and neck. Size and plumage differs between the sexes however colouring is relatively similar. They occur in singles or occasionally in twos. In Australia they breed in solitary pairs.

Eastern Ospreys breed along Australia's coastline from Albany in southwest WA, along the west, north and east coast, down to Lake Macquarie in NSW. The non-breeding range extends further than this, from Esperance on WA's south coast.

There are no published estimates of the extent of occurrence of the Eastern Osprey within Australia however it is considered to be moderately common.

This information was derived from the Species Profile and Threats Database (DotEE, 2016).

5.3.1.2 Chuditch

The Chuditch currently only occurs in areas dominated by sclerophyll forest or drier woodland, heath and mallee shrubland (Van Dyck & Strahan, 2008). The DPaW database shows one record from 1992 from south of Heron Point in the nature reserve adjacent to the Peel-Harvey Estuary. This record is 7 km south of the Survey Area.

Habitats critical to Chuditch survival and maintenance of important populations has been outlined in the DEC (2012) Chuditch recovery plan and comprises:

- Areas currently occupied by Chuditch
- Areas of natural vegetation in which Chuditch breed
- Areas of natural vegetation in which Chuditch forage
- Areas of natural vegetation that Chuditch use to move from one area to another
- Areas of suitable vegetation within the recorded range in which undiscovered Chuditch populations may exist
- Areas not currently occupied by Chuditch due to recent fire but are capable of supporting Chuditch populations when sufficiently recovered
- Areas previously occupied and that still provide suitable habitat and into which Chuditch can be reintroduced.

The Survey Area contains suitable vegetation within the recorded range in which undiscovered Chuditch populations may exist. This species may occupy the Banksia, Eucalypt and Sheoak Woodland which extends for 46.57 ha.

5.3.1.3 Quenda


The Quenda is considered likely to occur in the Survey Area. It is classified as a Priority 4 species. It is found in woodland, heath and shrub communities on the Swan Coastal Plain and prefers a combination of sandy soils and dense heathy vegetation (Van Dyck & Strahan, 2008).


The Quenda is considered likely to utilise the woodlands and potentially shrublands of the Survey Area. Key threatening processes for the Quenda include habitat loss and degradation, road trauma and predation by introduced carnivores.


5.3.2 Fauna habitat


Six fauna habitats were recorded and described which are directly related to the vegetation community mapping. The most extensive habitat was the wetland habitat extending approximately 74 ha. These habitats are likely to be utilised by the three Black Cockatoo species, Chuditch, and the Quenda, as outlined below.


Table 21 Fauna habitats including associated vegetation community, area within each lot, detailed description and photographs and assessment of habitat for conservation significant species


Fauna Habitats	Description	Photograph
<p>Banksia, Eucalypt and Sheoak Woodland</p> <p>Veg Unit: BaHhOe</p> <p>Area: 46.57 ha Lot 295: 11.90 ha Lot 842: 8.34 ha Lot 1262: 26.25 ha</p>	<p>Open to moderately open Banksia woodland with occasional mature Marri, Sheok and Jarrah trees. Occasional mature eucalypts with occasional hollows. Generally moderately open shrub understorey to 0.5 m over open herbaceous layer. Shrub layer not dense. Abundant coarse leaf litter layer and abundant fallen branches and logs of all sizes, with hollows. Some bare ground, with fine grey to brown sandy soils. Burrows and scraping in soil abundant.</p> <p>Conservation significance:</p> <ul style="list-style-type: none"> - Carnaby’s foraging: good quality foraging habitat with abundant proteaceous species and some Marri. - FRTBC foraging: moderate quality foraging habitat – with occasional Marri, Jarrah and Sheoak. - BC breeding: large mature trees sparsely present – low quality breeding habitat. - Chuditch: area of suitable vegetation within the recorded range in which undiscovered Chuditch populations may exist. - Quenda: suitable habitat. 	

Fauna Habitats	Description	Photograph
<p>Shrubland with <i>E. rudis</i></p> <p>Veg Unit: BaKgMr</p> <p>Area: 59.87 ha Lot 295: 21.14 ha Lot 842: 22.87 ha Lot 1262: 15.87 ha</p>	<p>Patches of varied density shrubs to 4 m, with occasional generally stunted <i>E. rudis</i> and <i>Banksia</i> sp. Large mature eucalypt trees (Tuart and Jarrah) and Sheoak were present but rare. <i>E. rudis</i> did not appear to contain hollows suitable for Black Cockatoos. Ground covered in either open herbaceous plant layer, bare ground of fine brown to grey sand common or leaf litter layer. Fallen logs and branches of various sizes are common. Occasional termite mounds.</p> <p>Conservation significance:</p> <ul style="list-style-type: none"> • Carnaby’s foraging: low value foraging habitat with occasional proteaceous species and Eucalypts. • FRTBC foraging: very low value foraging habitat with occasional Sheoak and very occasional <i>Eucalyptus marginata</i>. • BC breeding habitat: large mature trees sparsely present, considered low quality breeding habitat. • Quenda: suitable habitat. 	 <p>The photograph column contains three vertically stacked images. The top image shows a dense thicket of shrubs and a large, spiky plant in the foreground. The middle image shows a ground covered with fallen logs and branches, with sparse vegetation. The bottom image shows a wider view of the shrubland with scattered trees and fallen logs.</p>

Fauna Habitats	Description	Photograph
<p><i>Eucalyptus rudis</i> Woodland</p> <p>Veg unit: ErXpLh</p> <p>Area: 42.62 ha Lot 295: 28.45 ha Lot 842: 0.05 ha Lot 1262: 14.03 ha</p>	<p>Open woodland of generally stunted mallee form <i>Eucalyptus rudis</i>, with occasional larger <i>E. rudis</i> with minimal hollows. Patchy understorey, with very open areas with occasional zamia sp., and other areas containing a moderately open understorey of <i>Kunzia</i> sp. Ground covered with grasses and herbaceous plants to 30 cm, with occasional bare ground of fine brown sandy soils. Course leaf litter layer is common, as are fallen logs and branches of various sizes.</p> <p>Conservation significance:</p> <ul style="list-style-type: none"> • Carnaby’s foraging: very low quality Eucalypt woodland, no Marri or proteaceous species. • BC breeding habitat: low to valued quality mostly smaller <i>E. rudis</i>. 	

Fauna Habitats	Description	Photograph
<p>Large Mature Eucalypts</p> <p>Veg Unit: EgEtEI</p> <p>Area: 22.92 ha Lot 295: 8,57 ha Lot 842: 3.83 ha Lot 1262: 10.46 ha</p>	<p>Essentially cleared paddock with large mature eucalypts (mixed Tuart, Marri and Jarrah). Potentially suitable Black Cockatoo hollows present. Very limited understorey, with a groundcover of abundant grasses and weeds, and some macrozamia sp. Coarse leaf litter is common, with fine brown sandy soils. Branches and logs of various sizes were occasionally present on ground.</p> <p>Conservation significance:</p> <ul style="list-style-type: none"> • Carnaby’s foraging: good quality foraging habitat. • FRTBC foraging: good quality foraging habitat. • BC breeding habitat: quality habitat with high density of trees with DBH >500mm. 	

Fauna Habitats	Description	Photograph
<p>Wetland Veg Unit: ErMiLg Area: 74.81 ha Lot 295: 27.45 ha Lot 842: 23.43 ha Lot 1262: 23.85 ha</p>	<p>Open Paperbark overstorey to 4 m with very occasional <i>Eucalyptus rudis</i> in mallee form to 10 m. Some hollows but unlikely to be suitable for Black Cockatoos. Varied density shrub layer to 3 m, sometimes very dense. Groundcover of native tussock grasses and herbaceous plants to 50 cm, patchy but occasionally dense, with significant areas of standing water at the time of survey. Soils were loamy clays, grey-black in colour, with occasional coarse leaf litter. Fallen branches of various sizes common.</p> <p>Conservation significance: Important water source for Quenda, Chuditch and bird species</p>	 <p>The top photograph shows a dense thicket of trees and shrubs with a small stream visible in the background. The bottom photograph shows a close-up view of a tree trunk and branches, highlighting the complex structure of the vegetation.</p>

Fauna Habitats	Description	Photograph
<p>Coastal shrubland Veg unit: MrTpCc Area: 50.99 ha Lot 295: 12.18 ha Lot 842: 23.43 ha Lot 1262: 15.38 ha</p>	<p>Tidally inundated samphire and low shrubland with occasional stags and very occasional Sheoak (to approximately 8 m). Some hollows in stags but unlikely to be suitable for Black Cockatoo nesting. Occasional patches of bare grey brown silty mud substrate. Large areas of inundation. Occasional dead log or large branches. Inland to this tidal shrubland is a thin band of sparse open paperbark woodland.</p> <p>Conservation significance: Riparian vegetation of the Peel-Harvey Estuary which forms part of the Peel-Yalgorup Ramsar listed site. Provides important ecological functions as part of the wetland and provides habitat for a large variety of species including migratory/marine birds and birds listed under international agreements.</p>	
<p>Cleared</p>	<p>Cleared areas devoid of native vegetation.</p>	

5.4 Black Cockatoos

5.4.1 Carnaby's

The Survey Area contains 171.98 ha of potentially suitable foraging habitat based on 21 foraging assessments. These communities were dominated by Banksia and Eucalypt species and included *Banksia attenuata*, *B. grandis*, *Eucalyptus marginata*, *Corymbia calophylla* and *E. gomphocephala*.

A breakdown of suitable foraging area by Lot number is provided in Table 22. There were two potential pieces of Carnaby's foraging evidence recorded in the Survey Area (Table 23) in the form of grubs eaten from Banksia cones. No sightings of Carnaby's Black Cockatoo were recorded during the field survey.

Table 22 Carnaby's foraging habitat

	Lot 295	Lot 842	Lot 1262	Total
Foraging habitat	70.05	35.10	66.60	171.75

Table 23 Carnaby's observations

Record ID	Observation	Date	Location (GDA Zone 50)		Plate
FID10	Grub eaten from Banksia cone	10 Oct	381083	6386470	Plate 4
FID14	Grub eaten from Banksia cone	10 Oct	380799	6386688	Plate 5



Plate 4 Carnaby's foraging evidence 1



Plate 5 Carnaby's foraging evidence 2

5.4.2 Forest Red-tailed Black Cockatoo

The Survey Area contains 129.22 ha of FRTBC foraging habitat, derived from 22 FRTBC foraging assessments. A flock of Forest Red-tail Black Cockatoos was observed one kilometre west of the Survey Area, occupying trees in adjacent paddocks (Marri trees).

A breakdown of suitable foraging habitat present within each Lot is provided in Table 24. Evidence of recent foraging (chewed Marri nuts) was recorded twice during the field survey. Observations are shown in Table 25.

Table 24 FRTBC foraging habitat

	Lot 295	Lot 842	Lot 1262	Total
Foraging habitat	41.60	35.04	52.57	129.22

Table 25 Forest Red-tail Black Cockatoo observations

Record ID	Observation	Date	Location (GDA Zone 50)		Plate
FID0	Call heard	1 Aug 2016	380878	6386843	NA
FID1	Potential foraging evidence 1 – chewed Marri nuts	1 Aug 2016	380898	6386423	Plate 6
FID4	Potential foraging evidence 2 – chewed Marri nuts	2 Aug 2016	381617	6387040	Plate 7
FID5	Flock seen on adjacent property,	2 Aug 2016	382180	6386023	Plate 8
FID31	Potential foraging evidence 3 – chewed Marri nuts	10 Oct 2016	381739	6386478	Plate 9



Plate 6 FRTBC foraging evidence 1

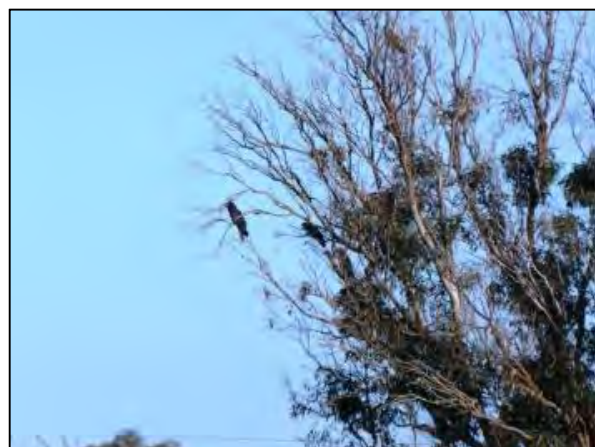



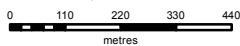
Plate 7 FRTBC foraging evidence 2

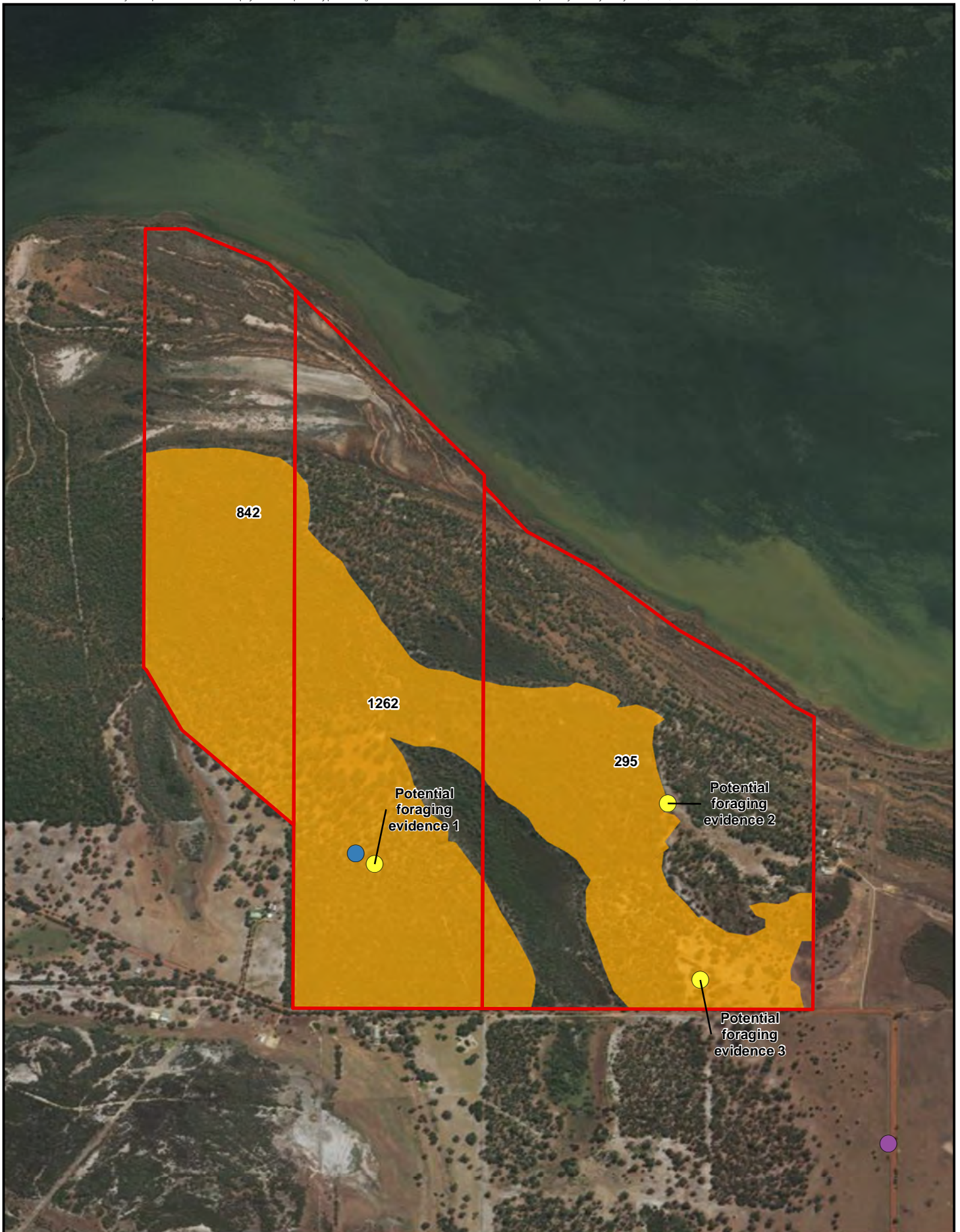
Plate 8 Flock of FRTBC on neighbouring property


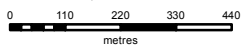


Plate 9 FRTBC foraging evidence 3



<p>PROJECT ID 60100953 CREATED BY DGF APPROVED BY JL LAST MODIFIED 12 JAN 2017</p>	 <p>www.aecom.com</p>	<p>LEGEND</p> <ul style="list-style-type: none"> ● Grub Eaten from Banksia Cone Survey Area Carnaby's Black Cockatoo Foraging Habitat 	<p>Carnaby's Black Cockatoo Foraging Habitat</p> <hr/> <p>MAIN ROADS</p> <p><i>NIRIMBA BIOLOGICAL ASSESSMENT</i></p>
<p>DATUM GDA 1994, PROJECTION MGA ZONE 50</p>  <p>1:15,000 when printed at A4</p>		<p><small>Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community</small></p>	<p style="text-align: right;">Figure 11</p>



<p>PROJECT ID 60100953 CREATED BY DGF APPROVED BY JL LAST MODIFIED 12 JAN 2017</p>	 <p>www.aecom.com</p>	<p>LEGEND</p> <ul style="list-style-type: none"> Survey Area Forest Red-tailed Black Cockatoo Foraging Habitat 	<p>Opportunistic Records</p> <ul style="list-style-type: none"> ● Call heard ● Flock seen on adjacent property ● Potential foraging evidence – chewed Marri nut 	<p>Forest Red-tailed Black Cockatoo Foraging Habitat and Opportunistic Records</p> <p>MAIN ROADS</p> <p><i>NIRIMBA BIOLOGICAL ASSESSMENT</i></p>
<p>DATUM GDA 1994, PROJECTION MGA ZONE 50</p>  <p>1:15,000 when printed at A4</p>		<p><small>Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community</small></p>		<p>Figure</p> <p style="font-size: 2em; text-align: center;">12</p>

5.5 Black Cockatoo breeding habitat

A total of 171.89 ha within the Survey Area was considered potential Black Cockatoo breeding habitat. That is, in these areas at least one or more potential breeding trees were observed either within quadrats or opportunistically as the Survey Area was traversed. A breeding quality assessment was undertaken based on the density of potentially suitable breeding trees within the defined vegetation communities. Vegetation with a high density of potentially suitable breeding trees was considered 'Quality' breeding habitat. Vegetation where trees were less dense was considered 'Valued', and vegetation with few potentially suitable trees was mapped as 'Low' quality breeding habitat. A breeding habitat map was produced, as shown in Figure 13.

The quadrats with the highest number of trees were within community EgEtEI, characterised by Tuart trees in a paddock. This community extends for 22.92 ha, and may support an estimated 1077 potentially suitable breeding trees. This vegetation community is considered 'Quality' breeding habitat. Communities BaHhOe, BaKgMr and ErXpLh were considered low quality breeding habitat. Across the 149.06 ha, only 36 trees were recorded from 14 quadrats. These communities potentially contain 1450 trees. The results of the Black Cockatoo Breeding Habitat Assessment including tree count and habitat quality is shown in Table 26. A breakdown of area for each Lot within the Survey Area is shown in Table 27.


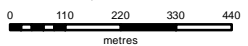
Table 26 Black Cockatoo potential breeding trees recorded and estimated total trees potentially present in the Survey Area

Breeding Quality	Vegetation Unit	# of Breeding Tree Quadrats	Total Trees Counted	Trees / ha	Total Area of Vegetation Units	Approximate # of Trees
Low	BaHhOe	7	16	9.14	46.57	426
Low	BaKgMr	2	4	8.00	59.87	1077
Low	ErXpLh	5	16	12.80	42.62	479
Quality	EgEtEI	4	47	47.00	22.92	545
Totals					171.98	2527

Table 27 Breeding quality results and extent for each of the three Lots in the Survey Area

Breeding Quality	Lot 295	Lot 842	Lot 1262	Total
Low	61.49	31.26	56.15	148.89
Quality	8.57	3.83	10.46	22.86
Totals	70.05	35.10	66.60	171.75



<p>PROJECT ID 60100953 CREATED BY DGF APPROVED BY JL LAST MODIFIED 12 JAN 2017</p>	 <p>www.aecom.com</p>	<p>LEGEND</p> <ul style="list-style-type: none"> Survey Area ◆ Black Cockatoo Breeding Tree Assessment <p>Black Cockatoo Potential Breeding Habitat</p> <ul style="list-style-type: none"> Quality Valued Low 	<p>Black Cockatoo Potential Breeding Habitat</p> <hr/> <p>MAIN ROADS</p> <p><i>NIRIMBA BIOLOGICAL ASSESSMENT</i></p>
<p>DATUM GDA 1994, PROJECTION MGA ZONE 50</p>  <p>1:15,000 when printed at A4</p>		<p><small>Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community</small></p>	<p style="text-align: right;">Figure 13</p>

5.6 Wetlands

5.6.1 Wetland vegetation

A number of wetlands associated with the Peel-Harvey inlet were subject to one Wetland Assessment (as a group) in accordance with DPaW (2013) Wetland Assessment methodology. These wetlands included UFI 2992, 3115 and 14562. The current classification of these wetlands varies from MU to RE. Other wetlands associated with this group were not visited due to inundation. Some clearing was evident adjacent to this wetland group, with open areas dominated by weeds.

A secondary evaluation was undertaken, which confirmed the initial assessment result that all wetlands in this group would be considered suitable for a Conservation management category based on wetland processes and fauna habitat.

Two wetlands (UFI 2995 and 3116) are located in their entirety within the Survey Area. Vegetation within these wetlands is represented by community ErMiLg. The vegetation community mapping closely follows the Geomorphic Wetlands Database boundaries for these two wetlands.

Implementing the DPaW (2013) Wetland Assessment triggered one preliminary attribute for these sumplands, leading to an immediate classification as Conservation wetlands. The attribute that triggered this assessment is that both wetlands have equal to or greater than 90% of wetland vegetation in 'Good' or better condition. It is possible that more preliminary evaluation triggers are present however lacking detailed desktop information regarding Threatened species and communities, these were not identified at this time.

The secondary evaluation also resulted in both wetlands being classified as Conservation wetlands. The evaluation showed that both wetlands contain significant geomorphology, wetland processes and flora values and are therefore suitable for consideration as Conservation category. These findings are consistent with the current Geomorphic Wetlands mapping which already classifies these wetlands as CC wetlands.

One Multiple Use wetland, UFI 3125 despite being located entirely within the Survey Area, was not subject to a Wetland Assessment. Access to this wetland was limited due to an electric fence and evidence of private use.

A summary of Wetland Assessment and foreshore assessment outcomes are provided in Table 28. Completed wetland forms are provided in Appendix F.

5.6.2 Boundary mapping

There are 14 wetlands completely or partially intersecting the Survey Area, comprising 23.49 ha of CCW, 23.82 ha of RE and 26.41 ha of MU wetlands (73.72 ha total). Despite the different categories, the Wetland Assessment showed all wetlands (or wetland groups) support attributes representative of a CCW.

Wetland vegetation was recorded along the edge of the Peel-Harvey inlet (mapped as AfThJp). The wetland vegetation mapping closely follows the boundaries mapped in the Geomorphic Wetlands of the Swan Coastal Plain dataset. Furthermore, the two CCW in the Survey Area were mapped as ErMiLg, considered in 'Excellent' condition. A total of 75.09 ha of wetland vegetation was mapped (Figure 9) and considered to closely resemble the existing Geomorphologic Wetlands dataset boundary mapping.

Table 28 Wetland assessment summary of results including foreshore assessment and DPaW (2013) Wetland Assessment results

UFI	Comments	Wetlands Assessment	
		Preliminary	Secondary
2995	Entirety of wetland situated within Survey Area supporting vegetation in 'Excellent' condition. No surface water evident at the time of the survey and unlikely to express water often.	- Equal to or greater than 90% of the wetland supports vegetation in a good or better condition.	Conservation - geomorphology, wetland processes and flora values
3116	This CCW wetland is situated in its entirety within the Survey Area. No surface water was present at the time of the field survey, and it seemed unlikely to express water at any time of the year. The entire wetland was vegetated with dense shrubs, sedges and rushes (see Table 16 for photographs and community description). The wetland vegetation was considered in 'Excellent' condition.	- Equal to or greater than 90% of the wetland supports vegetation in a good or better condition.	Conservation – geomorphology and flora values
14562, 2992 and 3115	Representing the edge of the Peel-Harvey estuary. Mosquito populations were high, and weeds were observed in areas seemingly bare from native vegetation. Vegetation condition considered 'Very Good' and 'Excellent'.	- Equal to or greater than 90% of the wetland supports vegetation in a good or better condition.	Conservation – wetland processes and fauna values

6.0 Conclusion

A flora and vegetation assessment, fauna assessment, Black Cockatoo foraging and breeding habitat assessment and wetlands assessment were undertaken within the Nirimba Study Area in August and October 2016. Field surveys were undertaken by experienced botanists and zoologists.

Two Priority flora species were recorded, including *Eucalyptus rudis* subsp. *cratyantha* and *Dillwynia dillwynioides*. *E. rudis* subsp. *cratyantha* is considered locally significant due to the extent and size of the population and lack of records in within 10 km of the Study Area.

Three Threatened Ecological Communities (TECs) were mapped in the Survey Area. The desktop assessment indicated recorded locations of these communities within the Survey Area, all related to the riparian vegetation of the Peel-Harvey estuary. The TECs include:

- Two TECs listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
 - Subtropical and Temperate Coastal Saltmarsh (Vulnerable)
 - Herb rich saline shrublands in clay claypans (Critically Endangered)
- One TEC listed under the *Wildlife Conservation Act 1950* (WC Act)
 - Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain (Vulnerable).

The Black Cockatoo assessment identified suitable breeding habitat for the Carnaby Cockatoo and the FRTBC, however the majority was considered 'low' quality based on the low density of suitable potential Black Cockatoo breeding trees. Foraging habitat was also recorded for both Cockatoos, with 171 ha of Carnaby's and 130 ha of FRTBC foraging habitat mapped.

A number of wetlands (14) intersect with the Study Area including the riparian vegetation associated with the Peel-Harvey estuary, representing the RAMSAR-listed Peel-Yalgorup site. A total of 23.49 ha of Conservation Category wetlands occur in the Study Area.

A number of limitations were considered for the biological assessments and none were considered to significantly impact the results of the field surveys. No additional work is considered necessary for meeting the objectives of the project.

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Appendix A

Conservation Codes

Appendix A – Conservation Categories

1.1 Western Australia

Plants and animals that are considered threatened and need to be specially protected because they are under identifiable threat of extinction are listed under the *Wildlife Conservation Act (WC Act)*. These categories are defined in Table 1. Threatened species are published as Specially Protected under the Wildlife Conservation Act 1950, and listed under Schedules 1 to 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora. The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as outlined in Table 1.

Species that have not yet been adequately surveyed to warrant being listed under Schedule 1 or 2 are added to the Priority Flora or Fauna Lists under Priority 1, 2 or 3. Species that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list for other than taxonomic reasons, are placed in Priority 4 and require regular monitoring. Conservation Dependent species and ecological communities are placed in Priority 5. Categories and definitions of Priority Flora and Fauna species are provided in Table 2.

Table 1 Conservation codes for WA flora and fauna listed under the *Wildlife Conservation Act 1950* updated November 2015

Conservation Code	Category
CR	<p>Critically endangered species</p> <p>Threatened species considered to be facing an extremely high risk of extinction in the wild. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.</p>
EN	<p>Endangered species</p> <p>Threatened species considered to be facing a very high risk of extinction in the wild. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.</p>
VU	<p>Vulnerable species</p> <p>Threatened species considered to be facing a high risk of extinction in the wild. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.</p>
EX	<p>Presumed extinct species</p> <p>Species which have been adequately searched for and there is no reasonable doubt that the last individual has died. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora.</p>

Conservation Code	Category
IA	<p>Migratory birds protected under an international agreement</p> <p>Birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Bonn Convention, relating to the protection of migratory birds. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice.</p>
CD	<p>Conservation Dependent Species</p> <p>Fauna that is of special conservation need as conservation dependent fauna. Coincides with Schedule 6 under the WC Act.</p>
OS	<p>Other specially protected fauna</p> <p>Fauna otherwise in need of special protection to ensure their conservation. Published as Specially Protected under the WC Act in Schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice.</p>

Table 2 Conservation codes for WA flora and fauna (DPaW 2015a)

Conservation Code	Category
P1	<p>Priority One – Poorly Known Species</p> <p>Species that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.</p>
P2	<p>Priority Two – Poorly Known Species</p> <p>Species that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc.</p> <p>Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.</p>
P3	<p>Priority Three – Poorly Known Species</p> <p>Species that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities 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 localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.</p>
P4	<p>Priority Four – Rare, Near Threatened and other species in need of monitoring</p> <ol style="list-style-type: none"> 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. b. Near Threatened. Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. c. Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

1.2 Commonwealth

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is Australia’s central piece of environmental legislation which provides for the listing of nationally Threatened native species and ecological communities, native migratory species and marine species. These species are listed as either Threatened, Migratory, or Marine.

Threatened fauna and flora may be listed under Section 178 of the EPBC Act in one of six categories (Table 3). Marine species are listed under Section 248 of the EPBC Act. Australia has a responsibility for the conservation of listed Marine species under the United Nations Convention on the Law of the Sea. The long-term strategy for the recovery of threatened marine species includes scientific research, community education and awareness, partnership building and working with relevant industries and other stakeholders.

Migratory species are listed under Section 209 of the EPBC Act and include species that are:

- migratory species which are native to Australia and are included in the appendices to the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals Appendices I and II)
- migratory species included in annexes established under the Japan-Australia Migratory Bird Agreement (JAMBA) and the China-Australia Migratory Bird Agreement (CAMBA)
- native, migratory species identified in a list established under, or an instrument made under, an international agreement approved by the Minister, such as the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

Table 3 Categories of Species Listed under Section 178 of the EPBC Act 1999 [Commonwealth]

Conservation	Code Category
Ex	Extinct Taxa which at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
ExW	Extinct in the Wild Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or 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.
CE	Critically Endangered Taxa which 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.
E	Endangered Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the immediate or near future, as determined in accordance with the prescribed criteria.
V	Vulnerable Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	Conservation Dependent Taxa which at a particular time if, at that time: <ol 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 b. the following subparagraphs are satisfied: <ol 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.

2.0 Threatened and Priority Ecological Communities

2.1 Western Australia

State listed TECs are not protected under any legislation, rather they are endorsed by the Environment Minister. Categories of TECs are defined in Table 4. Priority Ecological Communities are endorsed by the Environment Minister as having insufficient information available to be considered a TEC, or which are rare but not currently threatened. Categories are described in Table 5.

Table 4 Conservation codes for state-listed Threatened Ecological Communities

Conservation Code	Category
PD	<p>Presumed Totally Destroyed</p> <p>An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future.</p> <p>An Ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant and either of the following applies (A or B):</p> <ul style="list-style-type: none"> A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats or B) All occurrences recorded within the last 50 years have since been destroyed
CR	<p>Critically Endangered</p> <p>An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.</p> <p>An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting any one or more of the following criteria (A, B or C):</p> <ul style="list-style-type: none"> A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and either or both of the following apply (i or ii): <ul style="list-style-type: none"> i. geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years); ii. modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated. B) Current distribution is limited, and one or more of the following apply (i, ii or iii): <ul style="list-style-type: none"> i. geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years); ii. there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes; iii. there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).

Conservation Code	Category
EN	<p>Endangered</p> <p>An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.</p> <p>An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C).</p> <p>A) The geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 70% and either or both of the following apply (i or ii):</p> <ol style="list-style-type: none"> i. the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 20 years); ii. modification throughout its range is continuing such that in the immediate future (within approximately 20 years) the community is unlikely to be capable of being substantially rehabilitated. <p>B) Current distribution is limited, and one or more of the following apply (i, ii or iii):</p> <ol style="list-style-type: none"> i. geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 20 years); ii. there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes; iii. there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. <p>The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 20 years).</p>
VU	<p>Vulnerable</p> <p>An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatened processes continue or begin operating throughout its range.</p> <p>An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C).</p> <p>A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.</p> <p>B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.</p> <p>C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium or long term future because of existing or impending threatening processes.</p>

Table 5 Categories for Priority Ecological Communities

Conservation	Code Category
P1	<p>Priority One: poorly-known ecological communities 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>
P2	<p>Priority Two: poorly-known ecological communities 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 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>
P3	<p>Priority Three: poorly known ecological communities</p> <ul style="list-style-type: none"> 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 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 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, and inappropriate fire regimes. <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>
P4	<p>Priority Four: 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> <ul style="list-style-type: none"> 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. 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 Vulnerable. iii. Ecological communities that have been removed from the list of threatened communities during the past five years.
P5	<p>Priority Five: Conservation Dependent ecological communities. 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>

2.2 Commonwealth

Communities can be classified as TECs under the *Environment Protection and Biodiversity Conservation Act 1999*. The EPBC act protects Australia’s ecological communities by providing for:

- Identification and listing of ecological communities as threatened
- Development of conservation advice and recovery plans for listed ecological communities
- Recognition of key threatening processes
- Where appropriate, reducing the impact of these processes through threat abatement plans.

Categories of federally listed TECs are described in Table 6.

Table 6 Categories of TECs that are listed under the EPBC Act

Conservation Code	Category
CE	<p>Critically Endangered If, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future.</p>
E	<p>Endangered If, at that time, it is not critically endangered and is facing a very high risk of extinction in the wild in the near future.</p>
V	<p>Vulnerable If, at that time, it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future.</p>



Appendix B

Protected Matters
Search



EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 03/11/16 12:56:22

[Summary](#)

[Details](#)

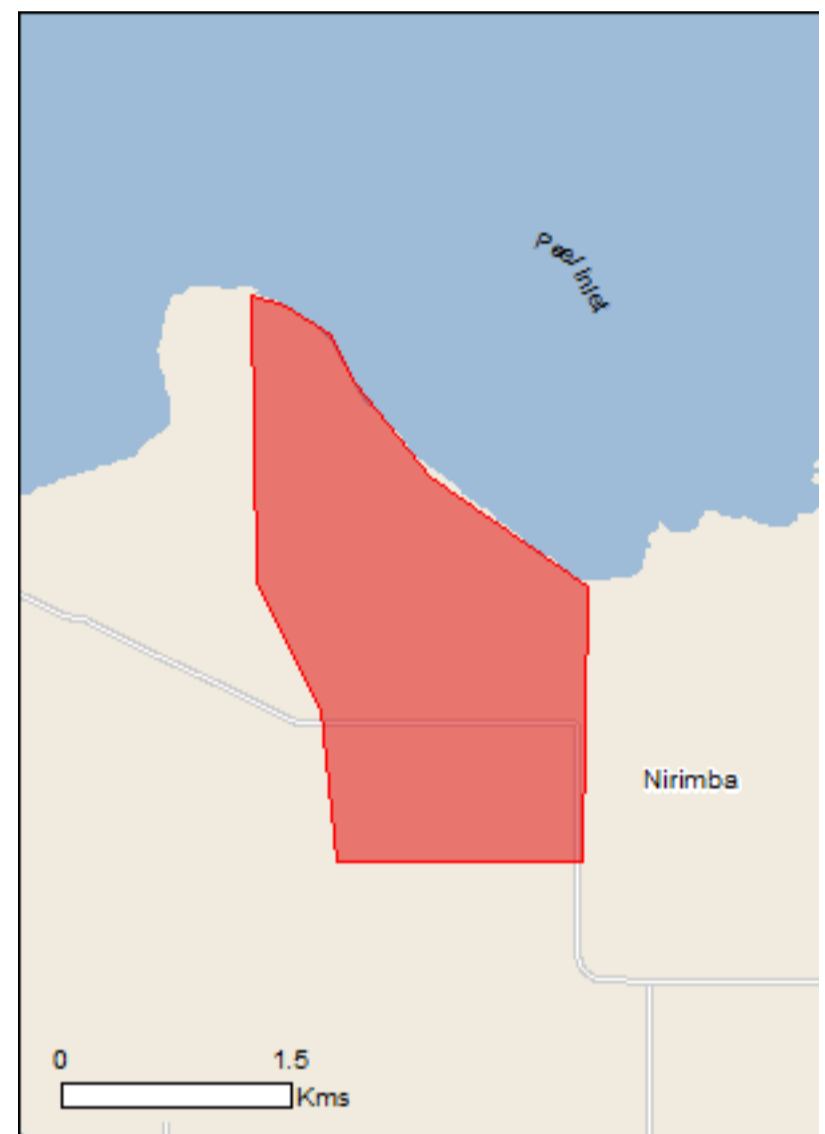
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

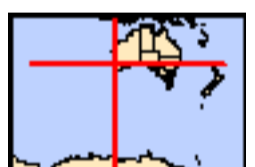
[Acknowledgements](#)



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

[Coordinates](#)

Buffer: 0.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	3
Listed Threatened Species:	43
Listed Migratory Species:	49

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at <http://www.environment.gov.au/heritage>

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	55
Whales and Other Cetaceans:	1
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	22
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar)	[Resource Information]
Name	Proximity
Peel-yalgorup system	Within Ramsar site

Listed Threatened Ecological Communities

 [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Banksia Woodlands of the Swan Coastal Plain	Endangered	Community likely to occur within area
Claypans of the Swan Coastal Plain	Critically Endangered	Community likely to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area

Listed Threatened Species

 [Resource Information]

Name	Status	Type of Presence
Birds		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Roosting known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat likely to occur within area
Calyptorhynchus baudinii Baudin's Cockatoo, Baudin's Black-Cockatoo, Long-billed Black-Cockatoo [769]	Vulnerable	Species or species habitat likely to occur within area
Calyptorhynchus latirostris Carnaby's Black-Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat likely to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area

Name	Status	Type of Presence
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat may occur within area
Diomedea epomophora (sensu stricto) Southern Royal Albatross [1072]	Vulnerable	Species or species habitat likely to occur within area
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Vulnerable	Species or species habitat likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat likely to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat likely to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Thalassarche cauta cauta Shy Albatross, Tasmanian Shy Albatross [82345]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta steadi White-capped Albatross [82344]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Mammals		
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Vulnerable	Species or species habitat may occur within area
Plants		
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat may occur within area
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat likely to occur within area
Diuris drummondii Tall Donkey Orchid [4365]	Vulnerable	Species or species habitat likely to occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat likely to occur within area
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat likely to occur within area
Drakaea elastica Glossy-leaved Hammer Orchid, Glossy-leaved Hammer Orchid, Warty Hammer Orchid [16753]	Endangered	Species or species habitat known to occur within area
Drakaea micrantha Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat likely to occur within area
Synaphea sp. Fairbridge Farm (D.Papenfus 696) Selena's Synaphea [82881]	Critically Endangered	Species or species habitat may occur within area
Synaphea stenoloba Dwellingup Synaphea [66311]	Endangered	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat likely to occur within area
Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat may occur within area
Diomedea epomophora (sensu stricto) Southern Royal Albatross [1072]	Vulnerable	Species or species habitat likely to occur within area
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Vulnerable	Species or species habitat likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta (sensu stricto) Shy Albatross, Tasmanian Shy Albatross [64697]	Vulnerable*	Species or species habitat likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Species or species habitat likely to occur within area
Migratory Marine Species		
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat likely to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Roosting known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Roosting known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Roosting known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Tringa totanus Common Redshank, Redshank [835]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Roosting known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Calidris melanotos Pectoral Sandpiper [858]		Roosting known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat may occur within area
Diomedea epomophora (sensu stricto) Southern Royal Albatross [1072]	Vulnerable	Species or species habitat likely to occur within area
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Vulnerable	Species or species habitat likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat likely to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Roosting known to occur within area
Himantopus himantopus Black-winged Stilt [870]		Roosting known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat likely to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Thalassarche cauta (sensu stricto) Shy Albatross, Tasmanian Shy Albatross [64697]	Vulnerable*	Species or species habitat likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Species or species habitat likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat may occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area

Name	Threatened	Type of Presence
Tringa totanus Common Redshank, Redshank [835]		Roosting known to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Whales and other Cetaceans [\[Resource Information \]](#)

Name	Status	Type of Presence
Mammals		
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves [\[Resource Information \]](#)

Name	State
Austin Bay	WA

Invasive Species [\[Resource Information \]](#)

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resources Audit, 2001.

Name	Status	Type of Presence
Birds		
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Mammals		
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area

Name

State

[Peel-Harvey Estuary](#)

WA

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-32.632379 115.724599,-32.632379 115.724599,-32.632379 115.724599,-32.632957 115.726659,-32.634403 115.729406,-32.636716 115.730779,-32.641341 115.735242,-32.646834 115.744512,-32.66042 115.744169,-32.66042 115.729749,-32.652905 115.728719,-32.646545 115.724943,-32.632379 115.724599

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [-Office of Environment and Heritage, New South Wales](#)
- [-Department of Environment and Primary Industries, Victoria](#)
- [-Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [-Department of Environment, Water and Natural Resources, South Australia](#)
- [-Parks and Wildlife Commission NT, Northern Territory Government](#)
- [-Department of Environmental and Heritage Protection, Queensland](#)
- [-Department of Parks and Wildlife, Western Australia](#)
- [-Environment and Planning Directorate, ACT](#)
- [-Birdlife Australia](#)
- [-Australian Bird and Bat Banding Scheme](#)
- [-Australian National Wildlife Collection](#)
- Natural history museums of Australia
- [-Museum Victoria](#)
- [-Australian Museum](#)
- [-South Australian Museum](#)
- [-Queensland Museum](#)
- [-Online Zoological Collections of Australian Museums](#)
- [-Queensland Herbarium](#)
- [-National Herbarium of NSW](#)
- [-Royal Botanic Gardens and National Herbarium of Victoria](#)
- [-Tasmanian Herbarium](#)
- [-State Herbarium of South Australia](#)
- [-Northern Territory Herbarium](#)
- [-Western Australian Herbarium](#)
- [-Australian National Herbarium, Atherton and Canberra](#)
- [-University of New England](#)
- [-Ocean Biogeographic Information System](#)
- [-Australian Government, Department of Defence Forestry Corporation, NSW](#)
- [-Geoscience Australia](#)
- [-CSIRO](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.



Appendix C

Fauna Desktop Assessment

Appendix C: Fauna Desktop Assessment

Name	Common Name	Conservation		Source	Likelihood	Comment
		Common wealth	State			
<i>Ardea ibis coromanda</i>	cattle egret		IA	DPaW		Not assessed.
<i>Ardea modesta</i>	great egret, white egret		IA	DPaW		Not assessed.
<i>Arenaria interpres interpres</i>	ruddy turnstone		IA	DPaW		Not assessed.
<i>Botaurus poiciloptilus</i>	Australasian bittern	E	EN	DPaW	Unlikely	No recent records.
<i>Calidris acuminata</i>	sharp-tailed sandpiper		IA	DPaW		Not assessed.
<i>Calidris alba</i>	sanderling		IA	DPaW		Not assessed.
<i>Calidris canutus</i>	red knot, knot		IA	DPaW		Not assessed.
<i>Calidris ferruginea</i>	curlew sandpiper	CE, Marine, M	VU & IA	DPaW	May	Migrant that does not breed within Australia - no records within survey area but multiple records in local area and suitable habitat within and adjacent the survey area.
<i>Calidris melanotos</i>	pectoral sandpiper		IA	DPaW		Not assessed.
<i>Calidris minuta</i>	little stint		IA	DPaW		Not assessed.
<i>Calidris ruficollis</i>	red-necked stint		IA	DPaW		Not assessed.
<i>Calidris subminuta</i>	long-toed stint		IA	DPaW		Not assessed.
<i>Calidris tenuirostris</i>	great knot	CE, Marine, M	VU & IA	DPaW	May	Migrant that does not breed within Australia. Recent records but not in survey area, though potentially suitable habitat occurs within survey area.
<i>Calyptorhynchus banksii naso</i>	forest red-tailed black cockatoo	V	VU	DPaW	Likely	Confirmed presence in survey area.
<i>Calyptorhynchus baudinii</i>	Baudin's cockatoo	V	EN	DPaW	Likely	Multiple recent records in local area with suitable habitat in survey area.
<i>Calyptorhynchus latirostris</i>	Carnaby's cockatoo	E	EN	DPaW	Likely	Confirmed presence in survey area.
<i>Charadrius leschenaultii</i>	greater sand plover, large sand plover		IA	DPaW		Not assessed.
<i>Charadrius mongolus</i>	lesser sand plover	E, Marine, M	EN & IA	DPaW	May	No recent records within survey area but potentially suitable habitat does occur within survey area.
<i>Chlidonias leucopterus</i>	white-winged black tern, white-winged tern		IA	DPaW		Not assessed.
<i>Ctenotus ora</i>	coastal plains skink	-	P3	DPaW	May	Recent records adjacent survey area.
<i>Dasyurus geoffroi</i>	chuditch, western quoll	V	VU	DPaW	May	Only one recent record in local area, though potentially suitable habitat does exist within survey area.

Name	Common Name	Conservation		Source	Likelihood	Comment
		Common wealth	State			
<i>Falco peregrinus</i>	peregrine falcon	-	OS	DPaW	Likely	Recent records adjacent survey area and potentially suitable habitat occurs within survey area.
<i>Gallinago hardwickii</i>	Latham's snipe, Japanese snipe		IA	DPaW		Not assessed.
<i>Isoodon obesulus fusciventer</i>	quenda, southern brown bandicoot	-	P4	DPaW	Likely	Recent records within local area and suitable habitat occurs within survey area.
<i>Limicola falcinellus sibiricus</i>	broad-billed sandpiper		IA	DPaW		Not assessed.
<i>Limosa lapponica</i>	bar-tailed godwit		IA	DPaW		Not assessed.
<i>Limosa limosa</i>	black-tailed godwit		IA	DPaW		Not assessed.
<i>Macropus irma</i>	western brush wallaby	-	P4	DPaW	Unlikely	Only one record within local area.
<i>Neophoca cinerea</i>	Australian sea-lion	V	VU	DPaW	Unlikely	Only one undated record in local area.
<i>Numenius madagascariensis</i>	eastern curlew	CE, Marine, M	VU & IA	DPaW		Migrant that does not breed within Australia. Recent records in local area but not in survey area, though potentially suitable habitat occurs within survey area.
<i>Numenius minutus</i>	little curlew, little whimbrel		IA	DPaW		Not assessed.
<i>Numenius phaeopus</i>	whimbrel		IA	DPaW		Not assessed.
<i>Oxyura australis</i>	blue-billed duck	-	P4	DPaW	Unlikely	Recent records in local area but no suitable habitat within survey area.
<i>Pandion haliaetus</i>	osprey		IA	DPaW		Not assessed.
<i>Philomachus pugnax</i>	ruff (reeve)		IA	DPaW		Not assessed.
<i>Plegadis falcinellus</i>	glossy ibis		IA	DPaW		Not assessed.
<i>Pluvialis fulva</i>	Pacific golden plover		IA	DPaW		Not assessed.
<i>Pluvialis squatarola</i>	grey plover		IA	DPaW		Not assessed.
<i>Sterna hirundo</i>	common tern		IA	DPaW		Not assessed.
<i>Thalassarche melanophris</i>	black browed albatross	V, Marine, M	EN & IA	DPaW	Unlikely	The Black-browed Albatross is a marine species that breeds on subantarctic and peri-antarctic islands. Only one record in local area.
<i>Tringa glareola</i>	wood sandpiper		IA	DPaW		Not assessed.
<i>Tringa nebularia</i>	common greenshank, greenshank		IA	DPaW		Not assessed.
<i>Tringa stagnatilis</i>	marsh sandpiper, little greenshank		IA	DPaW		Not assessed.
<i>Tyto novaehollandiae novaehollandiae</i>	masked owl (southwestern)	-	P3	DPaW	May	Two recent records within local area and suitable habitat occurs within the survey area.



Appendix D

Banksia Woodlands of
the SCP Assessment

Appendix D – Banksia Woodlands of the SCP Assessment

1.0 Banksia Woodlands of the Swan Coastal Plain

1.1 Introduction

The Banksia woodlands of the Swan Coastal Plain encompasses large natural variation across its range. Furthermore it is subject to varying degrees of disturbance and degradation that have influenced the quality of patches.

The Threatened Species Scientific Committee (TSSC) published the approved Conservation Advice for this community in September 2016. This document details the key diagnostic features applicable for determining the presence of this TEC. Patches must meet the following kei diagnostic characteristics, condition thresholds, and minimum patch sizes:

- Step 1: use key diagnostic characteristics to determine if TEC is present
- Step 2: determine condition of patch
- Step 3: consider if patch meets minimum size threshold
- Step 4: surrounding context of a patch must be taken into account when considering factors that add to the importance of a patch that meets the condition thresholds.

These steps are detailed in the following sections.

1.2 Key Diagnostic Features

The Nirimba Survey Area supports two patches of native vegetation, as outlined in the vegetation map. This includes patch one, comprising 27.14 ha of BaHhOe. This patch is isolated from the larger patch two, comprising 79.30 ha of BaHhOe and BaKgMr.

Patch one includes quadrats 1 and 2, and relevès 1 and 2. Patch 2 includes quadrats 5, 6, and 14 and relevès 4, 5 and 10. Patch one and two are assessed against the key diagnostic characteristics in Table 1. Where responses for both patches are the same, only one response is given. This was done due to the close proximity of the patches to one another. Individual quadrat data was used to provide responses for species composition and structure.

Table 1 key diagnostic features including location and physical environment, soils and landform, structure, and species composition

Key diagnostic characteristics	Patch 1	Patch 2
Location and physical environment	Yes	Yes
The Banksia Woodlands ecological community primarily occurs on the Swan Coastal Plain IBRA bioregion. Pockets of the community also extent into the adjacent lower parts of the Darling and Whicher escarpments that lie within the Jarrah Forest IBRA bioregion to the immediate east and south of the Swan Coastal Plain.	Patch is on SCP	
Soils and landform	Yes	Yes
Typically occurs on well drained, low nutrient soils on sandplain landforms, particularly deep Bassendean and Spearwood sands and occasionally on Quindalup sands.	Partly located on Southern River Complex, a combination of Bassendean Dunes and Pinjarra Plain.	No
Is also common on sandy colluvium and Aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau	No	No
In other less common scenarios (transitional substrates, sandflats)	Partly located on the Vasse Complex.	Located on Vasse Complex
Structure	Yes	Yes
A distinctive upper sclerophyllous layer of low trees (occasionally large shrubs more than 2 m tall), typically dominated or co-dominated by one or more of the <i>banksia</i> species identified below; AND	Low open forest of <i>Banksia</i> species.	
Emergent trees of medium or tall (<10 m) height <i>Eucalyptus</i> or <i>Allocasuarina</i> species may sometimes be present above the <i>Banksia</i> canopy; AND	Emergent <i>Corymbia calophylla</i> , <i>Eucalyptus marginata</i> and <i>Allocasuarina fraseriana</i> (<15% total)	<i>E. gomphocephala</i> , <i>E. marginata</i> and occasional <i>E. rudis</i> (<5% total each)
A often highly species-rich understorey that consists of: <ul style="list-style-type: none"> • A layer of sclerophyllous shrubs of various heights • A herbaceous ground layer of cord rushes, sedges and perennial and ephemeral forbs that sometimes includes grasses. The development of a ground layer may vary depending on the density of the shrub layer and disturbance history.	Forty eight native understorey species including sclerophyllous shrubs, forbs and rushes.	Forty native understorey species including sclerophyllous shrubs, forbs and rushes.

Key diagnostic characteristics	Patch 1	Patch 2
Composition	Yes	Yes
Canopy is most commonly dominated or co-dominated by <i>Banksia attenuata</i> and/or <i>Banksia menziesii</i> . Other <i>Banksia</i> species that dominate in some examples of the ecological community are <i>B. prionotes</i> or <i>B. ilicifolia</i> ; AND	<i>B. attenuata</i> is dominant overstorey species with some <i>B. grandis</i>	
Patch must include at least one of the following diagnostic species: <ul style="list-style-type: none"> • <i>Banksia attenuata</i> • <i>Banksia menziesii</i> • <i>Banksia prionotes</i> • <i>Banksia ilicifolia</i> 	Includes <i>B. attenuata</i> .	
If present, the emergent tree layer often includes <i>Corymbia calophylla</i> , <i>E. marginata</i> , or less commonly <i>E. gomphocephala</i> ; AND	Includes <i>C. calophylla</i> and <i>E. marginata</i>	Includes <i>E. gomphocephala</i> and <i>E. marginata</i> .
Other trees of a medium height may be present and may be co-dominant with the <i>Banksia</i> species across a patch, include <i>E. todtiana</i> , <i>Nuytsia floribunda</i> , <i>Allocasuarina fraseriana</i> , <i>Callitris arenaria</i> , <i>Callitris pyramidalis</i> and <i>Xylomelum occidentale</i> ; AND	Includes <i>A. fraseriana</i>	
Understorey typically contains high to very high diversity of shrub and herb species that often vary from patch to patch.	Forty eight native understorey species including sclerophyllous shrubs, forbs and rushes.	Forty native understorey species including sclerophyllous shrubs, forbs and rushes.
Contra-indicators	No	No
Patches clearly dominated by <i>Banksia littoralis</i> are not part of the TEC	NA	NA
Patches clearly dominated by <i>Banksia burdettii</i> are not the TEC	NA	NA
FCT 20c – Eastern shrublands and woodlands, corresponds with a separate EPBC ecological community listing, Shrublands and Woodlands of the eastern Swan Coastal Plain. Occurrences of this FCT should be considered under that separate listing.	NA	NA

1.3 Condition

The condition of vegetation of each patch needs to be determined in accordance with the following:

- The condition assessment of a patch should be centred on the area of highest native floristic diversity and/or cover of the patch.
- Timing of surveys and recent disturbance should be taken into account
- Surrounding context of a patch should be considered
- Certain vegetation components of Banksia Woodlands community merit consideration as critical elements to protect. Three components are recognised as threatened in their own right i.e. Priority Ecological Communities
- A relevant expert may be useful to help identify the ecological community and its condition.
- Vegetation must be in 'Good' or better condition in accordance with Table 2.

The condition of patch one is mapped as Very Good.

The condition of patch two varied between Degraded and Excellent, with the highest weed density recorded in quadrat 14 at 33.5%. The lowest weed cover was recorded in relevè 10 with 0.12% weed cover. The condition assessment was informed by the condition mapping and quadrat data. The variable condition is shown in the TEC figure provided in the report.

Table 2 Condition Table

Keighery (1994) Vegetation Condition Scale	Indicative condition measures/thresholds	
	Typical native vegetation composition	Typical weed cover
Pristine No obvious signs of disturbance	Native plant species diversity fully retained or almost so ¹	Zero or almost no weed cover/abundance
Excellent Vegetation structure intact, disturbance only affecting individual species, weeds are non-aggressive species.	High native plant species diversity ¹	Less than 10%
Very Good Vegetation structure altered, obvious signs of disturbance (e.g. repeated fires, dieback, logging, grazing). Aggressive weeds present.	Moderate native plant species diversity ¹	5 – 20%
Good Vegetation structure altered but retains basic vegetation structure or ability to regenerate it. Obvious signs of disturbance (from partial clearing, dieback, logging, grazing). Presence of very aggressive weeds.	Low native plant species diversity ¹	5 – 50%
Degraded Basic vegetation structure severely impacted by disturbance. Requires intensive management. Disturbance evident such as partial clearing, dieback, logging and grazing. Presence of very aggressive weeds at high density.	Very low native plant species diversity ¹	20 – 70%
Completely Degraded Vegetation structure is no longer intact and the area is completely or almost completely without native flora. Equivalent to 'Parkland Cleared'.	Very low to no native species diversity ¹	Greater than 70%

1. relative to expected natural range of diversity for that vegetation unit e.g. Floristic Community Type where comparative data exists.

1.4 Minimum Patch Size

Different minimum patch sizes apply to different levels of condition, as outlined below:

- Pristine – no minimum patch size
- Excellent – 0.5 ha or 5,000 m² (50 x 100 m)
- Very Good – 1 ha or 10,000 m² (100 x 100 m)
- Good – 2 ha or 20,000 m² (200 x 100 m)

Patch one was mapped as 'Very Good' condition. This patch is 27.14 ha, thereby far exceeding the minimum patch size. Patch two is of varying condition including Good, Very Good and Excellent. All patches are above 2 ha in size thereby complying to the size requirements as outlined above.

1.5 Further Information

The following information should be taken into consideration when applying the key diagnostic criteria and condition thresholds:

- Land use history and landscape position of patch including position relative to surrounding vegetation
- A patch is a discreet and mostly continuous area of the ecological community and may include small-scale variations (<30 m), gaps and disturbances such as tracks paths or breaks that do not significantly alter the overall functionality of the ecological community.
- Variation in canopy cover, quality or condition of vegetation across a patch should not be considered evidence of multiple patches
- A buffer zone is a contiguous area immediately adjacent to a patch of the ecological community. The recommended minimum buffer zone is 20-50 m. larger buffer zones should be considered for patches of particularly high conservation value, or if patches are down slope of drainage lines or a source of nutrient enrichment, or groundwater drawdown.
- Restored vegetation is not excluded provided it meets the key diagnostic criteria, condition threshold and patch size.
- Sampling protocols includes developing a quick map of the vegetation, landscape qualities and management history. Following this, a thorough sampling exercise must be undertaken to represent the range of variation. At least one hour per plot in early to mid-spring and a second survey in late spring may be required to detect the majority of species. plots to be at least 100 m² (10 x 10 m). Search effort (number of person hours per plot across entire patch) and surveyor's level of expertise can be useful for future reference.
- Timing of surveys should allow a reasonable interval after a disturbance. Surveys at least one year post fire may be required to assess a site against the key diagnostic characteristics and minimum condition thresholds.
- Surrounding environment, landscape context and other significance considerations:
 - patches that are more species rich and less disturbed are likely to provide greater biodiversity value.
 - Patches that provide corridors or linkages within a largely modified landscape are particularly important.

The Conservation Advice provides an additional ten indicators to be considered when assessing impacts of actions or proposed actions under the EPBC Act. These are not further listed here.

1.6 Protected in Reserves

The level of protection in reserves has been published based on estimated extent of major and partially corresponding vegetation system associations. This is shown in Table 3.

Table 3 Extent of Banksia Woodlands ecological community estimated to be protected in reserves

Subregion	Current extent (ha)	Extent in reserves (ha)	% Protected
Dandaragan (SWA01)	81,067.8	24,671.2	30.43
Perth (SWA02)	253,540.6	57,054.9	22.50
Jarrah Forests (JAF01/02)	1,881.4	105.9	5.63
TOTAL	336,489.9	81,832.0	24.32



Appendix E

Species by Family and
Community, Nirimba
2016

Appendix E Species by Family and Community, Nirimba 2016

Family	Cons	Taxon	BaHhOe	BaKgMr	EgEtEl	ErMiLg	ErXpLh	MrTpCc
Anarthriaceae			x					
		<i>Lyginia barbata</i>	x					
Apiaceae				x		x		x
		<i>Apium prostratum</i> var. <i>prostratum</i>						x
		<i>Eryngium pinnatifidum</i> subsp. <i>pinnatifidum</i> ms		x		x		
Araceae	* DP	<i>Zantedeschia aethiopica</i>	x				x	
Araliaceae			x	x		x		
		<i>Trachymene pilosa</i>	x	x		x		
Asparagaceae			x	x			x	
		<i>Chamaescilla corymbosa</i>	x	x				
		<i>Sowerbaea laxiflora</i>	x	x			x	
		<i>Thysanotus manglesianus</i>	x	x				
		<i>Thysanotus</i> sp.					x	
Asteraceae			x	x		x		
	*	<i>Arctotheca calendula</i>		x	x	x	x	x
	*	<i>Asteridea pulverulenta</i>	x	x				
		<i>Brachyscome iberidifolia</i>		x				
	*	<i>Cotula coronopifolia</i>						x
		<i>Craspedia variabilis</i>	x					
	*	<i>Hypochaeris glabra</i>	x	x	x	x	x	
		<i>Lagenophora huegelii</i>	x	x				
		<i>Myriocephalus helichrysoides</i>				x		
		<i>Podolepis gracilis</i>	x					
	*	<i>Sonchus oleraceus</i>	x	x				
	*	<i>Urospermum picrioides</i>	x	x				
	*	<i>Ursinia anthemoides</i>	x	x	x		x	x
Campanulaceae			x	x		x		
		<i>Lobelia rhytidosperra</i>	x	x		x		
	*	<i>Wahlenbergia capensis</i>		x				
Caryophyllaceae								
	*	<i>Silene gallica</i>		x				
	*	<i>Silene gallica</i> var. <i>quinquevulnera</i>	x	x				
Casuarinaceae			x	x		x		x
		<i>Allocasuarina fraseriana</i>	x	x		x		x
Chenopodiaceae					x			x
		<i>Maireana</i> sp.						x
		<i>Rhagodia baccata</i> subsp. <i>baccata</i>			x			
		<i>Tecticornia ? halocnemoides</i>						x
		<i>Tecticornia ? lepidosperma</i>						x
		<i>Tecticornia lepidosperma</i>						x
		<i>Tecticornia? pergranulata</i> subsp. <i>pergranulata</i>						x
Colchicaceae			x				x	
		<i>Burchardia congesta</i>	x				x	
Crassulaceae				x			x	
		<i>Crassula colorata</i>		x			x	

Family	Cons	Taxon	BaHhOe	BaKgMr	EgEtEl	ErMiLg	ErXpLh	MrTpCc
Cyperaceae		<i>Baumea rubiginosa</i>		X	X	X	X	X
		<i>Cyathochaeta avenacea</i>		X		X	X	X
		<i>Gahnia trifida</i>				X		
		<i>Isolepis cernua</i> var. <i>setiformis</i>						X
		<i>Isolepis marginata</i>		X	X			
		<i>Lepidosperma</i> sp.				X		
		<i>Lepidosperma squamatum</i>					X	
		<i>Schoenus subfascicularis</i>					X	
Dilleniaceae			X	X		X		
		<i>Hibbertia acerosa</i>	X					
		<i>Hibbertia hypericoides</i>	X	X				
		<i>Hibbertia racemosa</i>	X	X				
		<i>Hibbertia stellaris</i>				X		
		<i>Hibbertia vaginata</i>		X				
Droseraceae			X	X			X	
		<i>Drosera erythrorhiza</i>	X	X				
		<i>Drosera glanduligera</i>		X			X	
		<i>Drosera macrantha</i>	X	X				
Ericaceae			X	X				
		<i>Conostephium pendulum</i>	X	X				
		<i>Leucopogon propinquus</i>	X	X				
Euphorbiaceae								
	*	<i>Euphorbia terracina</i>			X			
Fabaceae			X	X		X	X	
		<i>Acacia ?saligna</i>		X				
		<i>Acacia pulchella</i>	X	X				
		<i>Acacia pulchella</i> var. <i>goadbyi</i>	X	X				
		<i>Acacia saligna</i>		X		X		
		<i>Bossiaea eriocarpa</i>	X					
	P3	<i>Dillwynia dillwynioides</i>				X		
		<i>Hardenbergia comptoniana</i>	X	X				
		<i>Hovea trisperma</i>	X					
		<i>Isotropis cuneifolia</i> subsp. <i>cuneifolia</i>	X	X				
		<i>Jacksonia sternbergiana</i>					X	
		<i>Kennedia prostrata</i>	X	X				
	*	<i>Lupinus cosentinii</i>			X			
	*	<i>Ornithopus pinnatus</i>	X	X		X	X	X
	*	<i>Trifolium campestre</i>	X	X	X	X		
	*	<i>Trifolium hybridum</i> var. <i>hybridum</i>					X	
		<i>Viminaria juncea</i>				X		
Geraniaceae								
	*	<i>Geranium molle</i>		X				
Goodeniaceae						X		
		<i>Goodenia trichophylla</i>				X		
Haemodoraceae			X		X			X
		<i>Conostylis aculeata</i> subsp. <i>aculeata</i>	X					
		<i>Haemodorum laxum</i>						X
		<i>Haemodorum</i> sp.			X			

Family	Cons	Taxon	BaHhOe	BaKgMr	EgEtEl	ErMiLg	ErXpLh	MrTpCc
Iridaceae								
	*	? <i>Trachyandra divaricata</i>	x	x	x	x		
	*	<i>Moraea flaccida</i>					x	x
		<i>Patersonia occidentalis</i>				x		
	*	<i>Romulea flava</i>	x			x		
	*	<i>Watsonia meriana</i>				x		
	*	<i>Watsonia</i> sp.	x					
Juncaceae								
	*	<i>Juncus bufonius</i>		x		x	x	x
		<i>Juncus kraussii</i>					x	
		<i>Juncus pallidus</i>				x	x	x
		<i>Luzula meridionalis</i>		x				
Juncaginaceae								
		<i>Triglochin mucronata</i>						x
Lauraceae								
		<i>Cassytha racemosa</i> forma				x	x	
		<i>racemosa</i>				x		
		<i>Cassytha</i> sp.				x	x	
Loranthaceae								
		<i>Nuytsia floribunda</i>	x					
Menyanthaceae								
		<i>Ornduffia albiflora</i>				x		
Myrtaceae								
		<i>Agonis flexuosa</i>	x	x	x	x	x	x
		<i>Astartea affinis</i>	x					
		<i>Calothamnus lateralis</i>				x		
		<i>Corymbia calophylla</i>	x		x			
		<i>Eucalyptus gomphocephala</i>		x	x			
		<i>Eucalyptus marginata</i>	x	x	x			
		<i>Eucalyptus rudis</i> subsp.						
	P4	<i>cratyantha</i>					x	
		<i>Eucalyptus rudis</i> subsp. <i>rudis</i>	x	x		x		x
		<i>Kunzea glabrescens</i>	x	x		x	x	
		<i>Kunzea recurva</i>				x		
		<i>Melaleuca incana</i> subsp. <i>incana</i>				x	x	x
		<i>Melaleuca preissiana</i>	x			x	x	x
		<i>Melaleuca raphiophylla</i>				x	x	x
		<i>Melaleuca teretifolia</i>				x		
Orchidaceae								
		<i>Caladenia flava</i>	x	x		x	x	
		<i>Caladenia marginata</i>		x				
		<i>Caladenia</i> sp.		x				
		<i>Elythranthera brunonis</i>	x					
		<i>Leporella fimbriata</i>	x	x				
		<i>Microtis media</i>				x		
		Orchidaceae sp.	x	x				
		<i>Pheladenia deformis</i>	x	x			x	
		<i>Pterostylis</i> sp.				x		
		<i>Pterostylis</i> sp. (nana complex)		x				
		<i>Pyrorchis nigricans</i>	x	x				
		<i>Thelymitra vulgaris</i>				x		
Orobanchaceae								
	*	<i>Orobanche minor</i>			x			
Oxalidaceae								
	*	<i>Oxalis</i> sp.					x	

Family	Cons	Taxon	BaHhOe	BaKgMr	EgEtEl	ErMiLg	ErXpLh	MrTpCc
Poaceae			x					
	*	<i>Aira caryophylla</i>	x	x				
	*	<i>Avena barbata</i>	x					
	*	<i>Briza maxima</i>	x	x		x	x	
	*	<i>Briza minor</i>	x	x		x	x	
	*	<i>Bromus diandrus</i>	x		x		x	
	*	<i>Ehrharta longiflora</i>			x		x	
	*	<i>Hordeum marinum</i>						x
	*	<i>Lagurus ovatus</i>	x					
	*	<i>Lolium rigidum</i>			x			
	*	Poaceae sp.		x				
	*	<i>Polypogon monspeliensis</i>						x
		<i>Tetrarrhena laevis</i>	x					
Polygonaceae								
	*	<i>Rumex brownii</i>			x			
Primulaceae								
	*	<i>Lysimachia arvensis</i>	x	x				
Proteaceae			x	x				
		<i>Banksia attenuata</i>	x	x				
		<i>Banksia grandis</i>	x	x			x	
		<i>Banksia littoralis</i>	x			x		
		<i>Hakea prostrata</i>	x					
		<i>Hakea varia</i>				x		
		<i>Xylomelum occidentale</i>	x					
Ranunculaceae					x			
		<i>Clematis pubescens</i>			x			
Restionaceae			x			x	x	x
		<i>Alexgeorgea nitens</i>	x					
		<i>Chaetanthus aristatus</i>				x	x	
		<i>Desmocladius flexuosus</i>	x					
		<i>Hypolaena exsulca</i>				x		x
		<i>Lepyrodia glauca</i>				x		
		<i>Loxocarya cinerea</i>	x					
		<i>Restionaceae sp.</i>	x					
Rubiaceae			x			x		
		<i>Opercularia echinocephala</i>	x			x		
Solanaceae								
	*	<i>Solanum nigrum</i>			x			
Stylidiaceae			x	x			x	
		<i>Stylidium calcaratum</i>	x	x			x	
		<i>Stylidium diversifolium</i>	x					
		<i>Stylidium piliferum</i>	x	x				
Thymelaeaceae			x			x		
		<i>Pimelea brevistyla</i> subsp. <i>brevistyla</i>	x					
		<i>Pimelea lanata</i>				x		
Violaceae			x	x				
		<i>Hybanthus calycinus</i>	x	x				
Xanthorrhoeaceae			x	x			x	
		<i>Xanthorrhoea gracilis</i>	x					
		<i>Xanthorrhoea preissii</i>	x	x			x	
Zamiaceae			x	x	x		x	
		<i>Macrozamia riedlei</i>	x	x	x		x	



Appendix F

Wetland Assessment Forms

Appendix F Wetland Assessment Forms

1.0 UFI 3116

1.1 General Information

Assessor details	
Name	Floora de Wit and Lyn van Gorp
Date of site visit	2 August 2016
Company	AECOM Australia Pty Ltd
Weather during visit	Cloudy
Landowner	Main Roads Western Australia
Property details	Vegetated, mostly in Very Good to Excellent condition.
Location (lot/street)	Lot 1262 and 295 Carrabungup Road
Latitude and longitude or Easting northing	
Wetland details	
Name	
UFI	3116
Hill et al. (1996) map sheet number and wetland ID number	
Consanguineous suite	Keysbrook
Area (ha) of wetland	~6 ha
Area (ha) subject to this evaluation	~6 ha
Is wetland assessed as portion of wetland with varying degrees of value?	No
Mapped management category	Conservation
Wetland type (see table below)	Sumpland

Water permanence	Host landform				
	Basin	Flat	Slope	Highland	Channel
Permanent inundation	Lake	-	-	-	River*
Seasonal inundation	Sumpland	Floodplain*	-	-	Creek*
Intermittent inundation	Playa*	Barlkarra*	-	-	Wadi*
Seasonal waterlogging	Dampland	Palusplain	Paluslope	Palusmont*	Trough*

*Wetland types not applicable to this evaluation methodology.

1.2 Wetland desktop evaluation

Land uses	
Current ownership of wetland	Main Roads Western Australia
Current land use	Vegetated
Past land use	Unknown
Surrounding land use	RAMSAR wetland, agriculture
Existing management	No known management
Fire history/regime	Unknown, no evidence of recent fire

International, national or regional significance	
Indicate whether the wetland is identified (permanent or interim) on one of the following international, national or state registers or listings.	
Conservation Significance	Y/N
Ramsar Convention on Wetlands (Ramsar 1971)	N
Directory of Important Wetlands in Australia (Environment Australia 2001)	N
Register of National Estate (Commonwealth of Australia 2007)	N
Conservation Reserves for Western Australia Systems 1, 2, 3, 5 (Department of Conservation and Environment, 1976)	n/a
Conservation Reserves for Western Australia, The Darling System – System 6 (Department of Conservation and Environment, 1983)	N
A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton – Walpole Region (Pen 1997)	N
The Environmental Significance of Wetlands in the Perth to Bunbury Region (Le Provost et al. 1987)	N
Bush Forever (Government of Western Australia 2000)	N
Swan Bioplan (Environmental Protection Authority 2010)	N
Environmental Protection (Swan Coastal Plain Lakes) Policy 1992	N
Environmental Protection (Western Swamp Tortoise Habitat) Policy Approval Order 2002	N
Conservation Estate (e.g. National Park, Nature Reserve, A Class Reserve)	N
Other (list):	Y ESA
Does the wetland retain the values for which it was originally registered or listed, describe:	

Fauna			
Note the presence (recorded or observed) or evidence of fauna in or surrounding the wetland which is listed by the Commonwealth (e.g. Environment Protection and Biodiversity Conservation Act 1999, CAMBA, RoKAMBA, JAMBA) or State (e.g. Threatened or Specially Protected Fauna under the Wildlife Conservation Act 1950) or Priority Fauna or Priority or Threatened Ecological Communities related to fauna which are listed by DPaW.			
Species / name of ecological community	Significance (e.g. EPBC Act, CAMBA)	Observations (e.g. population size, age, evidence, activities, habitat requirements)	Source of information (e.g. observatory, literature, DPaW, WA Museum)

Scientific value		
List any scientific values including geoheritage or geoconservation values (e.g. important sediments or geological features, fossils, pollen records, stromatolites, thrombolites, evidence of evolutionary processes, evidence of a change in climate, unique flora or fauna adaptations) that the wetland may contain.		
Scientific, geoheritage or geoconservation values	Significance and observations	Source of information (e.g. observatory, literature, DPaW, WA Museum)

Flora				
Use aerial photography and a site visit to determine and confirm the condition of the vegetation within and 50 metres surrounding the wetland. Using the scale outlined in Appendix B, display the locations of the vegetation conditions in the attached map and calculate their total area:				
Vegetation condition	Total area (%) within the wetland	Area (%) 50 metres surrounding the wetland		
Pristine				
Excellent	100%	100%		
Very Good				
Good				
Degraded				
Completely Degraded				
Using this information, is the wetland dominated by vegetation in a good or better condition:		Yes		
What vegetation complex (Hedde et al. 1980) does the wetland belong to:		Vasse complex		
Using the information sources outlined in Appendix B, what extent of the vegetation complex is remaining on the Swan Coastal Plain		35.9 %		
List any occurrences of Priority and Threatened Ecological Communities related to flora and wetland systems which are known to occur within and 5 kilometres surrounding the wetland. If they are located within or adjacent to the wetland display their boundary in the attached map:				
Name of ecological community	Significance (e.g. priority, threatened)	Observations (e.g. condition, area, habitat type)	Source of information (e.g. observatory, literature, DPaW)	
No detailed desktop undertaken				
List any occurrences of Declared Rare flora or Priority flora known to occur within and 1 kilometre surrounding the wetland and display their location in the attached map:				
Species	Significance (e.g. Declared Rare, Priority 1)	Population measure (number, single record, abundance comment)	Observations (e.g. habitat type, flowering season)	Source of information (e.g., literature, DPaW, surveyed population, Herbarium record)
No detailed desktop undertaken				

Representativeness	
Using the wetlands data outlined in section 4.3, Appendix D and available on DPaW's website record the corresponding area:	
	% area
What is the % area of wetlands with the same classification assigned a Conservation management category on the Swan Coastal Plain	37.0
What is the % area of wetlands in the same consanguineous suite assigned a Conservation management category	1.5
What is the % area of wetlands with the same classification in the same consanguineous suite assigned a conservation management category	8.1
Is the wetland rare? (e.g. only wetland in its consanguineous suite, best wetland example in its consanguineous suite or region, only Conservation management category wetland in the consanguineous suite or region, primary saline wetland within a consanguineous suite predominated by freshwater):	N

No.	Criteria	Y/N
1	<p>The wetland is currently recognised as internationally or nationally significant for its natural values. Lists/registers include:</p> <ul style="list-style-type: none"> - The Ramsar Convention on Wetlands - State government endorsed candidate sites for the Ramsar Convention on Wetlands - Directory of Important Wetlands in Australia - National Heritage List - Or equivalent. 	N N N N N
2	<p>The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is identified as significant for its natural values under one or more of the following:</p> <ul style="list-style-type: none"> - <i>Conservation Reserves for Western Australia Systems 1, 2, 3, 5</i> - <i>Conservation Reserves for Western Australia, The Darling System – System 6</i> - <i>A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton – Walpole Region</i> - <i>The Environmental Significance of Wetlands in the Perth to Bunbury Region</i> - <i>Bush Forever, Swan Bioplan or equivalent.</i> 	N N N N N
3	<p>The wetland supports a breeding, roosting, or refuge site or a critical feeding site for populations of fauna listed by the Australian Government (for example, <i>Environment Protection and Biodiversity Conservation Act 1999</i>, migratory bird agreements such as JAMBA, CAMBA and RoKAMBA) or the State (for example, Threatened and Specially Protected Fauna listed under the <i>Wildlife Conservation Act 1950</i>).</p>	N
4	<p>The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and supports one or more of the following:</p> <ul style="list-style-type: none"> - An occurrence of a Threatened Ecological Community - A confirmed occurrence of a Priority 1 or Priority 2 Ecological Community - A confirmed occurrence of a Declared Rare (Threatened) flora species. 	N N N
5	<p>Equal to or greater than 90% of the wetland supports vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B.</p>	Y

No.	Criteria	Y/N
6	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is known to support internationally, nationally or state-wide scientific values including geoheritage and geoconservation.	N
7	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and meets one of the following: <ul style="list-style-type: none"> - ≤10% of wetlands of the same type are assigned Conservation management category within the Swan Coastal Plain (by area) - ≤10% of all wetlands in the same consanguineous suite are assigned Conservation management category (by area) - ≤10% of wetlands of the same type in its consanguineous suite are assigned Conservation management category (by area) - best representative of its type within its consanguineous suite domain. 	N N N N

1.3 Secondary Assessment Form

No.	General criteria	Criteria	Score
Geomorphology			
1	<i>Representativeness</i>	≤20% of wetlands of the same type are assigned Conservation on the Swan Coastal Plain by area.	H
2		≤20% of wetlands in the same consanguineous suite are assigned Conservation by area.	H
3		≤20% of wetlands of the same type in the same consanguineous suite are assigned Conservation by area.	H
4		The wetland is outstanding in some geomorphic aspect, for example size, origin, height relative to sea level, depth, age.	H
5	<i>Naturalness</i>	Alteration to the wetland's geomorphology by % area: < 25% altered 25-75% altered > 75% altered.	H I L
6	<i>Scarcity</i>	The wetland exhibits unusual geomorphology or unusual internal geomorphic features compared to other wetlands of the same type in the consanguineous suite.	H
7		The wetland is the best example of its type in its consanguineous suite.	H
Wetland processes			
8	<i>Representativeness</i>	The wetland is an important component of the natural hydrological cycle providing natural functions (e.g. flood protection and recharge/discharge). The wetland's vegetation, geomorphology, hydrology or sediments are modified; however, the wetland is still a component of the hydrological cycle providing natural and artificial functions (e.g. flood remediation, recharge/discharge and hydrological storage). The wetland's vegetation, geomorphology, hydrology or sediments are modified to the extent that the wetlands hydrological functions are artificial such as storage, or the wetland has been disconnected from the natural hydrological cycle and no longer provides natural attributes and functions.	H I L
9		The wetland supports a representative process (e.g. wetland process typical of the wetland's hydrological setting, sediment accretionary process typical of the wetland's geomorphic setting or hydrochemical process typical of the wetland's geological setting).	H

No.	General criteria	Criteria	Score
10	<i>Naturalness</i>	The wetland is not subject to altered wetland processes or, is subject to altered wetland processes and the wetland's natural attributes and functions are maintained.	H
		The wetland is subject to altered wetland processes and the wetland's natural attributes and functions have been changed; however, they have the potential to be rehabilitated.	I
		The wetland is subject to altered wetland processes to the extent that the wetland no longer supports natural attributes and functions.	L
11	<i>Scarcity</i>	The wetland exhibits unusual processes (e.g. hydrological, sedimentological, chemical, biological) compared to other wetlands of the same type in the consanguineous suite.	H
Linkages			
12	<i>Representativeness</i>	The wetland is a hydrological link in a larger or more complex and intact system.	H
13	<i>Naturalness</i>	The wetland is part of a continuous ecological linkage or wildlife corridor, or a regionally significant ecological linkage or wildlife corridor connecting bushland or wetland areas.	H
		The wetland is part of a fragmented ecological linkage or wildlife corridor.	I
		The wetland is disturbed and isolated, surrounded by either a built or highly disturbed environment with no nearby native vegetation or waterways to support an intact or fragmented ecological linkage or wildlife corridor.	L
14	<i>Scarcity</i>	The wetland has unusual hydrological, hydrochemical or ecological linkages with adjacent wetland or bushland.	I
Habitats			
15	<i>Representativeness</i>	The wetland is isolated from other undisturbed wetlands or bushland and as a result, maintains important ecological or genetic fauna or flora diversity within its consanguineous suite domain.	H
16		The wetland contains evidence of surface water that is vital to maintaining regionally significant populations of native aquatic or terrestrial flora or fauna.	H
17		The wetland provides a nursery for native fauna populations, or maintains fauna populations at a vulnerable stage of their life cycle.	H
18	<i>Naturalness</i>	The wetland supports habitats that are unaltered or the wetland has been altered and its natural habitats are maintained.	H
		The wetland supports habitats that are altered; however, the habitats are still identifiable and have the potential to be rehabilitated.	I
		The wetland is altered and as a result is no longer supporting natural habitats which can be rehabilitated.	L
19	<i>Scarcity</i>	The wetland supports habitats that are unusual compared to other wetlands of the same type on the Swan Coastal Plain.	H

No.	General criteria	Criteria	Score
Flora			
20	<i>Representativeness</i>	<p>The wetland's current diversity of native flora is similar to what would be expected in an unaltered state.</p> <p>The wetland supports a reduced diversity of native flora due to human induced disturbances.</p> <p>The wetland supports a significantly reduced diversity of native flora species due to human induced disturbances.</p>	<p>H</p> <p>I</p> <p>L</p>
21		<p>The wetland is identified in a vegetation complex (Hedde et al. 1980) which is represented by:</p> <p>≤30% of the pre-European extent</p> <p>30-50% of the pre-European extent.</p>	<p>H</p> <p>I</p>
22	<i>Naturalness</i>	<p>Using the vegetation condition scale outlined in Appendix B, the wetland's vegetation condition by area is:</p> <p>≥ 75% Good, Very Good, Excellent or Pristine</p> <p>25-75% Good, Very Good, Excellent or Pristine</p> <p>< 25% Good, Very Good, Excellent or Pristine.</p>	<p>H</p> <p>I</p> <p>L</p>
23		<p>The wetland or ≥ 50% of the wetland boundary is surrounded by land dominated by remnant native vegetation.</p> <p>The wetland or 10-50% of the wetland boundary is surrounded by land dominated by remnant native vegetation.</p> <p>The wetland or < 10% of the wetland boundary is surrounded by land dominated by remnant native vegetation.</p>	<p>H</p> <p>I</p> <p>L</p>
24	<i>Scarcity</i>	<p>The wetland supports an occurrence of Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora, or an occurrence of 3 or more significant flora taxa.</p>	H
25		<p>The wetland is likely to support Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora; however, the occurrence cannot be located or its habitat has been altered and is no longer in a natural state.</p>	I
26		<p>The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.</p>	H
27		<p>The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community.</p>	I
Fauna			
28	<i>Representativeness</i>	<p>The wetland is an ecological refuge for regionally significant fauna species or fauna assemblages.</p> <p>The wetland has the potential to be an ecological refuge but is disturbed and its attributes and functions require rehabilitation.</p>	<p>H</p> <p>I</p>
29		<p>The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regionally significant native fauna.</p> <p>The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regional or local fauna but only in association with other surrounding natural areas.</p>	<p>H</p> <p>I</p>

No.	General criteria	Criteria	Score
30	<i>Naturalness</i>	The wetland's current diversity of native fauna is similar to what would be expected in an unaltered state, or the wetland supports diverse fauna compared to other wetlands of the same type. The wetland supports a reduced diversity of fauna compared to other wetlands of the same type.	H I
31		The wetland supports limited attributes and functions for fauna populations due to human induced disturbances.	L
32	<i>Scarcity</i>	The wetland is likely to support a breeding, roosting, refuge or feeding site for populations of fauna listed by the Commonwealth (e.g. <i>EPBC Act 1999</i> , JAMBA, CAMBA, RoKAMBA Agreements) or the State (e.g. Threatened or Specially Protected Fauna listed under the <i>Wildlife Conservation Act 1950</i>).	H
33		The wetland supports a breeding, roosting, refuge or feeding site for Priority 1, Priority 2, Priority 3 or Priority 4 fauna.	H
34		The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	H
35		The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community or a breeding, roosting, refuge or feeding site for significant fauna.	I
Cultural			
36	<i>Representativeness</i>	The wetland or its immediate surrounds is identified for its natural values on a national or State heritage list or the wetland supports other known regional heritage values.	H
37		The wetland or its immediate surrounds is identified for its natural values on a municipal heritage list or the wetland supports other known local heritage values.	I
38		The wetland or its immediate surrounds is identified on a national, State or local list or register for its Aboriginal cultural value (e.g. Department of Aboriginal Affairs register).	H
39		The wetland is important to the local community either nationally or state wide for its natural values.	H
40		The wetland is or has the potential to be a site for public or private based recreation.	I
41		The wetland is likely to support heritage, cultural or social values; however, the value cannot be confirmed or the value has been disturbed and are no longer as important or significant. The wetland did support heritage, cultural or social values; however, these have been significantly disturbed and are no longer important or the values have been removed.	I L
Scientific and educational			
42	<i>Representativeness</i>	The wetland supports known important teaching or research characteristics and for this reason is an existing or potential education or research site. Note, the wetland must still support the relevant teaching or research characteristics. The wetland has the potential to be used as a study or research site.	H I
43		The wetland supports known scientific, geoheritage or geoconservation values.	H
44		The wetland did support scientific or educational values; however, these have been significantly disturbed and are no longer as important or the values have been removed.	L

1.4 Results

Attributes/functions /values	Scores		
	High	Intermediate	Low
Geomorphology	3	0	0
Wetland processes	2	0	0
Linkages	0	1	0
Habitats	1	0	0
Flora	3	0	0
Fauna	1	0	0
Cultural	0	0	0
Scientific and educational	0	0	0
Total Score	10	1	0
Defining attributes/ functions/values	Geomorphology and flora values		
Applicable management category	Conservation		

2.0 UFI 14562, 2992, 3115

2.1 General Information

Assessor details	
Name	Floora de Wit and Lyn van Gorp
Date of site visit	2 August 2016
Company	AECOM Australia Pty Ltd
Weather during visit	Cloudy
Landowner	Main Roads Western Australia
Property details	Vegetated, mostly in Very Good to Excellent condition.
Location (lot/street)	Lot 1262, 295 and 842 Carrabungup Road
Latitude and longitude or Easting northing	
Wetland details	
Name	
UFI	14562, 2992 and 3115
Hill et al. (1996) map sheet number and wetland ID number	
Consanguineous suite	
Area (ha) of wetland	~53 ha
Area (ha) subject to this evaluation	~41 ha
Is wetland assessed as portion of wetland with varying degrees of value?	Yes, grouped with other wetlands considered MU and RE
Mapped management category	Conservation Category
Wetland type (see table below)	Estuary – Peripheral

Water permanence	Host landform				
	Basin	Flat	Slope	Highland	Channel
Permanent inundation	Lake	-	-	-	River*
Seasonal inundation	Sumpland	Floodplain*	-	-	Creek*
Intermittent inundation	Playa*	Barlkarra*	-	-	Wadi*
Seasonal waterlogging	Dampland	Palusplain	Paluslope	Palusmont*	Trough*

*Wetland types not applicable to this evaluation methodology.

2.2 Wetland desktop evaluation

Land uses	
Current ownership of wetland	Main Roads Western Australia
Current land use	Vegetated
Past land use	Unknown
Surrounding land use	RAMSAR wetland, agriculture
Existing management	No known management
Fire history/regime	Unknown, no evidence of recent fire

International, national or regional significance	
Indicate whether the wetland is identified (permanent or interim) on one of the following international, national or state registers or listings.	
Conservation Significance	Y/N
Ramsar Convention on Wetlands (Ramsar 1971)	N
Directory of Important Wetlands in Australia (Environment Australia 2001)	N
Register of National Estate (Commonwealth of Australia 2007)	N
Conservation Reserves for Western Australia Systems 1, 2, 3, 5 (Department of Conservation and Environment, 1976)	n/a
Conservation Reserves for Western Australia, The Darling System – System 6 (Department of Conservation and Environment, 1983)	N
A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton – Walpole Region (Pen 1997)	N
The Environmental Significance of Wetlands in the Perth to Bunbury Region (Le Provost et al. 1987)	N
Bush Forever (Government of Western Australia 2000)	N
Swan Bioplan (Environmental Protection Authority 2010)	N
Environmental Protection (Swan Coastal Plain Lakes) Policy 1992	N
Environmental Protection (Western Swamp Tortoise Habitat) Policy Approval Order 2002	N
Conservation Estate (e.g. National Park, Nature Reserve, A Class Reserve)	N
Other (list):	Y ESA
Does the wetland retain the values for which it was originally registered or listed, describe:	

Fauna			
Note the presence (recorded or observed) or evidence of fauna in or surrounding the wetland which is listed by the Commonwealth (e.g. Environment Protection and Biodiversity Conservation Act 1999, CAMBA, RoKAMBA, JAMBA) or State (e.g. Threatened or Specially Protected Fauna under the Wildlife Conservation Act 1950) or Priority Fauna or Priority or Threatened Ecological Communities related to fauna which are listed by DPaW.			
Species / name of ecological community	Significance (e.g. EPBC Act, CAMBA)	Observations (e.g. population size, age, evidence, activities, habitat requirements)	Source of information (e.g. observatory, literature, DPaW, WA Museum)

Scientific value		
List any scientific values including geoheritage or geoconservation values (e.g. important sediments or geological features, fossils, pollen records, stromatolites, thrombolites, evidence of evolutionary processes, evidence of a change in climate, unique flora or fauna adaptations) that the wetland may contain.		
Scientific, geoheritage or geoconservation values	Significance and observations	Source of information (e.g. observatory, literature, DPaW, WA Museum)

Flora			
Use aerial photography and a site visit to determine and confirm the condition of the vegetation within and 50 metres surrounding the wetland. Using the scale outlined in Appendix B, display the locations of the vegetation conditions in the attached map and calculate their total area:			
Vegetation condition	Total area (%) within the wetland	Area (%) 50 metres surrounding the wetland	
Pristine			
Excellent	80%	100%	
Very Good			
Good	20%		
Degraded			
Completely Degraded			
Using this information, is the wetland dominated by vegetation in a good or better condition:		Yes	
What vegetation complex (Hedde et al. 1980) does the wetland belong to:		Vasse complex	
Using the information sources outlined in Appendix B, what extent of the vegetation complex is remaining on the Swan Coastal Plain		35.9 %	
List any occurrences of Priority and Threatened Ecological Communities related to flora and wetland systems which are known to occur within and 5 kilometres surrounding the wetland. If they are located within or adjacent to the wetland display their boundary in the attached map:			
Name of ecological community	Significance (e.g. priority, threatened)	Observations (e.g. condition, area, habitat type)	Source of information (e.g. observatory, literature, DPaW)
No detailed desktop undertaken			
List any occurrences of Declared Rare flora or Priority flora known to occur within and 1 kilometre surrounding the wetland and display their location in the attached map:			

Flora				
Species	Significance (e.g. Declared Rare, Priority 1)	Population measure (number, single record, abundance comment)	Observations (e.g. habitat type, flowering season)	Source of information (e.g., literature, DPaW, surveyed population, Herbarium record)
No detailed desktop undertaken				

Representativeness	
Using the wetlands data outlined in section 4.3, Appendix D and available on DPaW's website record the corresponding area:	
	% area
What is the % area of wetlands with the same classification assigned a Conservation management category on the Swan Coastal Plain	55.3
What is the % area of wetlands in the same consanguineous suite assigned a Conservation management category	0.8
What is the % area of wetlands with the same classification in the same consanguineous suite assigned a conservation management category	69.2
Is the wetland rare? (e.g. only wetland in its consanguineous suite, best wetland example in its consanguineous suite or region, only Conservation management category wetland in the consanguineous suite or region, primary saline wetland within a consanguineous suite predominated by freshwater):	N

No.	Criteria	Y/N
1	The wetland is currently recognised as internationally or nationally significant for its natural values. Lists/registers include: <ul style="list-style-type: none"> - The Ramsar Convention on Wetlands - State government endorsed candidate sites for the Ramsar Convention on Wetlands - Directory of Important Wetlands in Australia - National Heritage List - Or equivalent. 	 N N N Y N
2	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is identified as significant for its natural values under one or more of the following: <ul style="list-style-type: none"> - <i>Conservation Reserves for Western Australia Systems 1, 2, 3, 5</i> - <i>Conservation Reserves for Western Australia, The Darling System – System 6</i> - <i>A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton – Walpole Region</i> - <i>The Environmental Significance of Wetlands in the Perth to Bunbury Region</i> - <i>Bush Forever, Swan Bioplan or equivalent.</i> 	 N N N N N
3	The wetland supports a breeding, roosting, or refuge site or a critical feeding site for populations of fauna listed by the Australian Government (for example, <i>Environment Protection and Biodiversity Conservation Act 1999</i> , migratory bird agreements such as JAMBA, CAMBA and RoKAMBA) or the State (for example, Threatened and Specially Protected Fauna listed under the Wildlife Conservation Act 1950).	N
4	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and supports one or more of the following: <ul style="list-style-type: none"> - An occurrence of a Threatened Ecological Community - A confirmed occurrence of a Priority 1 or Priority 2 Ecological Community - A confirmed occurrence of a Declared Rare (Threatened) flora species. 	 N N N

No.	Criteria	Y/N
5	Equal to or greater than 90% of the wetland supports vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B.	Y
6	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is known to support internationally, nationally or state-wide scientific values including geoheritage and geoconservation.	N
7	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and meets one of the following: <ul style="list-style-type: none"> - ≤10% of wetlands of the same type are assigned Conservation management category within the Swan Coastal Plain (by area) - ≤10% of all wetlands in the same consanguineous suite are assigned Conservation management category (by area) - ≤10% of wetlands of the same type in its consanguineous suite are assigned Conservation management category (by area) - best representative of its type within its consanguineous suite domain. 	N N N N

2.3 Secondary Assessment Form

No.	General criteria	Criteria	Score
Geomorphology			
1	<i>Representativeness</i>	≤20% of wetlands of the same type are assigned Conservation on the Swan Coastal Plain by area.	H
2		≤20% of wetlands in the same consanguineous suite are assigned Conservation by area.	H
3		≤20% of wetlands of the same type in the same consanguineous suite are assigned Conservation by area.	H
4		The wetland is outstanding in some geomorphic aspect, for example size, origin, height relative to sea level, depth, age.	H
5	<i>Naturalness</i>	Alteration to the wetland's geomorphology by % area: < 25% altered 25-75% altered > 75% altered.	H I L
6	<i>Scarcity</i>	The wetland exhibits unusual geomorphology or unusual internal geomorphic features compared to other wetlands of the same type in the consanguineous suite.	H
7		The wetland is the best example of its type in its consanguineous suite.	H
Wetland processes			
8	<i>Representativeness</i>	The wetland is an important component of the natural hydrological cycle providing natural functions (e.g. flood protection and recharge/discharge). The wetland's vegetation, geomorphology, hydrology or sediments are modified; however, the wetland is still a component of the hydrological cycle providing natural and artificial functions (e.g. flood remediation, recharge/discharge and hydrological storage). The wetland's vegetation, geomorphology, hydrology or sediments are modified to the extent that the wetlands hydrological functions are artificial such as storage, or the wetland has been disconnected from the natural hydrological cycle and no longer provides natural attributes and functions.	H I L
9		The wetland supports a representative process (e.g. wetland process typical of the wetland's hydrological setting, sediment accretionary process typical of the wetland's geomorphic setting or hydrochemical process typical of the wetland's geological setting).	H

No.	General criteria	Criteria	Score
10	<i>Naturalness</i>	The wetland is not subject to altered wetland processes or, is subject to altered wetland processes and the wetland's natural attributes and functions are maintained.	H
		The wetland is subject to altered wetland processes and the wetland's natural attributes and functions have been changed; however, they have the potential to be rehabilitated.	I
		The wetland is subject to altered wetland processes to the extent that the wetland no longer supports natural attributes and functions.	L
11	<i>Scarcity</i>	The wetland exhibits unusual processes (e.g. hydrological, sedimentological, chemical, biological) compared to other wetlands of the same type in the consanguineous suite.	H
Linkages			
12	<i>Representativeness</i>	The wetland is a hydrological link in a larger or more complex and intact system.	H
13	<i>Naturalness</i>	The wetland is part of a continuous ecological linkage or wildlife corridor, or a regionally significant ecological linkage or wildlife corridor connecting bushland or wetland areas.	H
		The wetland is part of a fragmented ecological linkage or wildlife corridor.	I
		The wetland is disturbed and isolated, surrounded by either a built or highly disturbed environment with no nearby native vegetation or waterways to support an intact or fragmented ecological linkage or wildlife corridor.	L
14	<i>Scarcity</i>	The wetland has unusual hydrological, hydrochemical or ecological linkages with adjacent wetland or bushland.	I
Habitats			
15	<i>Representativeness</i>	The wetland is isolated from other undisturbed wetlands or bushland and as a result, maintains important ecological or genetic fauna or flora diversity within its consanguineous suite domain.	H
16		The wetland contains evidence of surface water that is vital to maintaining regionally significant populations of native aquatic or terrestrial flora or fauna.	H
17		The wetland provides a nursery for native fauna populations, or maintains fauna populations at a vulnerable stage of their life cycle.	H
18	<i>Naturalness</i>	The wetland supports habitats that are unaltered or the wetland has been altered and its natural habitats are maintained.	H
		The wetland supports habitats that are altered; however, the habitats are still identifiable and have the potential to be rehabilitated.	I
		The wetland is altered and as a result is no longer supporting natural habitats which can be rehabilitated.	L
19	<i>Scarcity</i>	The wetland supports habitats that are unusual compared to other wetlands of the same type on the Swan Coastal Plain.	H

No.	General criteria	Criteria	Score
Flora			
20	<i>Representativeness</i>	<p>The wetland's current diversity of native flora is similar to what would be expected in an unaltered state.</p> <p>The wetland supports a reduced diversity of native flora due to human induced disturbances.</p> <p>The wetland supports a significantly reduced diversity of native flora species due to human induced disturbances.</p>	<p>H</p> <p>I</p> <p>L</p>
21		<p>The wetland is identified in a vegetation complex (Hedde et al. 1980) which is represented by:</p> <p>≤30% of the pre-European extent</p> <p>30-50% of the pre-European extent.</p>	<p>H</p> <p>I</p>
22	<i>Naturalness</i>	<p>Using the vegetation condition scale outlined in Appendix B, the wetland's vegetation condition by area is:</p> <p>≥ 75% Good, Very Good, Excellent or Pristine</p> <p>25-75% Good, Very Good, Excellent or Pristine</p> <p>< 25% Good, Very Good, Excellent or Pristine.</p>	<p>H</p> <p>I</p> <p>L</p>
23		<p>The wetland or ≥ 50% of the wetland boundary is surrounded by land dominated by remnant native vegetation.</p> <p>The wetland or 10-50% of the wetland boundary is surrounded by land dominated by remnant native vegetation.</p> <p>The wetland or < 10% of the wetland boundary is surrounded by land dominated by remnant native vegetation.</p>	<p>H</p> <p>I</p> <p>L</p>
24	<i>Scarcity</i>	<p>The wetland supports an occurrence of Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora, or an occurrence of 3 or more significant flora taxa.</p>	H
25		<p>The wetland is likely to support Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora; however, the occurrence cannot be located or its habitat has been altered and is no longer in a natural state.</p>	I
26		<p>The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.</p>	H
27		<p>The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community.</p>	I
Fauna			
28	<i>Representativeness</i>	<p>The wetland is an ecological refuge for regionally significant fauna species or fauna assemblages.</p> <p>The wetland has the potential to be an ecological refuge but is disturbed and its attributes and functions require rehabilitation.</p>	<p>H</p> <p>I</p>
29		<p>The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regionally significant native fauna.</p> <p>The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regional or local fauna but only in association with other surrounding natural areas.</p>	<p>H</p> <p>I</p>

No.	General criteria	Criteria	Score
30	<i>Naturalness</i>	The wetland's current diversity of native fauna is similar to what would be expected in an unaltered state, or the wetland supports diverse fauna compared to other wetlands of the same type. The wetland supports a reduced diversity of fauna compared to other wetlands of the same type.	H I
31		The wetland supports limited attributes and functions for fauna populations due to human induced disturbances.	L
32	<i>Scarcity</i>	The wetland is likely to support a breeding, roosting, refuge or feeding site for populations of fauna listed by the Commonwealth (e.g. <i>EPBC Act 1999</i> , JAMBA, CAMBA, RoKAMBA Agreements) or the State (e.g. Threatened or Specially Protected Fauna listed under the <i>Wildlife Conservation Act 1950</i>).	H
33		The wetland supports a breeding, roosting, refuge or feeding site for Priority 1, Priority 2, Priority 3 or Priority 4 fauna.	H
34		The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	H
35		The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community or a breeding, roosting, refuge or feeding site for significant fauna.	I
Cultural			
36	<i>Representativeness</i>	The wetland or its immediate surrounds is identified for its natural values on a national or State heritage list or the wetland supports other known regional heritage values.	H
37		The wetland or its immediate surrounds is identified for its natural values on a municipal heritage list or the wetland supports other known local heritage values.	I
38		The wetland or its immediate surrounds is identified on a national, State or local list or register for its Aboriginal cultural value (e.g. Department of Aboriginal Affairs register).	H
39		The wetland is important to the local community either nationally or state wide for its natural values.	H
40		The wetland is or has the potential to be a site for public or private based recreation.	I
41		The wetland is likely to support heritage, cultural or social values; however, the value cannot be confirmed or the value has been disturbed and are no longer as important or significant. The wetland did support heritage, cultural or social values; however, these have been significantly disturbed and are no longer important or the values have been removed.	I L
Scientific and educational			
42	<i>Representativeness</i>	The wetland supports known important teaching or research characteristics and for this reason is an existing or potential education or research site. Note, the wetland must still support the relevant teaching or research characteristics. The wetland has the potential to be used as a study or research site.	H I
43		The wetland supports known scientific, geoheritage or geoconservation values.	H
44		The wetland did support scientific or educational values; however, these have been significantly disturbed and are no longer as important or the values have been removed.	L

2.4 Results

Attributes/functions /values	Scores		
	High	Intermediate	Low
Geomorphology	2	0	0
Wetland processes	3	0	0
Linkages	2	1	0
Habitats	1	1	0
Flora	2	2	0
Fauna	3	2	0
Cultural	1	0	0
Scientific and educational	0	1	0
Total Score	14	6	0
Defining attributes/ functions/values	Wetland processes and fauna		
Applicable management category	Conservation		

3.0 UFI 2995

3.1 General Information

Assessor details	
Name	Floora de Wit and Lyn van Gorp
Date of site visit	2 August 2016
Company	AECOM Australia Pty Ltd
Weather during visit	Cloudy, rain patches
Landowner	Main Roads Western Australia
Property details	Vegetated, mostly in Excellent condition.
Location (lot/street)	Lot 252 Carrabungup Road
Latitude and longitude or Easting northing	
Wetland details	
Name	
UFI	2995
Hill et al. (1996) map sheet number and wetland ID number	
Consanguineous suite	Keysbrook
Area (ha) of wetland	~17 ha
Area (ha) subject to this evaluation	~17 ha
Is wetland assessed as portion of wetland with varying degrees of value?	No
Mapped management category	Conservation
Wetland type (see table below)	Sumpland

Water permanence	Host landform				
	Basin	Flat	Slope	Highland	Channel
Permanent inundation	Lake	-	-	-	River*
Seasonal inundation	Sumpland	Floodplain*	-	-	Creek*
Intermittent inundation	Playa*	Barlkarra*	-	-	Wadi*
Seasonal waterlogging	Dampland	Palusplain	Paluslope	Palusmont*	Trough*

*Wetland types not applicable to this evaluation methodology.

3.2 Wetland desktop evaluation

Land uses	
Current ownership of wetland	Main Roads Western Australia
Current land use	Vegetated
Past land use	Unknown
Surrounding land use	RAMSAR wetland, agriculture
Existing management	No known management
Fire history/regime	Unknown, no evidence of recent fire

International, national or regional significance	
Indicate whether the wetland is identified (permanent or interim) on one of the following international, national or state registers or listings.	
Conservation Significance	Y/N
Ramsar Convention on Wetlands (Ramsar 1971)	N
Directory of Important Wetlands in Australia (Environment Australia 2001)	N
Register of National Estate (Commonwealth of Australia 2007)	N
Conservation Reserves for Western Australia Systems 1, 2, 3, 5 (Department of Conservation and Environment, 1976)	n/a
Conservation Reserves for Western Australia, The Darling System – System 6 (Department of Conservation and Environment, 1983)	N
A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton – Walpole Region (Pen 1997)	N
The Environmental Significance of Wetlands in the Perth to Bunbury Region (Le Provost et al. 1987)	N
Bush Forever (Government of Western Australia 2000)	N
Swan Bioplan (Environmental Protection Authority 2010)	N
Environmental Protection (Swan Coastal Plain Lakes) Policy 1992	N
Environmental Protection (Western Swamp Tortoise Habitat) Policy Approval Order 2002	N
Conservation Estate (e.g. National Park, Nature Reserve, A Class Reserve)	N
Other (list):	Y ESA
Does the wetland retain the values for which it was originally registered or listed, describe:	

Fauna			
Note the presence (recorded or observed) or evidence of fauna in or surrounding the wetland which is listed by the Commonwealth (e.g. Environment Protection and Biodiversity Conservation Act 1999, CAMBA, RoKAMBA, JAMBA) or State (e.g. Threatened or Specially Protected Fauna under the Wildlife Conservation Act 1950) or Priority Fauna or Priority or Threatened Ecological Communities related to fauna which are listed by DPaW.			
Species / name of ecological community	Significance (e.g. EPBC Act, CAMBA)	Observations (e.g. population size, age, evidence, activities, habitat requirements)	Source of information (e.g. observatory, literature, DPaW, WA Museum)

Scientific value		
List any scientific values including geoheritage or geoconservation values (e.g. important sediments or geological features, fossils, pollen records, stromatolites, thrombolites, evidence of evolutionary processes, evidence of a change in climate, unique flora or fauna adaptations) that the wetland may contain.		
Scientific, geoheritage or geoconservation values	Significance and observations	Source of information (e.g. observatory, literature, DPaW, WA Museum)

Flora			
Use aerial photography and a site visit to determine and confirm the condition of the vegetation within and 50 metres surrounding the wetland. Using the scale outlined in Appendix B, display the locations of the vegetation conditions in the attached map and calculate their total area:			
Vegetation condition	Total area (%) within the wetland	Area (%) 50 metres surrounding the wetland	
Pristine			
Excellent	100%	100%	
Very Good			
Good			
Degraded			
Completely Degraded			
Using this information, is the wetland dominated by vegetation in a good or better condition:		Yes	
What vegetation complex (Hedde et al. 1980) does the wetland belong to:		Vasse complex	
Using the information sources outlined in Appendix B, what extent of the vegetation complex is remaining on the Swan Coastal Plain		35.9 %	
List any occurrences of Priority and Threatened Ecological Communities related to flora and wetland systems which are known to occur within and 5 kilometres surrounding the wetland. If they are located within or adjacent to the wetland display their boundary in the attached map:			
Name of ecological community	Significance (e.g. priority, threatened)	Observations (e.g. condition, area, habitat type)	Source of information (e.g. observatory, literature, DPaW)
No detailed desktop undertaken			
List any occurrences of Declared Rare flora or Priority flora known to occur within and 1 kilometre surrounding the wetland and display their location in the attached map:			

Flora				
Species	Significance (e.g. Declared Rare, Priority 1)	Population measure (number, single record, abundance comment)	Observations (e.g. habitat type, flowering season)	Source of information (e.g., literature, DPaW, surveyed population, Herbarium record)
No detailed desktop undertaken				

Representativeness	
Using the wetlands data outlined in section 4.3, Appendix D and available on DPaW's website record the corresponding area:	
	% area
What is the % area of wetlands with the same classification assigned a Conservation management category on the Swan Coastal Plain	37.0
What is the % area of wetlands in the same consanguineous suite assigned a Conservation management category	1.5
What is the % area of wetlands with the same classification in the same consanguineous suite assigned a conservation management category	8.1
Is the wetland rare? (e.g. only wetland in its consanguineous suite, best wetland example in its consanguineous suite or region, only Conservation management category wetland in the consanguineous suite or region, primary saline wetland within a consanguineous suite predominated by freshwater):	N

No.	Criteria	Y/N
1	The wetland is currently recognised as internationally or nationally significant for its natural values. Lists/registers include: <ul style="list-style-type: none"> - The Ramsar Convention on Wetlands - State government endorsed candidate sites for the Ramsar Convention on Wetlands - Directory of Important Wetlands in Australia - National Heritage List - Or equivalent. 	N N N N N
2	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is identified as significant for its natural values under one or more of the following: <ul style="list-style-type: none"> - <i>Conservation Reserves for Western Australia Systems 1, 2, 3, 5</i> - <i>Conservation Reserves for Western Australia, The Darling System – System 6</i> - <i>A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton – Walpole Region</i> - <i>The Environmental Significance of Wetlands in the Perth to Bunbury Region</i> - <i>Bush Forever, Swan Bioplan or equivalent.</i> 	N N N N N
3	The wetland supports a breeding, roosting, or refuge site or a critical feeding site for populations of fauna listed by the Australian Government (for example, <i>Environment Protection and Biodiversity Conservation Act 1999</i> , migratory bird agreements such as JAMBA, CAMBA and RoKAMBA) or the State (for example, Threatened and Specially Protected Fauna listed under the Wildlife Conservation Act 1950).	N
4	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and supports one or more of the following: <ul style="list-style-type: none"> - An occurrence of a Threatened Ecological Community - A confirmed occurrence of a Priority 1 or Priority 2 Ecological Community - A confirmed occurrence of a Declared Rare (Threatened) flora species. 	N N N

No.	Criteria	Y/N
5	Equal to or greater than 90% of the wetland supports vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B.	Y
6	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is known to support internationally, nationally or state-wide scientific values including geoheritage and geoconservation.	N
7	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and meets one of the following: <ul style="list-style-type: none"> - ≤10% of wetlands of the same type are assigned Conservation management category within the Swan Coastal Plain (by area) - ≤10% of all wetlands in the same consanguineous suite are assigned Conservation management category (by area) - ≤10% of wetlands of the same type in its consanguineous suite are assigned Conservation management category (by area) - best representative of its type within its consanguineous suite domain. 	N N N N

3.3 Secondary Assessment Form

No.	General criteria	Criteria	Score
Geomorphology			
1	<i>Representativeness</i>	≤20% of wetlands of the same type are assigned Conservation on the Swan Coastal Plain by area.	H
2		≤20% of wetlands in the same consanguineous suite are assigned Conservation by area.	H
3		≤20% of wetlands of the same type in the same consanguineous suite are assigned Conservation by area.	H
4		The wetland is outstanding in some geomorphic aspect, for example size, origin, height relative to sea level, depth, age.	H
5	<i>Naturalness</i>	Alteration to the wetland's geomorphology by % area: < 25% altered 25-75% altered > 75% altered.	H I L
6	<i>Scarcity</i>	The wetland exhibits unusual geomorphology or unusual internal geomorphic features compared to other wetlands of the same type in the consanguineous suite.	H
7		The wetland is the best example of its type in its consanguineous suite.	H
Wetland processes			
8	<i>Representativeness</i>	The wetland is an important component of the natural hydrological cycle providing natural functions (e.g. flood protection and recharge/discharge). The wetland's vegetation, geomorphology, hydrology or sediments are modified; however, the wetland is still a component of the hydrological cycle providing natural and artificial functions (e.g. flood remediation, recharge/discharge and hydrological storage). The wetland's vegetation, geomorphology, hydrology or sediments are modified to the extent that the wetlands hydrological functions are artificial such as storage, or the wetland has been disconnected from the natural hydrological cycle and no longer provides natural attributes and functions.	H I L
9		The wetland supports a representative process (e.g. wetland process typical of the wetland's hydrological setting, sediment accretionary process typical of the wetland's geomorphic setting or hydrochemical process typical of the wetland's geological setting).	H

No.	General criteria	Criteria	Score
10	<i>Naturalness</i>	The wetland is not subject to altered wetland processes or, is subject to altered wetland processes and the wetland's natural attributes and functions are maintained.	H
		The wetland is subject to altered wetland processes and the wetland's natural attributes and functions have been changed; however, they have the potential to be rehabilitated.	I
		The wetland is subject to altered wetland processes to the extent that the wetland no longer supports natural attributes and functions.	L
11	<i>Scarcity</i>	The wetland exhibits unusual processes (e.g. hydrological, sedimentological, chemical, biological) compared to other wetlands of the same type in the consanguineous suite.	H
Linkages			
12	<i>Representativeness</i>	The wetland is a hydrological link in a larger or more complex and intact system.	H
13	<i>Naturalness</i>	The wetland is part of a continuous ecological linkage or wildlife corridor, or a regionally significant ecological linkage or wildlife corridor connecting bushland or wetland areas.	H
		The wetland is part of a fragmented ecological linkage or wildlife corridor.	I
		The wetland is disturbed and isolated, surrounded by either a built or highly disturbed environment with no nearby native vegetation or waterways to support an intact or fragmented ecological linkage or wildlife corridor.	L
14	<i>Scarcity</i>	The wetland has unusual hydrological, hydrochemical or ecological linkages with adjacent wetland or bushland.	I
Habitats			
15	<i>Representativeness</i>	The wetland is isolated from other undisturbed wetlands or bushland and as a result, maintains important ecological or genetic fauna or flora diversity within its consanguineous suite domain.	H
16		The wetland contains evidence of surface water that is vital to maintaining regionally significant populations of native aquatic or terrestrial flora or fauna.	H
17		The wetland provides a nursery for native fauna populations, or maintains fauna populations at a vulnerable stage of their life cycle.	H
18	<i>Naturalness</i>	The wetland supports habitats that are unaltered or the wetland has been altered and its natural habitats are maintained.	H
		The wetland supports habitats that are altered; however, the habitats are still identifiable and have the potential to be rehabilitated.	I
		The wetland is altered and as a result is no longer supporting natural habitats which can be rehabilitated.	L
19	<i>Scarcity</i>	The wetland supports habitats that are unusual compared to other wetlands of the same type on the Swan Coastal Plain.	H

No.	General criteria	Criteria	Score
Flora			
20	<i>Representativeness</i>	<p>The wetland's current diversity of native flora is similar to what would be expected in an unaltered state.</p> <p>The wetland supports a reduced diversity of native flora due to human induced disturbances.</p> <p>The wetland supports a significantly reduced diversity of native flora species due to human induced disturbances.</p>	<p>H</p> <p>I</p> <p>L</p>
21		<p>The wetland is identified in a vegetation complex (Hedde et al. 1980) which is represented by:</p> <p>≤30% of the pre-European extent</p> <p>30-50% of the pre-European extent.</p>	<p>H</p> <p>I</p>
22	<i>Naturalness</i>	<p>Using the vegetation condition scale outlined in Appendix B, the wetland's vegetation condition by area is:</p> <p>≥ 75% Good, Very Good, Excellent or Pristine</p> <p>25-75% Good, Very Good, Excellent or Pristine</p> <p>< 25% Good, Very Good, Excellent or Pristine.</p>	<p>H</p> <p>I</p> <p>L</p>
23		<p>The wetland or ≥ 50% of the wetland boundary is surrounded by land dominated by remnant native vegetation.</p> <p>The wetland or 10-50% of the wetland boundary is surrounded by land dominated by remnant native vegetation.</p> <p>The wetland or < 10% of the wetland boundary is surrounded by land dominated by remnant native vegetation.</p>	<p>H</p> <p>I</p> <p>L</p>
24	<i>Scarcity</i>	<p>The wetland supports an occurrence of Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora, or an occurrence of 3 or more significant flora taxa.</p>	H
25		<p>The wetland is likely to support Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora; however, the occurrence cannot be located or its habitat has been altered and is no longer in a natural state.</p>	I
26		<p>The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.</p>	H
27		<p>The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community.</p>	I
Fauna			
28	<i>Representativeness</i>	<p>The wetland is an ecological refuge for regionally significant fauna species or fauna assemblages.</p> <p>The wetland has the potential to be an ecological refuge but is disturbed and its attributes and functions require rehabilitation.</p>	<p>H</p> <p>I</p>
29		<p>The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regionally significant native fauna.</p> <p>The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regional or local fauna but only in association with other surrounding natural areas.</p>	<p>H</p> <p>I</p>

No.	General criteria	Criteria	Score
30	<i>Naturalness</i>	The wetland's current diversity of native fauna is similar to what would be expected in an unaltered state, or the wetland supports diverse fauna compared to other wetlands of the same type. The wetland supports a reduced diversity of fauna compared to other wetlands of the same type.	H I
31		The wetland supports limited attributes and functions for fauna populations due to human induced disturbances.	L
32	<i>Scarcity</i>	The wetland is likely to support a breeding, roosting, refuge or feeding site for populations of fauna listed by the Commonwealth (e.g. <i>EPBC Act 1999</i> , JAMBA, CAMBA, RoKAMBA Agreements) or the State (e.g. Threatened or Specially Protected Fauna listed under the <i>Wildlife Conservation Act 1950</i>).	H
33		The wetland supports a breeding, roosting, refuge or feeding site for Priority 1, Priority 2, Priority 3 or Priority 4 fauna.	H
34		The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	H
35		The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community or a breeding, roosting, refuge or feeding site for significant fauna.	I
Cultural			
36	<i>Representativeness</i>	The wetland or its immediate surrounds is identified for its natural values on a national or State heritage list or the wetland supports other known regional heritage values.	H
37		The wetland or its immediate surrounds is identified for its natural values on a municipal heritage list or the wetland supports other known local heritage values.	I
38		The wetland or its immediate surrounds is identified on a national, State or local list or register for its Aboriginal cultural value (e.g. Department of Aboriginal Affairs register).	H
39		The wetland is important to the local community either nationally or state wide for its natural values.	H
40		The wetland is or has the potential to be a site for public or private based recreation.	I
41		The wetland is likely to support heritage, cultural or social values; however, the value cannot be confirmed or the value has been disturbed and are no longer as important or significant. The wetland did support heritage, cultural or social values; however, these have been significantly disturbed and are no longer important or the values have been removed.	I L
Scientific and educational			
42	<i>Representativeness</i>	The wetland supports known important teaching or research characteristics and for this reason is an existing or potential education or research site. Note, the wetland must still support the relevant teaching or research characteristics. The wetland has the potential to be used as a study or research site.	H I
43		The wetland supports known scientific, geoheritage or geoconservation values.	H
44		The wetland did support scientific or educational values; however, these have been significantly disturbed and are no longer as important or the values have been removed.	L

3.4 Results

Attributes/functions /values	Scores		
	High	Intermediate	Low
Geomorphology	3	0	0
Wetland processes	3	0	0
Linkages	0	1	0
Habitats	1	0	0
Flora	3	1	0
Fauna	1	0	0
Cultural	0	0	0
Scientific and educational	0	0	0
Total Score	11	2	0
Defining attributes/ functions/values	Geomorphology, wetland processes and flora		
Applicable management category	Conservation		



Appendix G

Plot Data

Plot Data

Site No: R01	Type: Revele	Easting: 381055	Northing: 6386550
Date: 1/8/2016		Soil Types: Sand	
Topography: Slope		Soil Colour: White to grey	
Rocky Type:		Soil Condition: Moist	
Community: BaHhOe		Fire History: 10+	
Vegetation Condition: Very Good, Weeds			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Corymbia calophylla</i>		1300	3
<i>Eucalyptus marginata</i>		1000	3
<i>Allocasuarina fraseriana</i>		900	10
<i>Kunzea glabrescens</i>		550	2
<i>Banksia attenuata</i>		500	20

Taxon	Cons. Code	Height (cm)	% Alive
<i>Hakea prostrata</i>		500	8
<i>Banksia grandis</i>		400	5
<i>Xylomelum occidentale</i>		400	1
<i>Xanthorrhoea preissii</i>		110	3
<i>Watsonia sp.</i>	*	90	
<i>Macrozamia riedlei</i>		90	1
<i>Burchardia congesta</i>		80	0.02
<i>Hibbertia hypericoides</i>		80	50
<i>Acacia pulchella</i>		70	0.5
<i>Conostephium pendulum</i>		60	0.5
<i>Opercularia echinocephala</i>		60	2
<i>Drosera macrantha</i>		50	0.1
<i>Craspedia variabilis</i>		40	
<i>Hibbertia racemosa</i>		40	
<i>Lyginia barbata</i>		40	0.01
<i>Conostylis aculeata subsp. aculeata</i>		30	
<i>Hibbertia racemosa</i>		30	0.02
<i>Leucopogon propinquus</i>		30	0.1
<i>Hovea trisperma</i>		20	0.02
<i>Hybanthus calycinus</i>		20	0.01
<i>Ursinia anthemoides</i>	*	15	0.5
<i>Hybanthus calycinus</i>		15	0.02
<i>Isotropis cuneifolia subsp. cuneifolia</i>		15	0.2
<i>Lagenophora huegelii</i>		15	0.1
<i>Orchidaceae sp.</i>		15	0.01
<i>Alexgeorgea nitens</i>		10	0.1
<i>Stylidium piliferum</i>		10	0.01
<i>Common weeds</i>	*	0.1	10
<i>Leporella fimbriata</i>		0.1	0.05
<i>Drosera erythrorhiza</i>		0	0.2
<i>Hardenbergia comptoniana</i>		0	1
<i>Pyrorchis nigricans</i>		0	0.5

Site No: R02	Type: Releve	Easting: 380851	Northing: 6386717
Date: 1/8/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: White grey	
Rocky Type:		Soil Condition: Moist	
Community: BaHhOe		Fire History: 10+	
Vegetation Condition: Very Good. Weeds, near paddock			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Eucalyptus marginata</i>		1500	3
<i>Allocasuarina fraseriana</i>		900	10
<i>Banksia grandis</i>		700	5
<i>Banksia attenuata</i>		600	30
<i>Corymbia calophylla</i>		600	2
<i>Xanthorrhoea gracilis</i>		200	
<i>Xanthorrhoea preissii</i>		130	3

Taxon	Cons. Code	Height (cm)	% Alive
<i>Macrozamia riedlei</i>		120	3
<i>Acacia pulchella</i>		100	1
<i>Hibbertia hypericoides</i>		80	50
<i>Zantedeschia aethiopica</i>	DP	60	
<i>Thysanotus manglesianus</i>		60	0.02
<i>Leucopogon propinquus</i>		30	0.1
<i>Chamaescilla corymbosa</i>		20	
<i>Ursinia anthemoides</i>	*	15	0.02
<i>Romulea flava</i>	*	10	0.1
<i>Alexgeorgea nitens</i>		10	0.02
<i>Isotropis cuneifolia subsp. cuneifolia</i>		10	0.5
<i>Loxocarya cinerea</i>		10	1
<i>Orchidaceae sp.</i>		10	0.02
<i>Pheladenia deformis</i>		6	0.01
<i>Stylidium piliferum</i>		5	0.1
<i>Trachymene pilosa</i>		5	0.05
<i>Leporella fimbriata</i>		0.5	0.1
<i>Common weeds</i>	*	0.1	15
<i>Drosera erythrorhiza</i>		0.1	0.1
<i>Pyrorchis nigricans</i>		0.1	0.5
<i>Hardenbergia comptoniana</i>		0	0.5

Site No: R03	Type: Releve	Easting: 380860	Northing: 6386985
Date: 1/8/2016		Soil Types: Sand loam	
Topography: Undulating		Soil Colour: Brown	
Rocky Type:		Soil Condition:	
Community: BaHhOe		Fire History: 10+	
Vegetation Condition: Degraded			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Eucalyptus gomphocephala</i>		2500	60
<i>Corymbia calophylla</i>		1700	2
<i>Eucalyptus marginata</i>		1600	7
<i>Macrozamia riedlei</i>		170	7
Common weeds	*	20	80
<i>Clematis pubescens</i>		0	0.5

Site No: R04	Type: Revele	Easting: 380686	Northing: 6387575
Date: 1/8/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Moist	
Community: BaKgMr		Fire History: 10+	
Vegetation Condition: Good. Weeds			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Eucalyptus gomphocephala</i>		2300	5
<i>Allocasuarina fraseriana</i>		1000	6
<i>Banksia grandis</i>		700	
<i>Banksia attenuata</i>		500	12
<i>Kunzea glabrescens</i>		500	40
<i>Macrozamia riedlei</i>		100	7
<i>Acacia ?saligna</i>		80	

Taxon	Cons. Code	Height (cm)	% Alive
<i>Conostephium pendulum</i>		30	
<i>Drosera macrantha</i>		20	0.02
<i>Hibbertia vaginata</i>		20	
<i>Ursinia anthemoides</i>	*	15	1
<i>Orchidaceae sp.</i>		15	0.02
<i>Poaceae sp.</i>	*	10	0.05
<i>Isotropis cuneifolia subsp. cuneifolia</i>		10	0.5
<i>Pheladenia deformis</i>		10	0.03
<i>Pterostylis sp. (nana complex)</i>		10	0.01
<i>Stylidium piliferum</i>		5	
<i>Trachymene pilosa</i>		5	0.1
<i>Hypochaeris glabra</i>	*	0.1	5
<i>Drosera erythrorhiza</i>		0.1	0.5
<i>Leporella fimbriata</i>		0.1	
<i>Pyrorchis nigricans</i>		0.1	0.5
<i>Hardenbergia comptoniana</i>		0	0.2
<i>Kennedia prostrata</i>		0	
<i>Chamaescilla corymbosa</i>			0.1

Site No: R05	Type: Releve	Easting: 380476	Northing: 6387750
Date: 1/8/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Moist	
Community: BaKgMr		Fire History:	
Vegetation Condition: Very Good. Weeds			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Allocasuarina fraseriana</i>		1300	15
<i>Banksia grandis</i>		700	2
<i>Kunzea glabrescens</i>		600	20
<i>Banksia attenuata</i>		550	10
<i>Acacia saligna</i>		300	1
<i>Macrozamia riedlei</i>		200	10
<i>Xanthorrhoea preissii</i>		170	3

Taxon	Cons. Code	Height (cm)	% Alive
<i>Acacia pulchella</i>		110	2
<i>Cyathochaeta avenacea</i>		60	1
<i>Conostephium pendulum</i>		30	0.1
<i>Geranium molle</i>	*	20	
<i>Ursinia anthemoides</i>	*	20	1
<i>Hybanthus calycinus</i>		20	0.8
<i>Poaceae sp.</i>	*	15	0.05
<i>Hibbertia vaginata</i>		15	0.02
<i>Pheladenia deformis</i>		15	0.01
<i>Isotropis cuneifolia subsp. cuneifolia</i>		10	
<i>Orchidaceae sp.</i>		10	0.01
<i>Lysimachia arvensis</i>	*	5	0.1
<i>Trachymene pilosa</i>		5	0.02
<i>Hypochoeris glabra</i>	*	0.1	2
<i>Drosera erythrorhiza</i>		0.1	0.1
<i>Leporella fimbriata</i>		0.1	0.05
<i>Pyrorchis nigricans</i>		0.1	

Site No: R06	Type: Revele	Easting: 380594	Northing: 6388101
Date: 1/8/2016		Soil Types: Loam sand	
Topography: Ramsay wetland		Soil Colour: Dark brown	
Rocky Type:		Soil Condition: Waterlogged	
Community: BaKgMr		Fire History: 10+	
Vegetation Condition: Excellent. A3 foreshore assessment			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Eucalyptus rudis subsp. rudis</i>		1200	8
<i>Allocasuarina fraseriana</i>		900	7
<i>Melaleuca raphiophylla</i>		500	8
<i>Haemodorum laxum</i>		120	1
<i>Melaleuca preissiana</i>		110	1
<i>Hypolaena exsulca</i>		80	0.5
<i>Juncus pallidus</i>		80	15
<i>Baumea rubiginosa</i>		80	5
<i>Tecticornia lepidosperma</i>		60	10
<i>Tecticornia ? halocnemoides</i>		30	50
<i>Ursinia anthemoides</i>	*	15	0.1
Common weeds	*	0.1	10

Site No: R07	Type: Releve	Easting: 380799	Northing: 6387923
Date: 1/8/2016		Soil Types: Sand some loam	
Topography: Flat		Soil Colour: Grey to brown	
Rocky Type:		Soil Condition: Moist	
Community: ErXpLh		Fire History: 10+	
Vegetation Condition: Good. Weeds, historical clearing			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Eucalyptus rudis subsp. cratyantha</i>	P4	1800	17
<i>Banksia grandis</i>		900	6
<i>Melaleuca preissiana</i>		900	2
<i>Jacksonia sternbergiana</i>		550	2
<i>Kunzea glabrescens</i>		400	5
<i>Macrozamia riedlei</i>		250	10
<i>Xanthorrhoea preissii</i>		250	10

Taxon	Cons. Code	Height (cm)	% Alive
<i>Juncus kraussii</i>		120	2
<i>Burchardia congesta</i>		110	0.5
<i>Zantedeschia aethiopica</i>	DP	90	0.2
<i>Baumea rubiginosa</i>		80	0.1
<i>Ursinia anthemoides</i>	*	20	0.5
<i>Pheladenia deformis</i>		15	0.01
Common weeds	*	0.1	20

Site No: R08	Type: Releve	Easting: 380931	Northing: 6387681
Date: 2/8/2016		Soil Types: Sandy, loamy	
Topography: Flat		Soil Colour: Dark brown	
Rocky Type:		Soil Condition: Moist	
Community: ErXpLh		Fire History: 10+	
Vegetation Condition: Degraded. Lack of understorey, weeds understorey			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Eucalyptus rudis</i> subsp. <i>cratyantha</i>	P4	1700	30
<i>Melaleuca raphiophylla</i>		800	4
<i>Xanthorrhoea preissii</i>		190	3
<i>Melaleuca incana</i> subsp. <i>incana</i>		170	2
Common weeds	*	0.1	70
<i>Cassytha</i> sp.		0	1

Site No: R09	Type: Releve	Easting: 381055	Northing: 6387555
Date: 2/8/2016		Soil Types: Sand loam	
Topography: Wetland		Soil Colour: Brown	
Rocky Type:		Soil Condition: Moist	
Community: ErMilg		Fire History:	
Vegetation Condition: Excellent. Ground weeds			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Eucalyptus rudis subsp. rudis</i>		1000	10
<i>Melaleuca raphiophylla</i>		370	10
<i>Acacia saligna</i>		300	1
<i>Calothamnus lateralis</i>		220	1
<i>Melaleuca incana subsp. incana</i>		200	40
<i>Melaleuca incana subsp. incana</i>		200	7
<i>Hypolaena exsulca</i>		100	5

Taxon	Cons. Code	Height (cm)	% Alive
<i>Chaetanthus aristatus</i>		100	30
<i>Lepyrodia glauca</i>		100	30
<i>Hypolaena exsulca</i>		100	30
<i>Goodenia trichophylla</i>		40	0.02
Common weeds	*	0.1	5
<i>Cassytha sp.</i>		0	3

Site No: R10	Type: Releve	Easting: 381332	Northing: 6387213
Date: 2/8/2016		Soil Types: Sand some loam	
Topography: Flat		Soil Colour: Grey brown	
Rocky Type:		Soil Condition: Moist	
Community: BaKgMr		Fire History:	
Vegetation Condition: Excellent.			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Allocasuarina fraseriana</i>		800	15
<i>Eucalyptus marginata</i>		800	
<i>Kunzea glabrescens</i>		800	40
<i>Banksia attenuata</i>		700	10
<i>Xanthorrhoea preissii</i>		170	
<i>Macrozamia riedlei</i>		100	5
<i>Acacia pulchella</i>		80	1

Taxon	Cons. Code	Height (cm)	% Alive
<i>Hibbertia hypericoides</i>		40	1
<i>Thysanotus manglesianus</i>		20	0.02
<i>Ursinia anthemoides</i>	*	15	0.02
<i>Isotropis cuneifolia subsp. cuneifolia</i>		10	0.05
<i>Trachymene pilosa</i>		5	0.02
<i>Hypochaeris glabra</i>	*	0.1	0.1
<i>Drosera erythrorhiza</i>		0.1	0.2
<i>Leporella fimbriata</i>		0.1	0.2
<i>Pyrorchis nigricans</i>		0.1	1
<i>Banksia grandis</i>			
<i>Chamaescilla corymbosa</i>			
<i>Eucalyptus gomphocephala</i>			
<i>Hibbertia racemosa</i>			
<i>Pheladenia deformis</i>			

Site No: R11	Type: Releve	Easting: 381323	Northing: 6386878
Date: 2/8/2016		Soil Types: Sand loam	
Topography: Wetland		Soil Colour: Grey	
Rocky Type:		Soil Condition: Moist	
Community: ErMilg		Fire History: 10+	
Vegetation Condition: Excellent.			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Banksia littoralis</i>		450	5
<i>Allocasuarina fraseriana</i>		400	1
<i>Melaleuca raphiophylla</i>		350	20
<i>Melaleuca raphiophylla</i>		350	3
<i>Kunzea glabrescens</i>		300	5
<i>Calothamnus lateralis</i>		180	10
<i>Melaleuca teretifolia</i>		180	0.5

Taxon	Cons. Code	Height (cm)	% Alive
<i>Melaleuca incana subsp. incana</i>		160	30
<i>Astartea affinis</i>		150	2
<i>Kunzea recurva</i>		150	3
<i>Chaetanthus aristatus</i>		100	8
<i>Lepyrodia glauca</i>		100	30
<i>Romulea flava</i>	*	10	0.02

Site No: R12	Type: Revele	Easting: 381638	Northing: 6386669
Date: 2/8/2016		Soil Types: Sand loam	
Topography: Flat		Soil Colour: Brown	
Rocky Type:		Soil Condition: Moist	
Community: BaHhOe		Fire History: 10+	
Vegetation Condition: Degraded.			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Corymbia calophylla</i>		2100	25
<i>Allocasuarina fraseriana</i>		1100	2
<i>Eucalyptus rudis subsp. rudis</i>		1000	5
<i>Banksia grandis</i>		800	10
<i>Banksia littoralis</i>		800	6
<i>Melaleuca preissiana</i>		700	6
<i>Nuytsia floribunda</i>		450	2

Taxon	Cons. Code	Height (cm)	% Alive
<i>Xanthorrhoea preissii</i>		200	10
<i>Macrozamia riedlei</i>		30	0.01
<i>Lagurus ovatus</i>	*	20	0.05
<i>Ursinia anthemoides</i>	*	20	0.1
<i>Opercularia echinocephala</i>		20	0.1
<i>Pheladenia deformis</i>		15	0.02
<i>Thysanotus manglesianus</i>		15	0.01
<i>Romulea flava</i>	*	10	0.05
Common weeds	*	5	20
<i>Trachymene pilosa</i>		5	0.03
<i>Drosera erythrorhiza</i>		0.1	0.05

Site No: Q01	Type: Quadrat	Easting: 380989	Northing: 6386556
Date: 10/10/2016		Soil Types: Sand loam	
Topography: Flat		Soil Colour:	
Rocky Type:		Soil Condition: Moist	
Community: BaHhOe		Fire History: 10+	
Vegetation Condition: Very Good.			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Allocasuarina fraseriana</i>		1000	6
<i>Banksia attenuata</i>		700	15
<i>Corymbia calophylla</i>		600	1
<i>Kunzea glabrescens</i>		500	2
<i>Conostephium pendulum</i>		80	1
<i>Xanthorrhoea preissii</i>		80	7
<i>Burchardia congesta</i>		70	0.1

Taxon	Cons. Code	Height (cm)	% Alive
<i>Hibbertia hypericoides</i>		70	25
<i>Macrozamia riedlei</i>		60	1
<i>Elythranthera brunonis</i>		40	0.1
<i>Stylidium diversifolium</i>		40	0.2
<i>Briza maxima</i>	*	30	5
<i>Bossiaea eriocarpa</i>		30	0.1
<i>Opercularia echinocephala</i>		30	1
<i>Podolepis gracilis</i>		30	0.2
<i>Sowerbaea laxiflora</i>		30	0.2
<i>Hibbertia acerosa</i>		20	0.1
<i>Hypochoeris glabra</i>	*	10	4
<i>Asteridea pulverulenta</i>	*	10	0.2
<i>Alexgeorgea nitens</i>		10	0.2
<i>Hardenbergia comptoniana</i>		10	0.1
<i>Stylidium calcaratum</i>		10	0.2
<i>Aira caryophyllea</i>	*	5	0.2
<i>Acacia pulchella</i> var. <i>goadbyi</i>		5	0.1
<i>Craspedia variabilis</i>		5	0.1
<i>Stylidium piliferum</i>		5	0.1
<i>Trachymene pilosa</i>		5	0.1
<i>Lysimachia arvensis</i>	*		
? <i>Trachyandra divaricata</i>	*		3
<i>Ursinia anthemoides</i>	*		
<i>Chamaescilla corymbosa</i>			0.1
<i>Drosera macrantha</i>			0.1
<i>Hakea prostrata</i>			
<i>Xylomelum occidentale</i>			
<i>Lagenophora huegelii</i>			0.2
<i>Lobelia rhytidosperma</i>			
<i>Pyrorchis nigricans</i>			1
<i>Xylomelum occidentale</i>			

Site No: Q02	Type: Quadrat	Easting: 380845	Northing: 6386703
Date: 10/10/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Moist	
Community: BaHhOe		Fire History: 10+	
Vegetation Condition: Very Good. Weeds			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Allocasuarina fraseriana</i>		800	10
<i>Banksia attenuata</i>		500	20
<i>Macrozamia riedlei</i>		100	1.5
<i>Hibbertia hypericoides</i>		50	15
<i>Briza maxima</i>	*	40	10
<i>Bromus diandrus</i>	*	40	0.2
<i>Sonchus oleraceus</i>	*	40	0.1

Taxon	Cons. Code	Height (cm)	% Alive
<i>Conostephium pendulum</i>		40	0.2
<i>Leucopogon propinquus</i>		40	0.2
<i>Restionaceae sp.</i>		40	0.2
<i>Sowerbaea laxiflora</i>		40	0.5
<i>Tetrarrhena laevis</i>		40	0.1
<i>Briza minor</i>	*	30	0.2
<i>Desmocladius flexuosus</i>		30	0.1
<i>Stylidium piliferum</i>		30	0.1
<i>Ornithopus pinnatus</i>	*	20	1
? <i>Trachyandra divaricata</i>	*	20	5
<i>Ursinia anthemoides</i>	*	20	0.2
<i>Asteridea pulverulenta</i>	*	15	0.1
<i>Hypochaeris glabra</i>	*	10	8
<i>Alexgeorgea nitens</i>		10	0.1
<i>Caladenia flava</i>		10	0.1
<i>Stylidium calcaratum</i>		10	0.5
<i>Elythranthera brunonis</i>		8	0.1
<i>Isotropis cuneifolia subsp. cuneifolia</i>		8	0.1
<i>Lysimachia arvensis</i>	*	5	0.2
<i>Trachymene pilosa</i>		5	1
<i>Avena barbata</i>	*		
<i>Urospermum picrioides</i>	*		
<i>Trifolium campestre</i>	*		
<i>Silene gallica var. quinquevulnera</i>	*		
<i>Banksia grandis</i>			
<i>Conostylis aculeata subsp. aculeata</i>			
<i>Drosera macrantha</i>			0.3
<i>Eucalyptus marginata</i>			
<i>Hardenbergia comptoniana</i>			0.5
<i>Hibbertia racemosa</i>			
<i>Hybanthus calycinus</i>			
<i>Kennedia prostrata</i>			
<i>Lagenophora huegelii</i>			0.3
<i>Lobelia rhytidosperra</i>			
<i>Pimelea brevistyla subsp. brevistyla</i>			
<i>Pyrorchis nigricans</i>			0.2
<i>Thysanotus manglesianus</i>			0.1

Site No: Q03 Type: Quadrat Easting: 380825 Northing: 6386967

Date: 10/10/2016

Soil Types: Sandy loam

Topography: Flat

Soil Colour: Dark Brown

Rocky Type:

Soil Condition: Moist

Community: Trees Mix

Fire History: 10+

Vegetation Condition: Degraded.



Taxon	Cons. Code	Height (cm)	% Alive
<i>Corymbia calophylla</i>		2000	20
<i>Eucalyptus gomphocephala</i>		2000	10
<i>Eucalyptus marginata</i>		1800	5
<i>Macrozamia riedlei</i>		100	4
<i>Haemodorum sp.</i>		80	0.1
<i>Bromus diandrus</i>	*	50	1
<i>Lolium rigidum</i>	*	40	0.5
<i>Rumex brownii</i>	*	40	0.4

Taxon	Cons. Code	Height (cm)	% Alive
<i>Ehrharta longiflora</i>	*	30	80
<i>Euphorbia terracina</i>	*	20	5
<i>Hypochaeris glabra</i>	*	20	0.5
<i>Ursinia anthemoides</i>	*	20	0.1
<i>Arctotheca calendula</i>	*	15	0.5
<i>Lupinus cosentinii</i>	*	10	0.5
<i>Orobanche minor</i>	*	10	
? <i>Trachyandra divaricata</i>	*	10	1
<i>Trifolium campestre</i>	*	5	1

Site No: Q04	Type: Quadrat	Easting: 380708	Northing: 6387181
Date: 10/10/2016		Soil Types: Sandy loam	
Topography: Undulating		Soil Colour: Medium Brown	
Rocky Type:		Soil Condition: Moist	
Community: Trees Mix		Fire History: 10+	
Vegetation Condition: Degraded. Weeds			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Eucalyptus gomphocephala</i>		2000	20
<i>Bromus diandrus</i>	*	50	1
<i>Lupinus cosentinii</i>	*	50	30
<i>Bromus diandrus</i>	*	50	1
<i>Lolium rigidum</i>	*	40	0.5
<i>Rumex brownii</i>	*	40	0.4
<i>Lolium rigidum</i>	*	40	0.5

Taxon	Cons. Code	Height (cm)	% Alive
<i>Rumex brownii</i>	*	40	0.4
<i>Ehrharta longiflora</i>	*	30	80
<i>Euphorbia terracina</i>	*	20	5
<i>Hypochaeris glabra</i>	*	20	0.5
<i>Ursinia anthemoides</i>	*	20	0.1
<i>Euphorbia terracina</i>	*	20	5
<i>Hypochaeris glabra</i>	*	20	0.5
<i>Ursinia anthemoides</i>	*	20	0.1
<i>Arctotheca calendula</i>	*	15	0.5
<i>Arctotheca calendula</i>	*	15	0.5
<i>Lupinus cosentinii</i>	*	10	0.5
<i>Orobanche minor</i>	*	10	
? <i>Trachyandra divaricata</i>	*	10	1
<i>Lupinus cosentinii</i>	*	10	0.5
<i>Orobanche minor</i>	*	10	
? <i>Trachyandra divaricata</i>	*	10	1
<i>Trifolium campestre</i>	*	5	1
<i>Trifolium campestre</i>	*	5	1

Site No: Q05	Type: Quadrat	Easting: 380785	Northing: 6387585
Date: 10/10/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Moist	
Community: BaKgMr		Fire History: 10+	
Vegetation Condition: Very Good. Weeds. Historical clearing? Minimal understorey species.			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Banksia attenuata</i>		600	
<i>Banksia grandis</i>		500	
<i>Kunzea glabrescens</i>		500	35
<i>Wahlenbergia capensis</i>	*	40	
<i>Macrozamia riedlei</i>		40	
<i>Briza maxima</i>	*	30	3
<i>Briza minor</i>	*	30	3

Taxon	Cons. Code	Height (cm)	% Alive
<i>Silene gallica</i>	*	30	0.1
<i>Sowerbaea laxiflora</i>		25	0.2
<i>Hypochaeris glabra</i>	*	20	1
<i>Brachyscome iberidifolia</i>		15	
<i>Eucalyptus rudis subsp. rudis</i>		12	5
<i>Lysimachia arvensis</i>	*	10	0.1
<i>Eucalyptus marginata</i>		10	0.1
<i>Isotropis cuneifolia subsp. cuneifolia</i>		10	0.2
<i>Trachymene pilosa</i>		10	1
<i>Caladenia marginata</i>		10	
<i>Ornithopus pinnatus</i>	*	5	0.1
<i>Trifolium campestre</i>	*	5	1
<i>Crassula colorata</i>		5	
<i>Drosera glanduligera</i>		4	0.2
<i>Arctotheca calendula</i>	*		
<i>Arctotheca calendula</i>	*		
<i>Eryngium pinnatifidum subsp. pinnatifidum ms</i>			
<i>Isolepis marginata</i>			
<i>Lagenophora huegelii</i>			0.1
<i>Leucopogon propinquus</i>			
<i>Pyrorchis nigricans</i>			
<i>Xanthorrhoea preissii</i>			

Site No: Q06	Type: Quadrat	Easting: 380588	Northing: 6387765
Date: 10/10/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Moist	
Community: AfThJp		Fire History: 10+	
Vegetation Condition: Very Good.			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Allocasuarina fraseriana</i>		600	
<i>Banksia attenuata</i>		500	6
<i>Kunzea glabrescens</i>		350	30
<i>Xanthorrhoea preissii</i>		250	
<i>Acacia pulchella</i> var. <i>goadbyi</i>		100	
<i>Macrozamia riedlei</i>		80	5
<i>Silene gallica</i> var. <i>quinquevulnera</i>	*	30	0.1

Taxon	Cons. Code	Height (cm)	% Alive
<i>Wahlenbergia capensis</i>	*	30	
<i>Luzula meridionalis</i>		25	
<i>Arctotheca calendula</i>	*	20	
<i>Ursinia anthemoides</i>	*	20	0.2
<i>Lobelia rhytidosperma</i>		20	0.1
<i>Hibbertia vaginata</i>		15	0.2
<i>Aira caryophyllea</i>	*	10	0.5
<i>Ornithopus pinnatus</i>	*	10	0.5
<i>Hypochaeris glabra</i>	*	10	10
<i>Trifolium campestre</i>	*	5	
<i>Caladenia sp.</i>		5	0.3
<i>Crassula colorata</i>		5	1
<i>Isotropis cuneifolia subsp. cuneifolia</i>		5	0.2
<i>Stylidium calcaratum</i>		5	0.1
<i>Trachymene pilosa</i>		5	0.2
<i>Briza maxima</i>	*		
<i>Briza minor</i>	*		
<i>Lysimachia arvensis</i>	*		
<i>Asteridea pulverulenta</i>	*		
? <i>Trachyandra divaricata</i>	*		
<i>Drosera erythrorhiza</i>			0.2
<i>Drosera macrantha</i>			
<i>Hardenbergia comptoniana</i>			0.2
<i>Kennedia prostrata</i>			0.1
<i>Lagenophora huegelii</i>			
<i>Leucopogon propinquus</i>			
<i>Pyrorchis nigricans</i>			2
<i>Sowerbaea laxiflora</i>			
<i>Stylidium pilliferum</i>			

Site No: Q07	Type: Quadrat	Easting: 380867	Northing: 6388167
Date: 10/10/2016		Soil Types: Clay sand	
Topography: Wetland		Soil Colour: Black	
Rocky Type:		Soil Condition: Waterlogged	
Community: AfThJp		Fire History:	
Vegetation Condition: Excellent. Melaleuca and Euc. rudis on edge			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Allocasuarina fraseriana</i>		500	1
<i>Melaleuca raphiophylla</i>		300	
<i>Tecticornia ? halocnemoides</i>		40	5
<i>Tecticornia? pergranulata subsp. pergranulata</i>		20	60
<i>Triglochin mucronata</i>		15	
<i>Cotula coronopifolia</i>	*	10	0.5
<i>Juncus bufonius</i>	*	5	0.5

Site No: Q08	Type: Quadrat	Easting: 381190	Northing: 6387908
Date: 10/10/2016		Soil Types: Clay	
Topography: Wetland		Soil Colour: Black	
Rocky Type:		Soil Condition: Waterlogged	
Community: AfThJp		Fire History: 10+	
Vegetation Condition: Very Good. Weeds			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Allocasuarina fraseriana</i>		400	1
<i>Polypogon monspeliensis</i>	*	70	0.5
<i>Tecticornia ? halocnemoides</i>		50	10
<i>Tecticornia? pergranulata subsp. pergranulata</i>		30	15
<i>Cotula coronopifolia</i>	*	20	6
<i>Triglochin mucronata</i>		20	1
<i>Apium prostratum var. prostratum</i>		20	0.5
<i>Tecticornia ? lepidosperma</i>		20	15

Site No: Q09	Type: Quadrat	Easting: 381013	Northing: 6387805
Date: 10/10/2016		Soil Types: Sandy loam	
Topography: Flat		Soil Colour: Dark Brown	
Rocky Type:		Soil Condition: Moist	
Community: ErXpLh		Fire History: 10+	
Vegetation Condition: Degraded. Weeds, fence			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Eucalyptus rudis subsp. cratyantha</i>	P4	1200	20
<i>Kunzea glabrescens</i>		490	
<i>Juncus pallidus</i>		80	1
<i>Macrozamia riedlei</i>		60	0.5
<i>Bromus diandrus</i>	*	40	0.5
<i>Moraea flaccida</i>	*	40	0.2
<i>Arctotheca calendula</i>	*	20	1

Taxon	Cons. Code	Height (cm)	% Alive
<i>Oxalis sp.</i>	*	20	1
<i>Hypochaeris glabra</i>	*	20	10
<i>Ornithopus pinnatus</i>	*	20	30
<i>Briza minor</i>	*	15	0.5
<i>Stylidium calcaratum</i>		10	0.1
<i>Drosera glanduligera</i>		4	1
<i>Briza maxima</i>	*		
<i>Ursinia anthemoides</i>	*		
<i>Crassula colorata</i>			
<i>Schoenus subfascicularis</i>			

Site No: Q10	Type: Quadrat	Easting: 381281	Northing: 6387677
Date: 11/10/2016		Soil Types: Sand, clay	
Topography: Flat		Soil Colour: Dark Brown	
Rocky Type:		Soil Condition: Moist	
Community: ErXpLh		Fire History: 10+	
Vegetation Condition: Degraded. Weeds, livestock			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Eucalyptus rudis subsp. cratyantha</i>	P4	800	20
<i>Melaleuca raphiophylla</i>		600	15
<i>Kunzea glabrescens</i>		350	8
<i>Chaetanthus aristatus</i>		50	10
<i>Schoenus subfascicularis</i>		50	0.5
<i>Briza maxima</i>	*	30	2
<i>Ursinia anthemoides</i>	*	30	0.2

Taxon	Cons. Code	Height (cm)	% Alive
<i>Hypochaeris glabra</i>	*	20	5
<i>Ornithopus pinnatus</i>	*	20	20
<i>Arctotheca calendula</i>	*	15	0.2
<i>Briza minor</i>	*	8	1
<i>Drosera glanduligera</i>		3	0.1
<i>Trifolium hybridum var. hybridum</i>	*		
<i>Ehrharta longiflora</i>	*		
<i>Crassula colorata</i>			
<i>Lepidosperma squamatum</i>			
<i>Sowerbaea laxiflora</i>			
<i>Thysanotus sp.</i>			

Site No: Q11	Type: Quadrat	Easting: 381617	Northing: 6387517
Date: 11/10/2016		Soil Types: Clay sand	
Topography: Wetland		Soil Colour: Black	
Rocky Type:		Soil Condition: Waterlogged	
Community: AfThJp		Fire History: 10+	
Vegetation Condition: Good.			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Allocasuarina fraseriana</i>		500	
<i>Melaleuca raphiophylla</i>		400	15
<i>Moraea flaccida</i>	*	50	2
<i>Polypogon monspeliensis</i>	*	40	1
<i>Tecticornia ? halocnemoides</i>		40	8
<i>Ornithopus pinnatus</i>	*	30	15
<i>Maireana sp.</i>		30	

Taxon	Cons. Code	Height (cm)	% Alive
<i>Tecticornia ? lepidosperma</i>		30	1
<i>Tecticornia? pergranulata subsp. pergranulata</i>		30	5
<i>Triglochin mucronata</i>		20	0.5
<i>Arctotheca calendula</i>	*	15	0.5
<i>Cotula coronopifolia</i>	*	15	25
<i>Hordeum marinum</i>	*	15	5
<i>Isolepis cernua var. setiformis</i>		8	0.2
<i>Melaleuca incana subsp. incana</i>	*	5	0.5

Site No: Q12	Type: Releve	Easting: 381469	Northing: 6387435
Date: 11/10/2016		Soil Types: Sandy loam	
Topography: Flat		Soil Colour: Dark Brown	
Rocky Type:		Soil Condition: Moist	
Community: ErXpLh		Fire History: 10+	
Vegetation Condition: Degraded. Livestock, tracks			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Eucalyptus rudis subsp. cratyantha</i>	P4	800	10
<i>Melaleuca preissiana</i>		800	2
<i>Melaleuca raphiophylla</i>		600	10
Weeds			100

Site No: Q13	Type: Quadrat	Easting: 381250	Northing: 6387446
Date: 11/10/2016		Soil Types: Clay loam	
Topography: Wetland		Soil Colour: Black	
Rocky Type:		Soil Condition: Waterlogged	
Community: ErMilg		Fire History: 10+	
Vegetation Condition: Excellent. Weeds			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Eucalyptus rudis subsp. rudis</i>		1300	25
<i>Viminaria juncea</i>		350	2
<i>Acacia saligna</i>		240	2
<i>Calothamnus lateralis</i>		200	2
<i>Melaleuca incana subsp. incana</i>		200	18
<i>Dillwynia dillwynioides</i>	P3	150	0.2
<i>Melaleuca preissiana</i>		150	1

Taxon	Cons. Code	Height (cm)	% Alive
<i>Watsonia meriana</i>	*	140	0.3
<i>Astartea affinis</i>		80	5
<i>Melaleuca incana subsp. incana</i>		80	8
<i>Baumea rubiginosa</i>		60	1
<i>Hibbertia stellaris</i>		60	0.5
<i>Lepidosperma sp.</i>		60	2
<i>Lepyrodia glauca</i>		60	8
<i>Chaetanthus aristatus</i>		50	0.5
<i>Hypolaena exsulca</i>		40	2
<i>Patersonia occidentalis</i>		40	0.5
<i>Microtis media</i>		35	0.3
<i>Briza maxima</i>	*	30	6
<i>Eryngium pinnatifidum subsp. pinnatifidum ms</i>		30	0.1
<i>Thelymitra vulgaris</i>		30	0.1
<i>Ornithopus pinnatus</i>	*	20	5
<i>Briza minor</i>	*	15	1
TBC - weed		10	0.2
<i>Myriocephalus helichrysoides</i>		8	0.3
<i>Pterostylis sp.</i>		8	0.1
<i>Hypochoeris glabra</i>	*	5	3
<i>Trachymene pilosa</i>		5	2
<i>Arctotheca calendula</i>	*		
? <i>Trachyandra divaricata</i>	*		0.5
<i>Cassytha racemosa forma racemosa</i>			0.5
<i>Ornduffia albiflora</i>			
<i>Lobelia rhytidosperra</i>			

Site No: Q14	Type: Quadrat	Easting: 381067	Northing: 6387327
Date: 11/10/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Dry	
Community: BaKgMr		Fire History: 10+	
Vegetation Condition: Good. Weeds, fence			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Eucalyptus gomphocephala</i>		2000	
<i>Allocasuarina fraseriana</i>		800	20
<i>Banksia attenuata</i>		600	30
<i>Kunzea glabrescens</i>		400	25
<i>Macrozamia riedlei</i>		60	6
<i>Silene gallica var. quinquevulnera</i>	*	30	0.5
<i>Sowerbaea laxiflora</i>		30	0.5

Taxon	Cons. Code	Height (cm)	% Alive
<i>Briza maxima</i>	*	20	10
<i>Briza minor</i>	*	20	1
<i>Ursinia anthemoides</i>	*	20	0.5
<i>Wahlenbergia capensis</i>	*	20	0.2
<i>Leucopogon propinquus</i>		20	0.2
<i>Ornithopus pinnatus</i>	*	15	2
<i>Hybanthus calycinus</i>		15	
<i>Hypochaeris glabra</i>	*	10	15
<i>Asteridea pulverulenta</i>	*	10	0.5
<i>Sonchus oleraceus</i>	*	10	0.1
<i>Urospermum picrioides</i>	*	10	0.5
<i>Lysimachia arvensis</i>	*	5	0.2
<i>Trifolium campestre</i>	*	5	1
<i>Trachymene pilosa</i>		5	0.5
<i>Aira caryophyllea</i>	*		
? <i>Trachyandra divaricata</i>	*		2
<i>Drosera macrantha</i>			
<i>Hardenbergia comptoniana</i>			0.1
<i>Isotropis cuneifolia</i> subsp. <i>cuneifolia</i>			
<i>Lagenophora huegelii</i>			0.2
<i>Pyrorchis nigricans</i>			
<i>Stylidium calcaratatum</i>			

Site No: Q16	Type: Quadrat	Easting: 381189	Northing: 6386998
Date: 11/10/2016		Soil Types: Clay loam	
Topography: Wetland		Soil Colour: Black	
Rocky Type:		Soil Condition: Inundated	
Community: ErMilg		Fire History: 10+	
Vegetation Condition: Excellent. Weeds			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Melaleuca preissiana</i>		400	
<i>Melaleuca raphiophylla</i>		300	15
<i>Melaleuca teretifolia</i>		300	5
<i>Melaleuca incana subsp. incana</i>		170	80
<i>Juncus pallidus</i>		150	2
<i>Pimelea lanata</i>		150	5
<i>Lepyrodia glauca</i>		120	10
<i>Hypolaena exsulca</i>		100	20
<i>Chaetanthus aristatus</i>		80	20
<i>Ornduffia albiflora</i>		40	0.2
<i>Opercularia echinocephala</i>		40	0.1
<i>Microtis media</i>		30	0.2
<i>Hibbertia stellaris</i>		20	0.1
<i>Briza minor</i>	*	10	1
<i>Myriocephalus helichrysoides</i>		10	1
<i>Trifolium campestre</i>	*	5	2

Taxon	Cons. Code	Height (cm)	% Alive
<i>Hypochaeris glabra</i>	*		0.5
<i>Calothamnus lateralis</i>			
<i>Cassutha racemosa forma racemosa</i>			0.5
<i>Kunzea recurva</i>			

Site No: Q17	Type: Quadrat	Easting: 381351	Northing: 6386654
Date: 11/10/2016		Soil Types: Loam, clay	
Topography: Wetland		Soil Colour: Black	
Rocky Type:		Soil Condition: Waterlogged	
Community: ErMilg		Fire History: 10+	
Vegetation Condition: Excellent. Weeds. Lots of dead plants. High leaf litter			



Taxon	Cons. Code	Height (cm)	% Alive
<i>Melaleuca raphiophylla</i>		400	35
<i>Melaleuca incana subsp. incana</i>		200	10
<i>Hakea varia</i>		180	2
<i>Gahnia trifida</i>		160	8
<i>Pimelea lanata</i>		40	2
<i>Briza maxima</i>	*	30	2
<i>Chaetanthus aristatus</i>		30	5

Taxon	Cons. Code	Height (cm)	% Alive
<i>Hypolaena exsulca</i>		30	10
<i>Briza minor</i>	*	10	1
<i>Myriocephalus helichrysoides</i>		10	0.5
<i>Hypochoeris glabra</i>	*		2
<i>Melaleuca preissiana</i>			

Site No: Q18	Type: Revele	Easting: 381559	Northing: 6386598
Date: 11/10/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Moist	
Community: BaHhOe		Fire History: 10+	
Vegetation Condition: Degraded. Livestock, weeds			

Taxon	Cons. Code	Height (cm)	% Alive
<i>Allocasuarina fraseriana</i>		1700	20
<i>Eucalyptus marginata</i>		1700	10
<i>Banksia attenuata</i>		1000	15
<i>Agonis flexuosa</i>		200	1
<i>Macrozamia riedlei</i>		80	4
<i>Opercularia echinocephala</i>		40	0.5

Site No: Trees mix	Type: Obs	Easting: 381724	Northing: 6386478
Date: 11/10/2016		Soil Types:	
Topography:		Soil Colour:	
Rocky Type:		Soil Condition:	
Community: Trees Mix		Fire History:	
Vegetation Condition:			

Site No: Trees mix	Type: Obs	Easting: 380824	Northing: 6387203
Date: 11/10/2016		Soil Types:	
Topography:		Soil Colour:	
Rocky Type:		Soil Condition:	
Community: Trees Mix		Fire History:	
Vegetation Condition:			

**Appendix B: Biological Assessments Lot 1000, 2240, 2275, 2657 & 3045 Preston
Beach Road Lake Clifton**

Biological Assessments Lot 1000, 2240, 2275, 2657 & 3045 Preston Beach Road Lake Clifton

Biological Assessments Lot 1000, 2240, 2275, 2657 & 3045 Preston Beach Road Lake Clifton

Client: Main Roads Western Australia

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Beach Road Lake Clifton

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Reviewed by Linda Kirchner

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Executive Summary

Main Roads Western Australia commissioned AECOM Australia Pty Ltd (AECOM) to undertake biological assessments for a proposed offset property. The objective of the assessment was to describe the environmental values associated with wetlands and riparian vegetation, flora and vegetation, fauna, and Black Cockatoo potential breeding, roosting and foraging habitat. To meet this objective, a Level 1 Flora and Vegetation Assessment, Level 1 Fauna Assessment, targeted Black Cockatoo Survey, and a Wetlands Assessment were undertaken.

A detailed desktop assessment was undertaken incorporating results (where relevant) from the Department of Parks and Wildlife (DPAW) database, the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool (PMST) and historical surveys available in the public domain. One Threatened and four Priority Ecological Communities are known to occur within the Survey Area, one Commonwealth-listed Threatened flora species and one Priority 1 flora species are known to occur. Sixty three conservation significant fauna species could potentially occur. Of these 63 fauna species; 12 species are likely to occur, 31 species may occur and 20 species are unlikely to occur.

Field surveys were undertaken by two botanists and an ecologist in June 2016 over a ten-day period. Flora and vegetation data was captured at 63 relevés which informed the development of a vegetation map and vegetation condition map. The Level 1 fauna survey primarily focused on recording observations of fauna (particularly conservation significant species), which included evidence of fauna activity such as scats, tracks, burrows, foraging evidence and diggings. Microhabitat searches of leaf litter, bark, fallen logs and rocks were also conducted opportunistically when appropriate areas were located. Eleven microhabitat searches were conducted, and motion activated cameras were installed at five locations to observe fauna, particularly nocturnal fauna. Eighteen detailed habitat assessments were also completed. For Black Cockatoos, a breeding habitat assessment was conducted at 19 sites and foraging assessments were conducted across 35 sites. Roosting sites were assessed opportunistically when appropriate areas were located.

One State-listed Threatened Ecological Community (TEC) was recorded, as identified in the desktop assessment. This community is a State-listed ecological community known as 'SCP26a *Melaleuca huegellii-Melaleuca acerosa (systema)* Shrublands on Limestone Ridges and was recorded extensively. This TEC is represented by vegetation code MsTd and was recorded in predominantly 'Very Good' condition, extending over 202 ha.

Four Priority Ecological Communities (PECs) may occur within the Survey Area, including:

- SCP25 – Southern *Eucalyptus gomphocephala-Agonis flexuosa*
- SCP30b – Quindalup *E. gomphocephala* and/or *A. flexuosa* woodlands
- SCP29a – Coastal shrublands on shallow sands
- SCP29b – Acacia shrublands on taller dunes.

Quadrat data captured over multiple seasons would be required to accurately determine and define the presence of these PECs by undertaking data analysis to infer the appropriate Floristic Community Type.

One Threatened flora species listed under the EPBC Act, *Eucalyptus argutifolia* occurs within the Survey Area. The 2016 survey combined with previous surveys shows more than 200 individuals occur within three populations. Furthermore, the Priority 3 *Stylidium maritimum* occurs throughout the western sand dune vegetation community. This species has been previously extensively mapped with more than 2,800 individuals located.

Forty-two fauna species were recorded. This comprised 31 bird, eight mammal, one reptile and two amphibian species. Of the 42 fauna species, 11 species were of conservation significance and six were introduced fauna species. The European Wild Rabbit (*Oryctolagus cuniculus*) and the Red Fox (*Vulpes vulpes*) were both recorded and are listed as Declared Pests under the *Biosecurity and Agricultural Management Act 2007* (BAM Act).

Five fauna habitats (including Cleared Areas) have been defined and mapped. The most common fauna habitat was the mid to tall shrubland / heathland at approximately 57% of the Survey Area. This is a quite varied habitat that would generally support many of the common species of the area and would potentially also be utilised by many of the conservation significant fauna species recorded such as Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) and the Quenda (*Isoodon obesulus fusciventer*). The Survey Area provides an important and ecologically valuable linkage between the north and south sections of Yalgorup National Park, ensuring a contiguous corridor of habitat throughout this area.

The Black Cockatoo foraging assessments determined that the property contains approximately 632 ha of Carnaby's Black Cockatoo foraging habitat, approximately 214 ha of Forest Red-tailed Black Cockatoo foraging habitat and approximately 45 ha of Baudin's Black Cockatoo foraging habitat. Carnaby's Black Cockatoo was heard and / or observed five times during the field survey. They were observed either flying over, foraging on *Banksia sessilis* in the Survey Area, or heard in close proximity. The Project Area contains significant amounts of mature Tuarts, with approximately 294 ha of Black Cockatoo breeding habitat.

The Survey Area intersects four Conservation Category Wetlands, including a small portion of Lake Clifton and an unnamed wetland which represent the Harvey-Yalgorup Ramsar Site. One unnamed wetland is situated entirely within the Survey Area and includes water, riparian vegetation and adjacent fringing vegetation. A total of approximately 65 ha of Conservation Category Wetlands (CCW) was mapped. The field assessment showed that existing geomorphic wetlands of the Swan Coastal Plain mapping depict the accurate boundaries of all wetlands.

1.0 Introduction

1.1 Background and scope

Main Roads Western Australia (MRWA) required biological surveys for three defined areas to determine their suitability as offset sites for current and future projects. Three offset sites located on the Swan Coastal Plain south of Perth were defined and a suite of field surveys undertaken to assess the environmental values of the areas.

The Lake Clifton Survey Area (the Survey Area) was subject to ecological investigations including:

- Verifying whether existing information is still relevant and an accurate depiction of environmental values
- A Wetlands Assessment to verify and map Conservation Category Wetland (CCW) boundaries
- Mapping and assessment of Black Cockatoo foraging habitat
- Mapping of potential Black Cockatoo breeding and roosting trees
- Identification of areas requiring rehabilitation (addressed in the Land Acquisition Management Plan [LAMP]).

1.2 Location

The proposed offset property (the Survey Area) is situated on the border between the City of Mandurah and the Shire of Waroona, 110 km south of Perth in Western Australia. The Survey Area is bordered by Lake Clifton on the east, the foredunes and beach on the west, and by Yalgorup National Park on the north, east and south sides. The Survey Area is comprised of Lots 1000, 2240, 2275, 2657, and 3045 (Figure 1).



PROJECT ID 60100953
 CREATED BY DGF
 APPROVED BY FDW
 LAST MODIFIED 19 AUG 2016

AECOM
 www.aecom.com

DATUM GDA 1994, PROJECTION MGA ZONE 50

0 380 760 1,140 1,520
 metres

1:50,000 when printed at A4

LEGEND
 Survey Area

Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Survey Area

MAIN ROADS

LAKE CLIFTON BIOLOGICAL ASSESSMENT

Figure
 1

2.0 Legislative Framework

2.1 Overview

Table 1 summarises the key legislation governing the protection and management of Western Australia's environment, discussed further below and in **Appendix A**.

Table 1 Relevant legislation and regulations

Legislation	Purpose
Commonwealth of Australia	
<i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act)	Provides for the protection of the environment and the conservation of biodiversity.
Western Australia	
<i>Wildlife Conservation Act 1950</i> (WC Act)	Provides for the conservation and protection of Western Australia's wildlife.
<i>Environmental Protection Act 1986</i> (EP Act)	Preventing, controlling and abating environmental harm and conserving, preserving, protecting, enhancing and managing the environment.
<i>Biosecurity and Agriculture Management Act 2007</i> (BAM Act)	Provides for the management, control and prevention of certain plants and animals, and for the protection of agriculture and related resources generally. (Appendix B)
<i>Land Administration Act 1997</i> (LAA)	An Act to consolidate and reform the law about Crown land and the compulsory acquisition of land generally, to repeal the <i>Land Act 1933</i> and to provide for related matters. The Act allows for the
<i>Rights in Water and Irrigation Act 1914</i> (RIWI Act)	An Act relating to rights in water resources, to make provision for the regulation, management, use and protection of water resources, to provide for irrigation schemes, and for related purposes.

3.0 Existing Environment

3.1 Climate

The Swan Coastal Plain has a warm Mediterranean climate, characterised by hot dry summers and cool to mild wet winters. The closest meteorological recording station to the Survey Area with comprehensive data is Pinjarra Refinery (BOM Station 9891), located 30 km east of the Survey Area. The weather station has been collecting data since 1984.

Rainfall in the 12 months preceding the field survey is shown in Figure 2, and shows higher than average rainfall in March to May. The mean annual rainfall is 828.5 mm at Pinjarra refinery. In the twelve months prior to conducting the field survey, the recording station had received 682.4 mm of rainfall. The 'drying' climate in south-western Australia has been well documented (Climate Commission, 2011) and is likely to continue having minor impacts on the survey results. For this project, it is unlikely to have affected the outcomes of the Level 1 assessment.

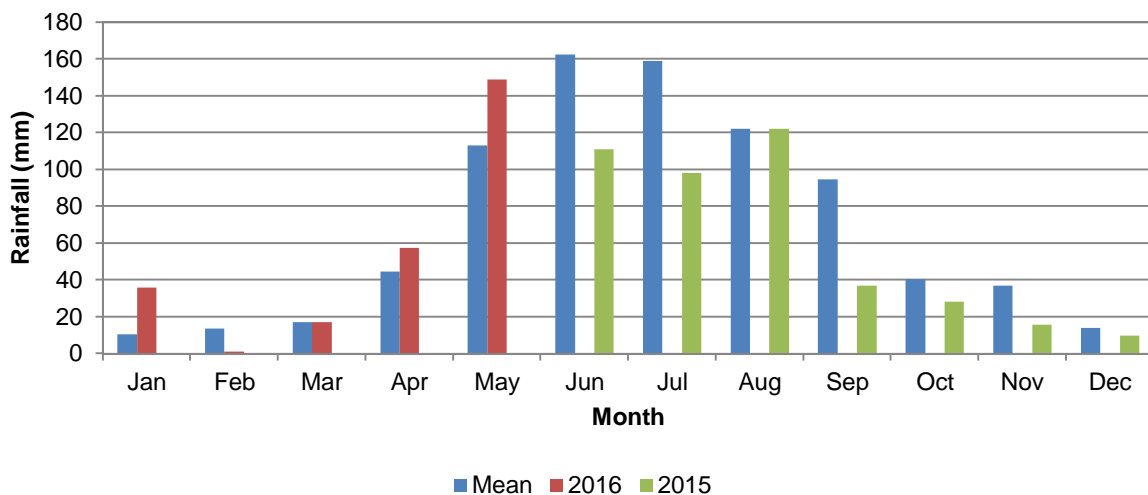


Figure 2 Rainfall graph, data obtained from Pinjarra Refinery Station 9891, BOM (2016)

3.2 IBRA region

There are 89 recognised Interim Biogeographic Regionalisation for Australia (IBRA) regions across Australia that have been defined based on climate, geology, landforms and characteristic vegetation and fauna (Commonwealth of Australia, 2013a). The Survey Area lies within the Swan Coastal Plain IBRA region and, at a finer scale, within the Perth subregion (Mitchell *et al.*, 2002).

The Survey Area is located on the Swan Coastal Plain bioregion described in CALM (2002), includes Perth and the outer suburbs (excluding the Hills suburbs). The Swan Coastal Plain consists of the Dandaragan Plateau and the Perth Coastal Plain and is comprised of a narrow belt less than 30 km wide of Aeolian, alluvial and colluvial deposits of Holocene or Pleistocene age incorporating a complex series of seasonal fresh water wetlands, alluvial river flats, coastal limestone and several offshore islands. Younger sandy areas and limestone are dominated by heath and/or Tuart woodlands, while *Banksia* and Jarrah-*Banksia* woodlands are found on the older dune systems.

The Swan Coastal Plain subregion, described by Mitchell *et al.* (2002), is a low-lying coastal plain covered with woodlands dominated by *Banksia* or Tuart on sandy soils, *Casuarina obesa* on outwash plains, and paperbark in swampy areas. The area includes a complex series of seasonal wetlands and includes Rottneest, Carnac and Garden Islands. Land use is predominantly cultivation, conservation, urban and rural residential. The area contains a number of rare features including Holocene dunes and wetlands and a large number of threatened species and ecological communities.

3.3 Vegetation

3.3.1 Pre-European vegetation

The pre-European vegetation association mapping completed by Beard (1981) shows two vegetation associations are present in the Survey Area including a medium woodland of Tuart and shrubland mosaic (Table 2).

Heddle *et al.* (1980) mapping is used to determine the current extent of remnant vegetation when compared to pre-European vegetation extent. The Environmental Protection Authority's (EPA) objective is to retain at least 30% of all pre-European ecological communities, which is consistent with recognised retention levels (EPA, 2000; EPA, 2015).

Heddle *et al.* (1980) mapped four vegetation complexes within the Survey Area (Table 3). None of the vegetation complexes are reduced to less than 30% extent remaining.

Table 2 Beard (1981) vegetation types mapped within the Survey Area

Vegetation Association	Description
998	Medium woodland; Tuart
1007	Mosaic: Shrublands; <i>Acacia lasiocarpa</i> & <i>Melaleuca acerosa</i> heath / Shrublands; <i>Acacia rostellifera</i> & <i>Acacia cyclops</i> thicket

Table 3 Heddle *et al.* (1980) vegetation complexes mapped within the Survey Area and the extent remaining using the Perth @ 3.5 million document (EPA, 2015)

Vegetation association	Description	Extent Remaining
Cottesloe Complex – Central and South	Mosaic of woodland of <i>Eucalyptus gomphocephala</i> and open forest of <i>Eucalyptus gomphocephala</i> – <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> ; closed heath on the limestone outcrops	33%
Yoongarillup Complex	Woodland to tall woodland of <i>Eucalyptus gomphocephala</i> with <i>Agonis flexuosa</i> in the second storey. Less consistently an open forest of <i>Eucalyptus gomphocephala</i> – <i>Eucalyptus marginata</i> and <i>Corymbia calophylla</i>	38%
Quindalup	Coastal dune complex consisting mainly of two alliances – the strand and foredune alliance and the mobile and stable dune alliance. Local variations include the low closed forest of <i>Melaleuca lanceolata</i> – <i>Callitris preissii</i> and the closed scrub of <i>Acacia rostellifera</i>	55%
Vasse Complex	Estuarine and marine deposits.	35.9%

3.4 Wetlands

3.4.1 Ramsar site

Lake Clifton is located adjacent to the Peel-Yalgorup Ramsar site. The Peel-Yalgorup site comprises the estuarine Peel Inlet and Harvey Estuary, the freshwater wetlands of lakes McLarty and Mealup, and the Yalgorup National Park (including the saline lakes system with sections of fringing upland). The system stretches for 60 km north to south and approximately 10 km east to west.

The Ramsar site was recognised as a wetland of international importance in 1990 and is considered to be representative of wetlands of the Swan Coastal Plain forming a chain of diverse habitat types which in turn support an array of ecologically important species and communities (Peel-Harvey Catchment Council, 2009).

3.4.2 Geomorphic Wetlands of the Swan Coastal Plain

Lake Clifton intersects four Conservation Category Wetlands (CCW), including UFI 3096 (in its entirety), UFI 3089 (edge only), UFI 3094 (edge only) and UFI 3100 (small sliver). All four wetlands, their extent within the Survey Area, and comments regarding vegetation present and condition, are outlined in Table 4. All four wetlands are part of the consanguineous suite of Clifton (DPaW, 2013).

Table 4 Wetlands within the Survey Area

Unique Feature Identifier	Extent within Survey Area	Vegetation Present, Condition and Additional Comments
3096	51.38 ha	The area represents the entire wetland system including water, riparian vegetation and adjacent <i>Agonis flexuosa/Eucalyptus gomphocephala</i> woodland. Majority of wetland vegetation is mapped as 'Excellent' with some fringing vegetation considered 'Very Good'.
3089	6.46 ha	The Survey Area intersects with fringing vegetation of Lake Clifton, representing the Peel-Yalgorup Ramsar Site. Vegetation is in 'Excellent' condition.
3094	7.49 ha	Vegetation includes AfXpHhTp and MrGtTd in excellent condition. This wetland represents the Peel-Yalgorup Ramsar Site.
3100	0.02 ha	Representing the eastern edge of vegetation associated with a wetland southeast of the Survey Area.

3.5 Conservation estates, Bush Forever and Environmentally Sensitive Areas

Lake Clifton is located wholly within an Environmentally Sensitive Area (ESA) which is associated with the Peel-Yalgorup Ramsar site and the Yalgorup National Park. The Yalgorup National Park is located adjacent to the Survey Area along its north, south and eastern borders. Yalgorup National Park represents the largest coastal reserve on the Swan Coastal Plain, and includes coastal wetlands that are part of the Peel-Yalgorup wetland system recognised as a "Wetland of National Importance" under the Ramsar convention.

There are no Bush Forever Sites at Lake Clifton. The conservation estates and Environmentally Sensitive Areas are shown on Figure 4.



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DATUM GDA 1994, PROJECTION MGA ZONE 50

0 380 760 1,140 1,520
 metres

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LEGEND

- Survey Area
- Peel-Yalgorup System Ramsar

Geomorphic Wetlands

- Conservation
- Multiple Use
- Resource Enhancement

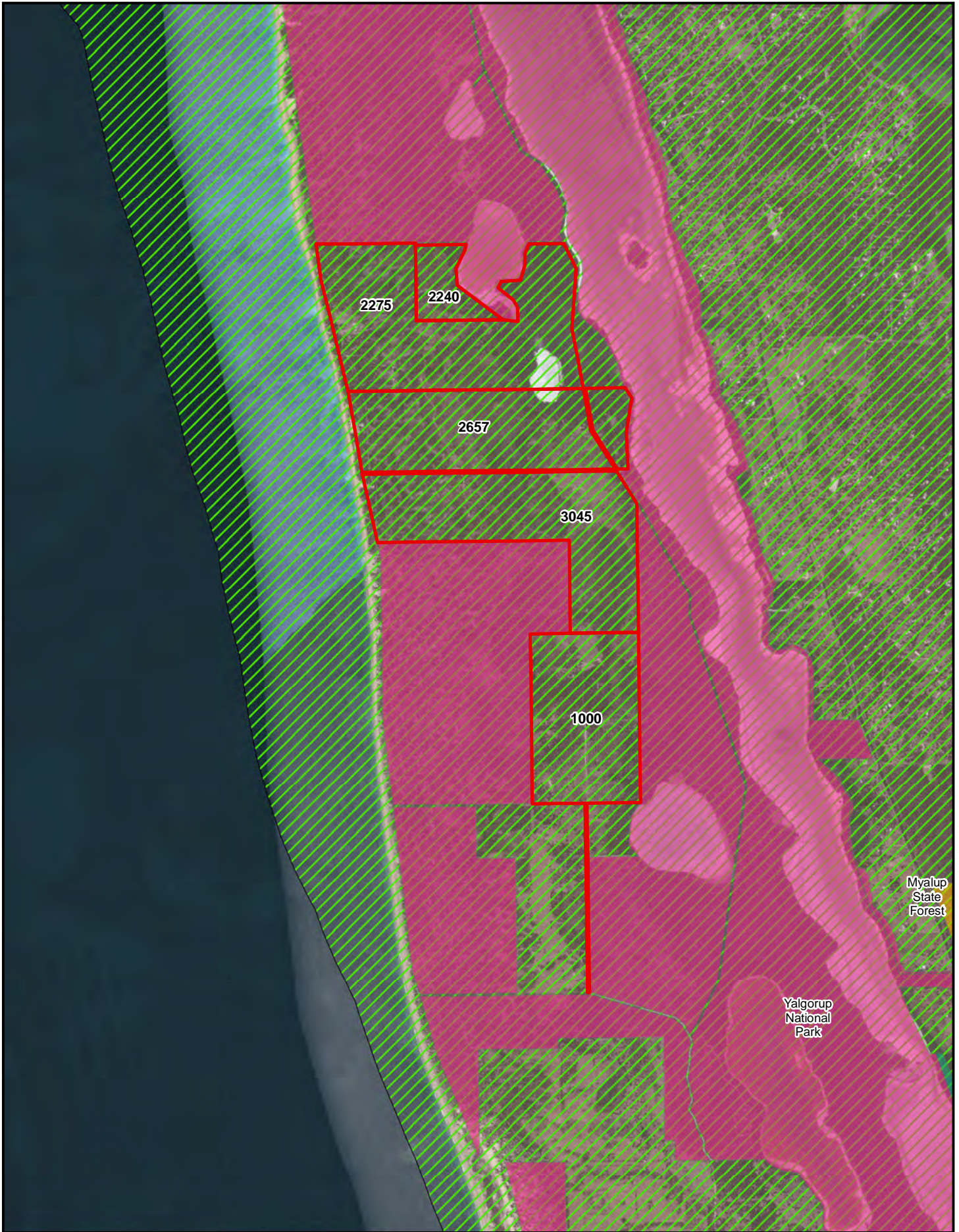
Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Wetlands

MAIN ROADS

LAKE CLIFTON BIOLOGICAL ASSESSMENT

Figure
3



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DATUM GDA 1994, PROJECTION MGA ZONE 50

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LEGEND

- Survey Area
- Environmentally Sensitive Areas

DPAW Managed Lands and Water

- 5(1)(g) Reserve
- National Park
- Nature Reserve
- State Forest

Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Conservation Estates and ESAs

MAIN ROADS

LAKE CLIFTON BIOLOGICAL ASSESSMENT

Figure
4

4.0 Methodology

4.1 Desktop assessment

The desktop assessment included compilation of relevant information for conservation significant matters from a variety of sources including publicly available literature, DPaW databases (including additional Black Cockatoo observational data), EPBC Protected Matters Search Tool (online resource) and Naturemap. The literature review was undertaken in May 2016 prior to the June field surveys. Data searches were conducted in May 2016 prior to the 2016 Spring field survey.

A total of 12 historical studies that are directly relevant to this Study Area were identified, listed below. Of the significant survey effort, three reports were available for review prior to conducting the field survey, including the latest ENV (2009) Public Environmental Review (PER) report incorporating the entire Survey Area. Particularly the flora and vegetation technical appendix of the ENV (2009) PER was used for informing the survey sample plan.

The search results were reviewed to assess the potential presence of conservation significant environmental values. All conservation significant matters including flora, fauna and communities were reviewed and a likelihood of occurrence was completed based on the categories outlined in Table 5.

Table 5 Categories of likelihood of occurrence for species and communities

Likelihood Category	Flora	Fauna	Communities
Likely to occur	Habitat is present in the Survey Area and the species has been recorded in close proximity to the Survey Area	Survey Area is within the known distribution of the species, habitat is present in the Survey Area and the species has been recorded in close proximity to the Survey Area	Known occurrences of the community in close proximity to the Survey Area. Vegetation looks the same within the known occurrence and Study area based on aerial imagery. Geographic location is similar to the Survey Area
May occur	Habitat may be present and/or the species has been recorded in close proximity to the Survey Area	Survey Area is within the known distribution of the species, marginal habitat may be present and/or the species has been recorded in close proximity to the Survey Area	Known occurrence of the community in the local area, and/or vegetation looks the same within known occurrence and Survey Area based on aerial imagery. Geographic location is similar to the Survey Area
Unlikely to occur	No suitable habitat is present and the species has not been recorded in close proximity to the Survey Area	Survey Area is outside the known distribution for the species, or no suitable habitat is present and the species has not been recorded in close proximity to the Survey Area	Known occurrence of the community in close proximity to the project area however geographic location does not occur in Survey Area

4.1.1 Previous surveys

A number of studies have been undertaken in, or within the vicinity, of Lake Clifton, that are directly relevant to this assessment. Relevant studies include:

- Bamford 2003 Fauna Values of Cape Bouvard Investments Pty Ltd
- ENV 2009 Clifton Beach Fauna Assessment
- ENV 2009 Clifton Beach Flora and Vegetation Assessment
- Trudgen 1991 Flora and Vegetation Survey of the Coast of the City of Mandurah
- Freeman *et al.* 2009 Flora and Vegetation of the Dawesville to Binningup Region

- Trudgen 1997 Occurrences and Potential Occurrences of Rare and Priority Flora on Access Options to the Cape Bouvard Investments Block
- Weston 1998a Vegetation survey of eastern park of Lake Clifton: Location 4185 and parts of 2240, 2275, 2657, 3045, 4981 and 5182
- Weston 1998b Potential Rare Flora in the proposed White Hill Road to Lake Clifton West Access Road Corridor
- Weston 1998c Floristic Community Types and Comparable Vegetation Units in the Proposed White Hill Road to Lake Clifton West Access Corridor
- Weston 1998d Comparisons of Vegetation, Flora and Rare Flora of Proposed Exchange Areas in Lake Clifton West and Yalgorup National Park
- Weston 2003 Vegetation and Flora of Cape Bouvard Land Holding Lake Clifton West
- Ecoscape 2003 An Atlas of Tuart Woodlands on the Swan Coastal Plain in Western Australia

Of these reports, three including the Freeman *et al.*, (2009) ENV (2009) and Ecoscape (2003) reports were available in the public domain.

4.2 Flora and vegetation assessment

A Level 1 Flora and Vegetation survey was undertaken, as outlined by the EPA in Guidance Statement 51 *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment*, and DPaW and EPA (2015) *Technical Guide for Terrestrial Flora and Vegetation Surveys*. This included a site reconnaissance, and low-level sampling to verify existing mapping already available for Lake Clifton.

Historically, the Survey Area has been traversed on foot and vegetation mapped using transects. Following this, Floristic Community Types (FCTs) were inferred and two permanent 10 x 10m quadrats established within each FCT. In addition, relevés were used to sample other vegetation communities. This field survey aimed to verify existing vegetation mapping and undertake vegetation condition mapping, and collect floristic data representative of the broad vegetation groups present. Due to the level of detail in the previous mapping available for Lake Clifton, a new vegetation map was produced to represent the broad vegetation types present.

The flora and vegetation survey was undertaken by two botanists Floora de Wit (Collection Permit SL011555) and Lyn van Gorp (Collection Permit SL011558) between 20 and 30 June 2016 (**Appendix C**). The sample plan was informed by the vegetation map published in ENV (2009), review of aerial imagery, and a site reconnaissance inspection undertaken on the first day of commencing the field surveys.

Sample point locations were selected to document the floristics, vegetation composition and structure, condition, and other identifying features of the vegetation community. A total of 63 relevés were completed to capture flora and vegetation data. These data were used to inform the vegetation map and condition map. Despite there already being a vegetation map available for Lake Clifton, on-ground observations indicated that the map is outdated, and no longer adequately represents vegetation communities present. A new vegetation map was produced, with communities described using the National Vegetation Information System framework (Australian Government, 2013).

Any species unable to be identified in the field were collected for identification in AECOM's in-house herbarium and the specimens and taxonomic references and keys at the Western Australian Herbarium (WAH). Naming of species followed the convention of the WAH.

Vegetation condition mapping was reviewed and updated as required using the scale developed by M.E. Trudgen (1991) and published by the Wildflower Society WA (Keighery, 1994) condition scale (Table 6). The scale is based on disturbance (e.g. grazing, erosion), degree of alteration to community and habitat structure and site ecology.

Table 6 Bushland condition ratings (Keighery, 1994)

Descriptor	Explanation
Pristine	Pristine or nearly so, no obvious signs of disturbance
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species
Very Good	Vegetation structure altered obvious signs of disturbance. For example, 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. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, 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. For example, disturbance of vegetation structure caused by very frequent fires, the presence of very aggressive weeds, 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 or shrubs

4.3 Fauna assessment

The survey primarily focused on recording observations of fauna at Lake Clifton, which included evidence of fauna activity such as scats, tracks, burrows, foraging evidence and diggings. This survey was undertaken in accordance with EPA (2002) Position Statement No. 3 Terrestrial Biological Surveys as an Element of Biodiversity Protection, and EPA (2004b) Guidance Statement No. 56 Guidance for the Assessment of Environmental Factors – Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. Particular attention was given to locating species of conservation significance that have the potential to occur at Lake Clifton, as identified in the desktop assessment. All observations were made during daylight hours of 0730 and 1700.

Scats unable to be identified in the field were collected in paper bags, dried whilst in the field and then identified by specialist Barbara Triggs.

Microhabitat searches of leaf litter, bark, fallen logs and rocks were also conducted opportunistically when appropriate areas were located. Eleven microhabitat searches were conducted (refer to Figure 5 for locations).

Motion activated cameras (Scoutguard Zeroglow 10M) were also installed to observe fauna, particularly nocturnal fauna. These cameras were placed in five locations in habitats assessed as potentially containing conservation significant fauna, and were generally left out for three nights in each location. Figure 5 illustrates these locations.

The taxonomy and nomenclature of vertebrate species for mammals, reptiles and amphibians is consistent with the Western Australian Museum's Checklist of Vertebrates of Western Australia (2010) and for bird species the Bird's Australia Checklist of Australian Birds by Christidis and Boles (2008).

4.3.1 Fauna habitats

The fauna habitats were mapped during the field survey, in conjunction with the vegetation mapping. Eighteen detailed habitat assessments were completed in habitats throughout Lake Clifton. Fauna habitats were assessed for specific habitat components in order to determine the potential for these habitats to support conservation significant species. Information collected included:

- Location
- General habitat description
- Habitat condition and disturbance types
- Dominant / characteristic flora species and vegetation layers
- Presences and abundance of hollows (large / small), fallen logs (<10 cm / 10-30 cm / >30 cm), litter (course / fine), decorticating bark, bare ground, grass, stones and boulders (<20 cm / 20-60 cm / 60 cm – 2 m / >2 m), rock crevices, soil cracks, cryptogamic crust, vines, mistletoe, dense shrubs, water bodies etc.
- Presence of animal signs (e.g. scats, digging, tracks, burrows, egg shell, bones, feathers etc)
- Fauna observations
- Connectivity and potential significance of habitat.



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0 260 520 780 1,040
 metres

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LEGEND

- Survey Area
- Black Cockatoo Breeding Trees Quadrat
- Microhabitat Assessment Locations
- Black Cockatoo Foraging Assessment Quadrats
- Habitat Assessment Locations
- Camera Locations

Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Fauna Survey Assessment Locations

MAIN ROADS

LAKE CLIFTON BIOLOGICAL ASSESSMENT

Figure 5

4.4 Black Cockatoos

A targeted Black Cockatoo assessment was conducted to identify potential breeding, roosting and foraging habitat for the three threatened Black Cockatoo species that occur in Western Australia. These are Carnaby's Black Cockatoo (*Calyptorhynchus latirostris* [Endangered under the EPBC Act and Vulnerable under the WC Act]), Baudin's Black Cockatoo (*Calyptorhynchus baudinii* [Vulnerable under the EPBC Act and under the WC Act]), and the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii* subsp. *naso* [Vulnerable under the EPBC Act and under the WC Act]). Refer to Section 6.3.3 for further information on these species.

The field survey was conducted in accordance with DSEWPaC (2012) Referral Guidelines for the three species of Black Cockatoos. The field survey was conducted by Floora de Wit (who has more than four years' experience conducting Black Cockatoo assessments), Ecologist Jared Leigh and Environmental Scientist Lyn van Gorp. The field survey was conducted between 20-25 June 2016.

The ENV (2009) vegetation community mapping, Tuart condition mapping and fauna habitat maps were utilised to identify potentially suitable habitat for the three Black Cockatoo species, and to inform the sample plan. The sample plan was then refined in the field, with the following assessments conducted at relevant sample points:

- foraging quality assessment
- breeding habitat including potential and actual breeding trees
- roosting habitat.

4.4.1 Breeding habitat

A Black Cockatoo breeding habitat assessment was conducted which focussed on quantifying potential breeding trees and associated habitat. Table 7 defines breeding habitat and identifies those trees that Black Cockatoos will utilise as breeding trees, according to the DSEWPaC (2012). Vegetation communities were assessed for their potential to provide breeding habitat by installing a 50 x 50 m quadrat as a sample point. All trees within this quadrat were then assessed for their suitability as a breeding tree. A total of 19 quadrats were assessed (refer to Figure 5). These quadrats were used to provide a representative sample to determine the total amount of breeding habitat (and approximate number of trees). Opportunistic records of trees with a DBH >500 mm were also made within the Survey Area, where time permitted. The following information was collected for all potential breeding trees with a DBH >500 mm:

- location
- fire scarring present
- tree species
- DBH
- height
- presence and number of hollows
- potential suitability of hollows.

Photographs were also taken of each tree

Table 7 Breeding habitat for the three Western Australian Threatened Black Cockatoo species

	Baudin's	Carnaby's	Forest Red-Tailed
Specific breeding habitat for the three Cockatoos	Nest in hollows in live or dead trees of <i>Eucalyptus diversicolor</i> , <i>Corymbia calophylla</i> , <i>E. wandoo</i> and <i>E. gomphocephala</i> .	Nest in hollows in live or dead trees of <i>E. salmonophloia</i> , <i>E. wandoo</i> , <i>E. gomphocephala</i> , <i>E. marginata</i> , <i>E. rudis</i> , <i>E. loxophleba</i> subsp. <i>loxophleba</i> , <i>E. accedens</i> , <i>E. diversicolor</i> and <i>Corymbia calophylla</i> .	Nest in hollows in live or dead trees of <i>E. diversicolor</i> and <i>Corymbia calophylla</i> , <i>E. wandoo</i> , <i>E. megacarpa</i> , <i>E. patens</i> , <i>E. gomphocephala</i> and <i>E. marginata</i> .
Definition of breeding habitat	'Breeding habitat' is defined in these referral guidelines as trees of species known to support breeding within the range of the species which either have a suitable nest hollow OR are of a suitable DBH to develop a nest hollow. For most tree species, suitable DBH is 500 mm.		

Source: DSEWPac (2012).

4.4.2 Roosting habitat

Table 8 defines the suitable trees that the three Western Australian Black Cockatoo species may utilise as roosting trees. Both white-tailed Black Cockatoo species roost in or near riparian environments or near other permanent water sources. The Forest Red-Tailed Cockatoos prefers the edges of forests for roosting (DSEWPac, 2012). Potential roosting trees were searched for and assessed during the field survey.

Table 8 Suitable roosting trees for the three Threatened Black Cockatoos

Baudin's	Carnaby's	Forest Red-Tailed
<i>Corymbia calophylla</i> , <i>E. marginata</i> , <i>E. rudis</i> , <i>E. patens</i> , and <i>E. gomphocephala</i> .	<i>E. salmonophloia</i> , <i>E. wandoo</i> , <i>Corymbia calophylla</i> , <i>Eucalyptus diversicolor</i> , <i>E. patens</i> , and <i>E. gomphocephala</i> .	<i>Corymbia calophylla</i> , <i>E. marginata</i> , and <i>E. gomphocephala</i> .

Source: DSEWPac (2012).

4.4.3 Foraging habitat

Foraging species for the three Western Australian Black Cockatoo species is presented in Table 9 as reported in various literature.

Table 9 Foraging species utilised by the three Western Australian Threatened Black Cockatoo species

Baudin's (DSEWPaC, 2012)	Carnaby's (DSEWPaC, 2012)	Forest Red-tail (Johnstone et al. 2013 and DSEWPaC, 2012)
Eucalypt woodlands and forests, proteaceous woodland and heath. During breeding season feed primarily on native vegetation, particularly Marri. Outside breeding season they can feed on fruit orchards (apple and pear, also persimmon) and tips of <i>Pinus</i> species. Common food items also include insects and insect larvae, and pith of kangaroo paw <i>Anigozanthos flavidus</i> .	Native shrubland, kwongan heathland and woodland dominated by proteaceous plant species (e.g. <i>Banksia</i> sp., <i>Hakea</i> sp. and <i>Grevillea</i> sp.) as well as eucalypt woodland and forest that is dominated by foraging species. Also will feed on Callistemon, seeds of introduced species such as <i>Pinus</i> species and <i>Erodium</i> species, wild radish, canola, almonds and pecan nuts and occasionally apples and persimmons.	The principal foods of the FRTBC are the seeds of Marri and Jarrah. Other less important foods include Blackbutt <i>E. patens</i> , <i>E. wandoo</i> , Sheoak <i>A. fraseriana</i> , Snottygobble <i>P. longifolia</i> , <i>Hakea</i> spp., also introduced species (including Cape Lilac <i>Melia azedarach</i> , Spotted Gum <i>C. maculata</i> , Lemon-scented Gum <i>C. citriodora</i> , Silver Princess <i>E. caesia</i> , Illyarrie <i>E. erythrocorys</i> and Kaffir Plum <i>Harpephyllum caffrum</i>) and in southern forests Albany Blackbutt <i>E. staeri</i> and Karri <i>E. diversicolor</i> . Rarely observed grubbing for insect larvae on <i>Allocasuarina</i> spp.

The quality of foraging habitat not only reflects the availability of food sources, but also the proximity to reliable water sources, connectivity to other suitable habitat, presence of potential breeding trees, and proximity to confirmed roost and breeding sites (amongst others). These parameters were utilised by the DotE to produce a draft quality of foraging habitat scoring system. AECOM has amended this system and this is presented in Table 11. This scoring system was utilised to assess potential foraging habitat for each Black Cockatoo species. Initially a desktop assessment was conducted to select sample point locations in varying representative habitats throughout the Survey Area, and these sites were then refined in the field. 50 x 50 m quadrats were established in the field at each of these 35 sites and the scoring assessment tool utilised.

The scoring tool is used by initially defining the quality of the overall habitat present (i.e. High, Quality, Valued, Low) and then adding or subtracting points from this depending on the ecological values of the habitat (i.e. proximity to water, proximity to a known roost site, evidence of foraging material etc.). This determines an overall quantitative rating. These scores were then used as representative scores for that vegetation unit. Table 10 defines the levels of foraging habitat quality used during the assessment.

Table 10 Black Cockatoo foraging assessment scoring

Score	Foraging Quality
1 - 3	Low
4 - 6	Valued
7 - 9	Quality
10	High

Table 11 Quality of foraging habitat assessment tool for the three Western Australian Threatened Black Cockatoo species

Score	Carnaby's	Baudin's	Forest Red-tailed
≥10 High	Quality foraging habitat that is being managed for Black Cockatoos, including 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 or greater	Quality foraging habitat that is being managed for Black Cockatoos, including 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 or greater	Quality foraging habitat that is being managed for Black Cockatoos, including 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 or greater
7 Quality	Native shrubland, kwongan heathland and woodland dominated by proteaceous plant species (e.g. <i>Banksia</i> sp., <i>Hakea</i> sp. and <i>Grevillea</i> sp.) as well as eucalypt woodland and forest that is dominated by foraging species. Does not include orchards, canola, or areas under a RFA	Eucalypt (not mallee) woodlands and forest, and proteaceous woodland and heath, particularly Marri. 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. Does not include areas under a RFA
5 Valued	Pine plantation or introduced eucalypts	Pine plantation or introduced eucalypts	Introduced eucalypts as well as the introduced Cape lilac (<i>Melia acedarach</i>)
1 Low	Individual foraging plants or small stand of foraging plants (≤2 ha)	Individual foraging plants or small stand of foraging plants (≤2 ha)	Individual foraging plants or small stand of foraging plants (≤2 ha)
Additions: Context adjustor – attributes improving habitat quality			
+3	Is within the Swan Coastal Plain	Is within the known foraging area	Jarrah and/or Marri shows good recruitment (i.e. evidence of young trees)
+3	Contains trees known to be used for breeding	Contains trees known to be used for breeding	Contains trees known to be used for breeding
+2	Primarily comprises Marri	Primarily contains Marri	Primarily contains Marri and/or Jarrah
+2	Contains trees with potential to be used for breeding (DBH ≥500 mm or ≥300 mm for Salmon Gum and Wandoo)		
+2	Known to be a large or key roosting site		
+1	Is <12 km from known breeding location		
+1	Is <2 km from a watering point		
+1	Is used for roosting		

Score	Carnaby's	Baudin's	Forest Red-tailed
Subtractions: Context adjustor – attributes reducing habitat quality			
-2	No other foraging habitat within 6 km		
-1	Is >12 km from known breeding location		
-1	Is >2 km from watering point		
-1	Disease present (e.g. <i>Phytophthora cinnamomi</i> or Marri canker)		

Source: 2016 DotE workshop

4.5 Wetlands

The vegetation within wetland boundaries, as mapped in the Geomorphic Wetlands dataset, was investigated to determine the extent of riparian vegetation, as well as vegetation condition. A wetland evaluation was completed for wetlands located entirely, or mostly within the Survey Area, inclusive of riparian vegetation, water, and fringing vegetation that grades from riparian to adjacent floodplain woodlands. Wetlands where only a small area intersected with the Survey Area, i.e. slivers and edges, were not considered.

The wetland evaluation methodology for the Swan Coastal Plain is a two tiered approach. This approach has been adopted to avoid detailed evaluations being undertaken where it may not be necessary. The two tiers of evaluation are as follows:

1. Preliminary Evaluation – if any one of the preliminary evaluation criteria is met the wetland is automatically to be assigned a Conservation management category and no further evaluation is required
2. Secondary Evaluation – if the wetland does not meet the preliminary evaluation criteria the secondary evaluation should be conducted to determine the wetland's management category.

The Preliminary evaluation was undertaken using the information contained in the *Wetland evaluation and desktop and site assessment form*. In accordance with DPaW (2013) methodology, if a wetland met any one of the Preliminary evaluation criteria then it was assigned a Conservation management category.

4.5.1 Geomorphic Wetlands dataset of the Swan Coastal Plain

The Geomorphic Wetlands of the SCP dataset displays the location, boundary, geomorphic classification (wetland type) and management category of wetlands on the SCP. The mapping, classification and evaluation of wetlands on the SCP was initially conducted by Hill *et al.* in 1996 and then subsequently conducted in accordance with EPA Bulletin 686: *A Guide to Wetland Management in the Perth and Near Perth Swan Coastal Plain Area* (EPA, 1993). These mapping and evaluation results have been digitised into the *Geomorphic Wetlands of the SCP dataset* administered by DPaW. Geomorphic classifications are determined based on the duration of wetland inundation and associated landform.

In addition to geomorphic classifications, evaluation of wetlands is undertaken to assign the relevant management categories. EPA Guidance Statement 33 outlines the three key management categories which have been applied on the SCP, along with guidance on management objectives for each category (Table 12).

Table 12 Management Categories and Objectives for the Geomorphic Wetlands of the Swan Coastal Plain

Management Category	General Description	Management Objectives
Conservation (CC or CCW)	Wetlands which support a high level of attributes and functions.	Highest priority wetlands. Objective is to preserve and protect the existing conservation values of the wetlands through various mechanisms including: <ul style="list-style-type: none"> · reservation in national parks, crown reserves and State owned land protection under Environmental Protection Policies · wetland covenanting by landowners. No development or clearing is considered appropriate. These are the most valuable wetlands and any activity that may lead to further loss or degradation is inappropriate.
Resource Enhancement (RE)	Wetlands which may have been partially modified but still support substantial ecological attributes and functions	Priority wetlands. Ultimate objective is to manage, restore and protect towards improving their Conservation value. These wetlands have the potential to be restored to Conservation Category. This can be achieved by restoring wetland function, structure and biodiversity. Protection is recommended through a number of mechanisms.

Management Category	General Description	Management Objectives
Multiple Use (MU)	Wetlands with few remaining important attributes and functions	Use, development and management should be considered in the context of ecologically sustainable development and best management practice catchment planning through landcare.

4.5.2 Riparian vegetation

Riparian vegetation condition was assessed using the Water & Rivers Commission (1999) foreshore condition scale, developed for application in farming areas of south-west Australia. It takes into account vegetation health, presence of weeds and erosion (Waters & Rivers Commission, 1999). The categories and sub-categories for a detailed foreshore assessment are presented in Table 13.

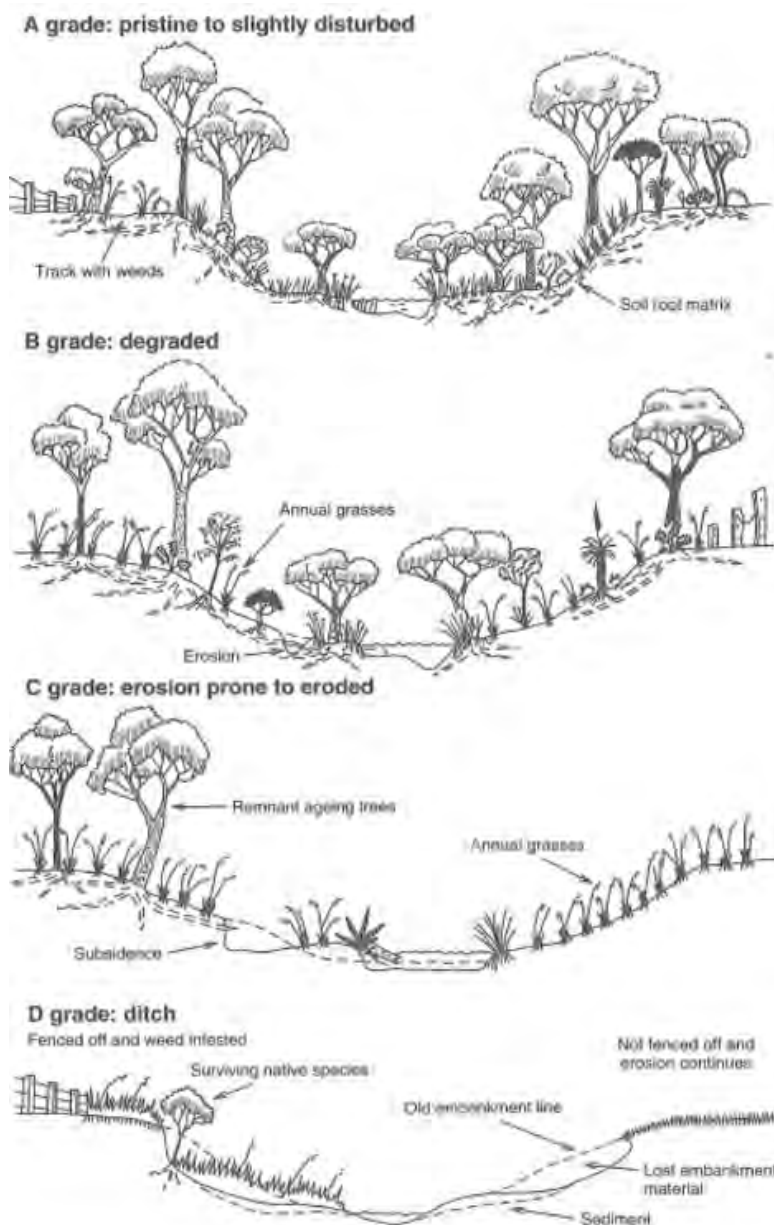
The extent of the riparian vegetation was mapped using on-ground observations and aerial imagery.

Table 13 Condition classes for a detailed assessment of foreshore condition

Category	Sub-category	Description
A	A1	Pristine. The river embankments and floodway are entirely vegetated with native species, and there is no evidence of human presence or livestock damage.
	A2	Near pristine. Native vegetation dominates. Some introduced weeds may be present in the understorey, but not to the extent that they displace native species. Otherwise there is no evidence of human impact. (A river valley in this condition is as good as will be found today)
	A3	Slightly disturbed. Native vegetation dominates, but there are some areas of human disturbance where soil may be exposed and weeds are relatively dense (such as along tracks). The native vegetation would quickly recolonise the disturbed areas if human activity declined.
B	B1	Degraded - weed infested. Weeds have become a significant component of the understorey vegetation. Although native species are dominant, a few have been replaced by weeds.
	B2	Degraded - heavily weed infested. In the understorey, weeds are about as abundant as native species. The regeneration of some tree and large shrub species may have declined.
	B3	Degraded - weed dominated. Weeds dominate the understorey, but many native species remain. Some trees and large shrub species may have declined or disappeared altogether.
C	C1	Erosion prone. Trees remain, and possibly some large shrubs or tree grasses, but the understorey consists entirely of weeds, mainly annual grasses. The trees are generally resilient or long lived species but there is little or no evidence of regeneration. The shallow-rooted weedy understorey provides no support to the soil, and only a small increase in physical disturbance will expose the soil and make the river embankments and floodway vulnerable to erosion.
	C2	Soil exposed. Older trees remain, but the ground is virtually bare. Annual grasses and other weeds have been removed by livestock trampling or grazing, or through over use by humans. Low-level soil erosion has begun, by the action of either wind or water.
	C3	Eroded Soil is washed away from between tree roots, trees are being undermined and unsupported embankments are subsiding into the river valley.

Category	Sub-category	Description
D	D1	Ditch – eroding. There is not enough fringing vegetation to control erosion. Some trees and shrubs remain and act to retard erosion in certain spots, but are doomed to be undermined eventually.
	D2	Ditch - freely eroding. No significant fringing vegetation remains and erosion is completely out of control. Undermined and subsided embankments are common, and large sediment plumes are visible along the river channel.
	D3	Drain - weed dominated. The highly eroded river valley has been fenced off, preventing control of weeds by stock. Perennial (long lived) weeds have become established. The river has become a simple drain, similar or identical to a typical major urban drain.

Source: Water & Rivers Commission, 1999.



Source: Water & Rivers Commission, 1999.

Figure 6 Foreshore condition assessment used to assess riparian vegetation condition

4.6 Limitations

The objective of the assessment was to verify existing information on ecological values of the defined Survey Area. Field surveys were completed as a Level 1 investigation. This requires a desktop study and reconnaissance survey to verify desktop results, delineate and characterise flora and the range of vegetation units and fauna habitats present (EPA, 2004a; EPA 2004b). The limitations were therefore addressed based on this objective.

Table 14 Limitations associated with the biological surveys

Limitation	Constraints	
	Flora and Vegetation Assessment	Fauna / Black Cockatoo Assessment
Competency/experience of consultant conducting survey	Nil. The flora and vegetation assessment was led by Floora de Wit who has 8 years' experience addressing similar scopes on the Swan Coastal Plain.	Nil. Floora has four years' experience conducting Black Cockatoo assessments. Jared is an ecologist with over 14 years' experience in the environmental industry and has conducted fauna surveys in a range of bioregions within Western Australia. Jared has also conducted multiple Black Cockatoo assessments.
Scope (i.e. what life forms were sampled)	Nil. Effort was spent on documenting all vascular flora species. Sterile juvenile forbs were sometimes difficult to identify to species level and were therefore named to genus only. As a Level 1 survey, this is not considered a limitation as it is unlikely to have influenced the overall results.	Nil. The level 1 fauna survey: <ul style="list-style-type: none"> · Assessed all fauna habitats within the Survey Area · Documented secondary evidence (scats, diggings, burrows etc.) and fauna sightings · Conducted microhabitat searches at appropriate sites · Utilised motion activated cameras. Although reptiles would generally have been in brumation and not sampled effectively, it is not the objective of a Level 1 survey to trap or sample for fauna groups extensively.
Proportion of flora/fauna identified, recorded and/or collected (based on sampling, timing and intensity)	Nil. Sterile juvenile forbs were sometimes difficult to identify to species level and were therefore named to genus only. Sampling effort included 63 relevés and numerous additional observations recorded on field maps.	Nil. Information gained for a Level 1 Fauna survey was sufficient. Fauna were observed (through direct or indirect evidence) during daylight hours (0700 and 1730hrs). Therefore nocturnal species were only predominantly observed through indirect evidence, although three motion activated cameras were installed in appropriate habitats. Although reptiles would generally have been in brumation and not sampled effectively, it is not the objective of a Level 1 survey to trap or sample for fauna groups extensively.

Limitation	Constraints	
	Flora and Vegetation Assessment	Fauna / Black Cockatoo Assessment
Sources of information	<p>Minor.</p> <p>The latest published survey for Lake Clifton was used to inform this assessment. This was further supported by DPaW database searches.</p>	<p>Moderate.</p> <p>DPaW database (with additional Black Cockatoo observational data), Naturemap and EPBC Act Protected Matters Search Tool were utilised. Numerous studies have also been undertaken in the Study Area, however only three reports are available in the public domain. Information within these historical reports (e.g. vegetation mapping) were utilised to aid in the selection of Black Cockatoo foraging assessment sites for the survey. However, the on-ground observations indicated that these maps are outdated, and no longer adequately represents vegetation communities present. The location of the Black Cockatoo foraging assessment sites was refined in the field.</p>
Completion (is further work needed)	<p>Nil.</p> <p>For the purpose of meeting the objective of this assessment, no further work is required.</p>	<p>Nil.</p> <p>The objectives of the assessment were completed and no further work is required.</p>
Timing, weather, season, cycle	<p>Nil.</p> <p>The survey was conducted in winter, outside the ideal detection period for Swan Coastal Plain vegetation. For the purposes of undertaking a Level 1 Flora and Vegetation Assessment, this is not considered a limitation. It was considered that enough information was able to be captured at this time to provide an understanding of the ecological values of the Survey Area.</p>	<p>Minor</p> <p>The survey was conducted during the colder months when some fauna groups (reptiles in particular) are not as active. This assessment was also limited to one survey period during one year. However, this does not significantly impact a Level 1 fauna survey.</p>

Limitation	Constraints	
	Flora and Vegetation Assessment	Fauna / Black Cockatoo Assessment
Disturbances (e.g. fire flood, accidental human intervention) which affected results of the survey	Minor. Historical clearing and weed invasion has affected the condition of the Survey Area. Partial clearing of rows in the southern portion of the Survey Area led to cryptic vegetation mosaics present between rows.	Nil. The fauna survey was not disrupted or impacted.
Intensity (was the intensity adequate)	Nil. A total of 63 relevés were completed over ten field days to assess the floristic values of the Survey Area. This is considered suitable for meeting a Level 1 Assessment requirement as stipulated by EPA (2004a).	Nil. The Survey Area was surveyed over a five day period. It enabled sufficient time to conduct the Black Cockatoo foraging, breeding and roosting assessments. It also enabled sufficient time to assess the fauna habitats present, search for and collect opportunistic records for conservation significant species. The fauna survey was conducted in accordance with EPA Guidance Statement 56 (EPA, 2004b).
Resources (degree of expertise available in plant/animal identification)	Nil. Sufficient time was allocated for the survey. Plant identification was undertaken by Floora de Wit and Lyn van Gorp at the WA Herbarium.	Nil. Sufficient time was allocated for the survey and equipment utilised (e.g. motion activated cameras) were above that required for a Level 1 fauna survey. Floora has four years' experience conducting Black Cockatoo assessments, and Jared is an ecologist with over 14 years' experience in the environmental industry who has also conducted multiple Black Cockatoo assessments.
Remoteness and/or access problems	Nil. Multiple tracks dissect the Survey Area, enabling access to all vegetation communities encountered.	Minor. Not all of the Survey Area was covered on-ground due to the size of the project Area and the availability of tracks. However, this minor limitation was not deemed significant as the requirements of a Level 1 fauna survey were met.

Limitation	Constraints	
	Flora and Vegetation Assessment	Fauna / Black Cockatoo Assessment
Availability of contextual information on the region	Minor. Publicly available resources such as Beard (1981), Heddle (1980), and historical reports including ENV (2009) informed the report. Many historical biological reports relevant for this Survey Area are not available in the public domain and were therefore not able to be further considered.	Minor. Many historical biological reports relevant for this Survey Area are not available in the public domain and were therefore not able to be further considered.

5.0 Desktop Results

5.1 Threatened and Priority Ecological Communities

5.1.1 Commonwealth

Lake Clifton is located within the buffer of one Commonwealth-listed Threatened Ecological Community (TEC) (Figure 7). The Thrombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton) is listed as Critically Endangered under the EPBC Act, and Critically Endangered under the WC Act (where it is listed as Stromatolite like Freshwater Microbialite Community of Coastal Brackish Lakes). This TEC incorporates Lake Clifton and the stromatolites present in the Lake. Despite the buffer of this community encompassing the Survey Area, this TEC is not present within the Survey Area.

5.1.1 State

Two State-listed TECs and five Priority Ecological Communities (PECs) were identified in the desktop assessment as occurring in the vicinity of Lake Clifton. Of the seven communities, five are known to occur, one may occur, and one is unlikely to occur (Table 15; Figure 7).

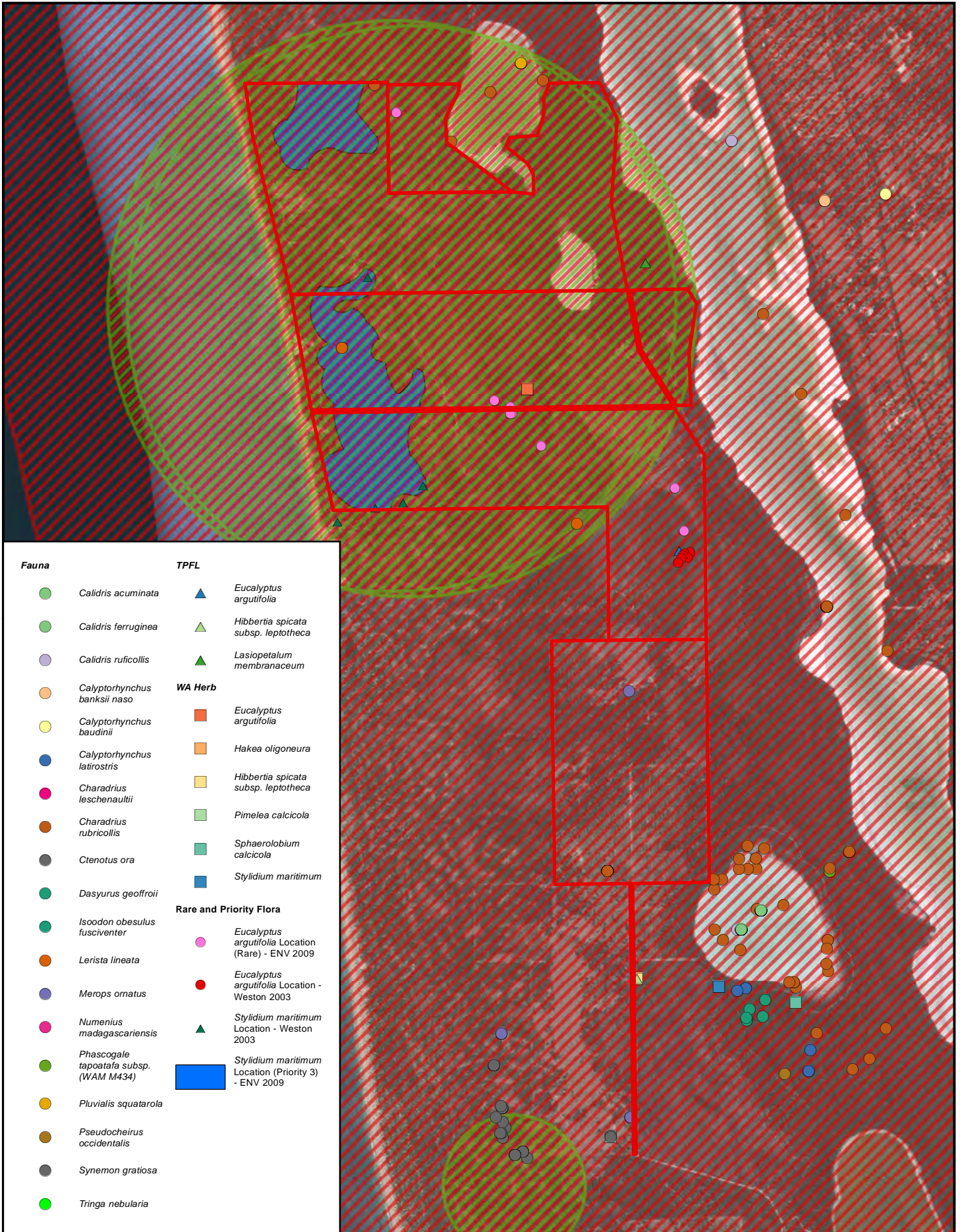
The TEC, FCT26a – *Melaleuca huegelii* – *Melaleuca acerosa* (*systema*) Shrublands on Limestone Ridges, is listed as Endangered (EN) by DPaW and endorsed by the Minister of the Environment. Gibson et al. (1994) characterised this community as including *Acacia lasiocarpa*, *Banksia sessilis*, *Grevillea thelemanniana* subsp. *preissii*, *Melaleuca acerosa*, *Melaleuca huegelii* and *Trymalium albicans* with numerous herbs. FCT26a is restricted to large limestone ridges north of Perth and those in the Yalgorup area on skeletal soils of ridge slopes and ridge tops dominated by heath vegetation. This community has been identified as occurring in the Survey Area in ENV (2009). The DPaW database has no records of this community at this location, but does show a known location 2.7 km east of the Survey Area.

Similarly, the TEC, FCT18 Shrublands on Calcareous Silts was recorded by ENV (2009) however the DPaW databases show no records of this community in the Survey Area. Gibson *et al.* (1994) recorded this community in Yalgorup National Park and describes it as a very species-rich community characterised by open low scrubs with rich annual flora. Common taxa include *Acacia saligna*, *Leptomeria lehmannii*, *Xanthorrhoea preissii*, *Gahnia trifida* and *Melaleuca teretifolia* on damplands.

Table 15 Threatened and Priority Ecological Communities identified as occurring in the Study Area

	Cons. Status	Presence
FCT18 Shrublands on calcareous silts	WC Act: Vulnerable	May occur. There are no DPaW database records however ENV (2009) identified it as potentially occurring at one location following FCT analysis of field survey results.
SCP25 – Southern <i>Eucalyptus gomphocephala</i> – <i>Agonis flexuosa</i> woodlands	Priority 3	Known. Mapped by ENV (2009) however no DPaW database records in the Survey Area with the nearest record 4 km east of Lake Clifton.
SCP29a – Coastal shrublands on shallow sands	Priority 3	Known from DPaW database 2016 and mapped by ENV (2009).
SCP29b – Acacia shrublands on taller dunes	Priority 3	Known from DPaW database 2016 and mapped by ENV (2009).
SCP30b – Quindalup <i>Eucalyptus gomphocephala</i> and / or <i>Agonis flexuosa</i> woodlands	Priority 3	Known from DPaW database 2016 and mapped by ENV (2009).

	Cons. Status	Presence
Elongate Fluvial Delta System – Peel-Harvey inlet	Priority 1	Unlikely. Associated with Peel-Harvey inlet located 5km east of the Survey Area on the east side of Lake Clifton.
FCT26a – <i>Melaleuca huegelii</i> – <i>Melaleuca acerosa (systema)</i> shrublands on limestone ridges	WC Act: Endangered	Known. Mapped by ENV (2009) however no DPaW database records in the Survey Area, with the nearest record 2.7 km east of Lake Clifton.



Fauna		TPFL	
	<i>Calidris acuminata</i>		<i>Eucalyptus argutifolia</i>
	<i>Calidris ferruginea</i>		<i>Hibbertia spicata subsp. leptotheca</i>
	<i>Calidris ruficollis</i>		<i>Lasiopetalum membranaceum</i>
	<i>Calyptorhynchus banksii naso</i>	WA Herb	
	<i>Calyptorhynchus baudinii</i>		<i>Eucalyptus argutifolia</i>
	<i>Calyptorhynchus latirostris</i>		<i>Hakea oligoneura</i>
	<i>Charadrius leschenaultii</i>		<i>Hibbertia spicata subsp. leptotheca</i>
	<i>Charadrius rubricollis</i>		<i>Pimelea calcicola</i>
	<i>Ctenotus ora</i>		<i>Sphaerolobium calcicola</i>
	<i>Dasyurus geoffroi</i>		<i>Stylidium maritimum</i>
	<i>Isoodon obesulus fusciventer</i>	Rare and Priority Flora	
	<i>Lerista lineata</i>		<i>Eucalyptus argutifolia</i> Location (Rare) - ENV 2009
	<i>Merops ornatus</i>		<i>Eucalyptus argutifolia</i> Location - Weston 2003
	<i>Numenius madagascariensis</i>		<i>Stylidium maritimum</i> Location - Weston 2003
	<i>Phascogale tapoatafa subsp. (WAM M434)</i>		<i>Stylidium maritimum</i> Location (Priority 3) - ENV 2009
	<i>Pluvialis squatarola</i>		
	<i>Pseudocheirus occidentalis</i>		
	<i>Synemon gratiosa</i>		
	<i>Tringa nebularia</i>		

PROJECT ID 60100953
 CREATED BY DGF
 APPROVED BY FDW
 LAST MODIFIED 19 AUG 2016

DATUM GDA 1994, PROJECTION MGA ZONE 50

1:35,000 when printed at A4

LEGEND

- Survey Area
- Priority 3
- Critically Endangered

TEC/PEC

- Priority 3
- Critically Endangered

Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Desktop Assessment Results

MAIN ROADS

LAKE CLIFTON BIOLOGICAL ASSESSMENT

Figure 7

5.2 Threatened and Priority flora

The desktop assessment identified ten flora species of conservation significance, including two species listed under the EPBC Act and WC Act, and eight species listed as Priority by DPaW and endorsed by the Minister for Environment.

Of the ten species, five species are known to occur within the Survey Area based on ENV (2009) which includes a figure showing Weston (2003) Threatened flora locations, and DPaW database search results. Furthermore, one species is considered likely to occur, three may occur, and one is considered unlikely to occur.

Details of all ten species are provided in Table 16 and historical locations shown in Figure 7.

Table 16 Desktop flora results showing species, conservation code (Commonwealth and State), habitat description and likelihood of occurrence

Species	Conservation code ¹	Habitat ²	Flowering Period	Likelihood
<i>Eucalyptus argutifolia</i> , Yanchep Mallee, Wabbling Mallee	VU, VU	Grows on slopes and gullies near coast and close to summits of limestone ridges. Soils are shallow, well drained and grey with outcrops of limestone. Commonly associated with heath and thicket species.		Known , ENV (2009) mapped three populations with more than 200 individuals. Weston (2003) mapped one population. DPaW database shows ten records from two distinct populations.
<i>Caladenia huegelii</i> Grand Spider Orchid	EN, CR	Grows in deep sandy soil in <i>Banksia-Eucalyptus marginata</i> woodland	Sep-late Oct	Unlikely , no suitable habitat present.
<i>Caladenia swartziorum</i>	P1	Winter wet areas.	Unknown	May , suitable habitat present but no known occurrences in the Study Area.
<i>Stylidium maritimum</i>	P3	Sand over limestone. Dune slopes and flats. Coastal heath and shrubland, open <i>Banksia</i> woodland	Sep-Nov	Known , more than 2,800 records (ENV (2009) in the western sand dune communities. No DPaW database records in the Study Area.
<i>Hakea oligoneura</i>	P4	Limestone. Known only from Mandurah and Waroona. Recorded by Weston (2003) in Yalgorup National Park in <i>Banksia sessilis</i> woodlands	Unknown	Known , recorded by Weston (2003) and suitable habitat present. No known occurrences from DPaW or ENV (2009).
<i>Hibbertia spicata</i> subsp. <i>leptotheca</i>	P3	Near-coastal limestone ridges, outcrops and cliffs.	Jul-Oct	Known , recorded by Weston (2003) and one DPaW database record near the access road.
<i>Lasiopetalum membranaceum</i>	P3	Sand over limestone.	Sep-Dec	Known , one DPaW database record located in the northeast of Lake Clifton.
<i>Platysace ramosissima</i>	P3	Sandy soils.	Oct-Nov	Likely , suitable habitat present and one DPaW database record in close proximity.
<i>Pimelea calcicola</i>	P3	Coastal limestone ridges, sand.	Sep-Nov	May , suitable habitat present but no records in the Study Area.
<i>Sphaerolobium calcicola</i>	P3	White-grey-brown sand, sandy clay over limestone, black peaty sandy clay. Tall dunes, winter-wet flats, interdunal swamps, low-lying areas.	Jun or Sep	May , suitable habitat present but no records in the Study Area.

1. Shows EPBC Act listing and WC Act listing based on categories described in Appendix A and Section 2.0. P refers to Priority flora listed by DPaW.

2. Information obtained from DotE (2016) Species Profiles Database (SPRAT) or WA Herbarium Florabase (1998)

5.3 Threatened and Priority fauna

The desktop assessment identified 63 conservation significant fauna species that could potentially occur within the Survey Area. Of these:

- 12 species are likely to occur (Table 17)
- 31 species may occur
- 20 species are unlikely to occur.

The species likely to occur in the Survey Area include eight bird, two mammal, one reptile and one invertebrate species. The likelihood of occurrence of fauna species was determined by assessing the presence of suitable habitat in the Survey Area, and reviewing the recent records and distribution of the species. Table 17 identifies the 12 species likely to occur. The conservation significant categories as defined by DPaW, the WC Act and EPBC Act are defined in **Appendix A**.

The full desktop assessment for all 63 fauna species and their likelihood of occurrence are presented in **Appendix D**.

Table 17 Threatened Fauna species likely to occur within the Survey Area

Name	Common Name	Conservation Status		Ecology
		Commonwealth	State	
Birds				
<i>Calidris ruficollis</i>	Red-necked Stint	Migratory / Marine	IA	The Red-necked Stint is a small Calidridinae approximately 13–16 cm in length and is the smallest shorebird in Australia (Geering <i>et al.</i> 2007). The Red-necked Stint has been recorded in all coastal regions, and found inland in all states when conditions are suitable. The Red-necked Stint breeds in Siberia and sporadically in north and west Alaska. In Australasia, the Red-necked Stint is mostly found in coastal areas. The Red-necked Stint mostly forages on bare wet mud on intertidal mudflats or sandflats, or in very shallow water; mostly in areas with a film of surface water and mostly close to edge of water. During high tides they sometimes forage in non-tidal wetlands (DotE, 2016b). Within Australia, there are a number of threats common to most migratory shorebirds, including habitat loss, habitat degradation, disturbance and direct mortality (DotE, 2016b).
<i>Calyptorhynchus latirostris</i>	Carnaby's Black Cockatoo	E	EN	Carnaby's Black Cockatoo is endemic to the southwest of Western Australia and is a large black cockatoo with a white patch on its cheek, white bands on its tail and a strong short curved bill. This species display strong pair bonds and nest in the hollows of live or dead Eucalypts. On the Swan Coastal Plain, the birds feed on a large variety of plants, preferring proteaceae species and Marri nuts, and some introduced species (e.g. <i>Pinus</i> sp.). Carnaby's Black Cockatoo has undergone a dramatic decline in recent years, declining by 50 percent in the past 45 years, one of the main contributing factors being land clearing (DotE, 2016). Refer to Section 6.3.3.1 for further detail.

Name	Common Name	Conservation Status		Ecology
		Commonwealth	State	
<i>Charadrius rubricollis</i>	Hooded Plover	Marine	P4	Hooded Plovers are small to medium-sized, stocky shorebirds with short bills, large eyes and rounded heads. The Hooded Plover is pale-coloured, 19 - 23 cm in length with a wingspan of 26 - 44 cm. Hooded Plovers utilise sandy ocean beaches, tidal bays and estuaries, rock platforms and rocky or sand-covered reefs near sandy beaches, small beaches in lines of cliffs, near-coastal saline and freshwater lakes and lagoons. In south-west Western Australia the Hooded Plover is not restricted to the coast, and can also live and breed around inland salt lakes (OEH, 2016). Threats to the Hooded Plover include disturbance, predation of eggs and chicks by foxes, dogs, and cats, Australian ravens, silver gulls and raptors, habitat modification (OEH, 2016).
<i>Charadrius ruficapillus</i>	Red-capped Plover	Marine	-	The Red-capped Plover is a small grey-brown plover that is white underneath and has a red-brown crown. The Red-capped Plover is the most common of Australia's beach-nesting shorebirds. It is widespread throughout Australia and is found in wetlands, especially in arid areas, and prefers saline and brackish waters. They usually inhabit wide, bare sandflats or mudflats at the margins of saline, brackish or freshwater wetlands where they forage by taking small invertebrates from the surface (http://www.birdlife.org.au/bird-profile/red-capped-plover).

Name	Common Name	Conservation Status		Ecology
		Commonwealth	State	
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	Marine	-	The White-bellied Sea-Eagle is a large raptor that has long, broad wings and a short, wedge-shaped tail. It measures 75–85 cm in length, and has a wingspan of 180–220 cm. This species is distributed along the Australian coastline, and it also extends inland along some of the larger waterways. The White-bellied Sea-Eagle is found in coastal habitats (especially those close to the sea-shore) and around terrestrial wetlands in tropical and temperate regions of mainland Australia and its offshore islands (DotE, 2016b). Potential threats to the White-bellied Sea-Eagle are the loss of habitat due to land development, disturbance of nesting pairs by human activity, poisoning, shooting, competition with Wedge-tailed Eagles, and the deterioration of inland water resources (DotE, 2016b).
<i>Merops ornatus</i>	Rainbow Bee-eater	Marine	-	The Rainbow Bee-eater is a common species which occupies numerous habitats including open woodlands with sandy loamy soil, sand ridges, sandpits, riverbanks, road cuttings, beaches, dunes, cliffs, mangroves and rainforests (Morcombe, 2003). The Rainbow Bee-eater breeds in monogamous pairs and nests are usually concentrated together in loose colonies with other pairs. In Australia the breeding season begins in August and carries through until January. Nests are constructed in a chamber at the end of a long burrow that is excavated by the pair. Burrows are typically recorded in flat or sloping ground in a variety of locations where suitable sandy loam substrate occurs (DotE, 2016b).

Name	Common Name	Conservation Status		Ecology
		Commonwealth	State	
<i>Numenius madagascariensis</i>	Eastern Curlew	CE	VU & IA	The Eastern Curlew is a large wader with a long neck, long legs, and a heavy bill that curves downwards. Within Australia, the Eastern Curlew has a primarily coastal distribution and is most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass. The birds are also found in saltworks and sewage farms (Marchant & Higgins 1993). Threats to the Eastern Curlew include human disturbance, habitat loss and modification, pollution and hunting (DoTE, 2016b).
<i>Tringa nebularia</i>	Common Greenshank	Migratory / Marine	IA	The Common Greenshank is a heavily built, elegant wader, 30–35 cm in length, with a wingspan of 55–65 cm and weight up to 190 g. The Common Greenshank does not breed in Australia, but does occur in all types of wetlands and has the widest distribution of any shorebird in Australia (DoTE, 2016). Within Australia, threats to the Common Greenshank include loss and modification of habitat; silt, weeds or pest invasion; disturbance and introduced species (DoTE, 2016b).

Name	Common Name	Conservation Status		Ecology
		Commonwealth	State	
Mammals				
<i>Isoodon obesulus fusciventer</i>	Quenda, Southern Brown Bandicoot	-	P4	The Quenda or Southern Brown Bandicoot is a small marsupial with coarse dark grey / yellow brown fur above, creamy-white below and a short, tapered, dark brown tail (DPaW, 2016). It is found in woodland, heath and shrub communities on the Swan Coastal Plain and prefers a combination of sandy soils and dense heathy vegetation (Van Dyck & Strahan 2008). Key threatening processes for the Quenda include habitat loss and degradation, road trauma and predation by introduced carnivores.
<i>Pseudocheirus occidentalis</i>	Western Ringtail Possum	V	EN	The Western Ringtail Possum is a medium sized nocturnal marsupial, up to 1.3 kg in weight and approximately 40 cm in body length. Its fur is dark brown above with cream to grey fur underneath, with a strong prehensile tail (Van Dyck & Strahan 2008). The Western Ringtail Possum has a patchy distribution in predominantly two areas: near Bunbury to Leeuwin-Naturaliste National Park (with a small translocated subpopulation near Dawesville); and near Albany. Habitat parameters affecting the distribution of the subpopulation on the Swan Coastal Plain are associated with stands of myrtaceous trees (usually <i>Agonis flexuosa</i>) growing near swamps, water courses or floodplains, and at topographic low points which provide cooler, often more fertile, conditions (DoTE, 2016). The main threats to the Western Ringtail Possum include climate change and extreme weather events, predation by the European Red Fox (<i>Vulpes vulpes</i>) and the Cat (<i>Felis catus</i>), inappropriate fire regimes, and habitat loss and fragmentation (Woinarski <i>et al.</i> , 2014).

Name	Common Name	Conservation Status		Ecology
		Commonwealth	State	
Reptiles				
<i>Lerista lineata</i>	Lined Skink	-	P3	<i>Lerista lineata</i> is a small reptile growing to 11 cm long, with characteristic dark brown ventral stripes (Storr <i>et al.</i> , 1999). This burrowing species is found in loose sand beneath logs and termite mounds and inhabits coastal heath and shrubland areas in the southwest and midwest coast of Western Australia (Wilson & Swan, 2010).
Invertebrates				
<i>Synemon gratiosa</i>	Graceful Sunmoth	-	P4	The Graceful Sunmoth is a medium-sized diurnal flying sunmoth that is similar in appearance to a butterfly. It has a wingspan of 25–35 mm with females generally larger than males. The upper surface of the forewings is dark grey, whereas the upper surface of the hind wings and the entire underside of all the wings are bright orange, with some dark grey markings (TSSC, undated). The Graceful Sunmoth is found only in southwest Western Australia, along a narrow strip of approximately 630 km of coastal habitat, from Kalbarri to Binningup (DEC, 2012). The main threats to this species are clearing of habitat for urban, rural and industrial development, particularly in the greater Perth to Peel urban area (Yanchep to Dawesville), and inappropriate management of habitat (TSSC, undated).

Note: Species listed as Marine under the EPBC Act are only considered conservation significant when in a Commonwealth marine reserve.

5.4 Black Cockatoos

5.4.1 Carnaby's Black Cockatoos

Carnaby's Black Cockatoo is endemic to the southwest of Western Australia, extending from the Murchison River to Esperance, and inland to Coorow, Kellerberrin and Lake Cronin (DotE, 2016). This black cockatoo has a white patch on its cheek, white bands on its tail, and a strong curved bill.

Carnaby's Black Cockatoo feed on seeds, nuts and flowers of a variety of native and exotic plants. Feed plants include the various proteaceous species (e.g. *Banksia*, *Grevillea* and *Hakea*), *Corymbia calophylla* (Marri), *Eucalyptus* (e.g. Jarrah [*Eucalyptus marginata*]), and seeds from the cones of Pine trees (*Pinus* sp.).

Carnaby's Black Cockatoo display strong pair bonds and nest in the hollows of live or dead mature eucalypts including Salmon Gum (*Eucalyptus salmonophloia*), York Gum (*Eucalyptus loxophleba* subsp. *loxophleba*), Flooded Gum (*Eucalyptus rudis*), Karri (*Eucalyptus diversicolor*), Marri (*Corymbia calophylla*), Wandoo (*Eucalyptus wandoo*) and Tuart (*Eucalyptus gomphocephala* [DSEWPaC, 2012]). Nest hollows generally range from 2.5-12 m above ground, size of entrance from 23-30 cm and depth of hollows from 1-2.5 m (Johnstone & Storr, 1998). On the SCP, Carnaby's Black Cockatoo are known to breed in small numbers at Regans Ford, Yanchep, Gingin, Mandurah and Bunbury (Johnstone & Johnstone, 2004). The species appears to be expanding its current breeding range westward and south into the Jarrah-Marri forests of the Darling Range and into the Tuart forests of the SCP (Johnstone & Kirkby, 2006). After breeding, Carnaby's Black Cockatoo disperse to the higher rainfall coastal areas of the south-west of Western Australia to feed in late December to July (DEC, 2009). Breeding has been recorded from early July to mid-December.

Carnaby's Black Cockatoo has undergone a dramatic decline of approximately 50 percent in the past 45 years, with the main contributing factors the clearing of core breeding habitat in the wheatbelt, the deterioration of nesting hollows, and clearing of foraging habitat.

Under the Perth-Peel strategic assessment, it is proposed that a minimum of 116,000 ha of additional conservation reserves be created that supports suitable Carnaby's habitat including the replacement of 5,000 ha of pines (Government of Western Australia, 2015).

5.4.2 Forest Red-tailed Black Cockatoos

The Forest Red-tailed Black Cockatoo is endemic to the south-west humid and semi-humid zones of Western Australia, where it inhabits dense Jarrah, Karri and Marri forests which receive more than 600 mm average annual rainfall (DSEWPaC, 2012). The species has a pair of black central tail feathers and a bright red, orange or yellow barring on the tail.

This species predominantly feeds in eucalypt forests, preferring Marri (*Corymbia calophylla*) and Jarrah (*Eucalyptus marginata*) seeds, but also feeding in Blackbutt (*Eucalyptus patens*), Albany Blackbutt (*Eucalyptus staeri*), Karri (*Eucalyptus diversicolor*), Sheoak (*Allocasuarina fraseriana*) and Snottygobble (*Persoonia longifolia*) (Johnstone, 2016 pers. comm.). Forest Red-tailed Black Cockatoo are monogamous and pairs nest in tree hollows from 6.5–33 m above ground. Most nests are in very large and very old, mature Marri (*Corymbia calophylla*) (Johnstone, Kirkby & Sarti, 2013), though they will nest in other eucalypts such as Tuart (Johnstone, 2016 pers. comm.).

The modelled distribution of Forest Red-Tailed black Cockatoos in the *Referral Guidelines for three threatened black cockatoo species* (DSEWPaC, 2012) ranges from Perth to Albany encompassing the south west of the state. Formerly common, but now rare to uncommon and patchily distributed, the Forest Red-tailed Black Cockatoo has disappeared from about 30% of its former range. It has suffered a marked decline in numbers over the past 60 years because of the destruction and fragmentation of habitat (especially Jarrah-Marri forest), the apparent decline in Marri along the eastern side of the Darling Scarp (possibly due to climate change), logging, the impact of competitors for nest hollows, and fire (Chapman, 2008).

According to Johnstone *et al.* (2013) the foraging ecology of the Forest Red-tail is changing as their range is expanding. New foraging species, including introduced species, are being added to their diet. Lack of food and the discovery of new food sources is leading this change in foraging range. Sedentary flocks are now becoming regular visitors to the Swan coastal Plain, particularly for breeding. Principal foods are Marri and Jarrah with less important foods including Blackbutt, Sheoak, *Hakea*, introduced eucalypts and cape lilac.

Habitat mapping for the Forest Red-tail was undertaken as part of the Strategic Assessment for the Perth and Peel Regions (Government of Western Australia, 2015). In the Strategic Assessment the following plant species were included as target species for the feeding habitat layer for the Forest Red-tailed Black Cockatoo and are also used by Carnaby's Cockatoo: Marri (*Corymbia calophylla*), Jarrah (*Eucalyptus marginata*), Parrot Bush (*Banksia sessilis*), Wandoo (*E. wandoo*), Flooded Gum (*E. rudis*) and Tuart (*E. gomphocephala*). The majority of the Survey Area was mapped as Forest Red-tailed Black Cockatoo habitat in the *Draft EPBC Act Strategic Impact Assessment Report Part D: MNES Assessment*.

The potential for Flooded Gum (*E. rudis*) and Tuart (*E. gomphocephala*) as forage species was discussed with Johnstone as part of this survey and he confirmed that these species were not foraging species. Contradictions regarding foraging species for the Forest Red-tailed Black Cockatoo have caused difficulty with determining foraging habitat at the Survey Area. Species ultimately used to define habitat for this report were those as listed in Table 9.

5.4.3 Baudin's Black Cockatoo

Baudin's Black Cockatoo is distributed throughout the south-western humid and subhumid zones, from the northern Darling Range and adjacent far east of the SCP (south of the Swan River), south to Bunbury and across to Albany (Johnstone & Storr 1998). It is a large black cockatoo with rectangular white patches in the tail. Males have a pink eye ring, the female a dark eye ring.

Baudin's Black Cockatoo forages primarily in eucalypt forest, where it feeds on seeds, flowers, nectar and buds from Marri (*Corymbia calophylla*), and seeds of *Eucalyptus* and proteaceous species (e.g. *Banksia* and *Hakea*), as well as orchard fruits and Pines (*Pinus* sp.). It also takes insect larvae and insects (including beetle, wasp and moth larvae) from under bark and in wood of live and dead trees, from galls and from flower spikes of *Xanthorrhoea* and the pith of *Anigozanthos flavidus* (Johnstone & Kirkby, 2008).

This black cockatoo primarily nests in tree hollows in live or dead Karri (*Eucalyptus diversicolor*), Marri (*Corymbia calophylla*), Wandoo (*Eucalyptus wandoo*) and Tuart (*Eucalyptus gomphocephala* [DSEWPac, 2012]). Baudin's Black Cockatoo nests in spring in the deep southwest of Western Australia. It has suffered a substantial decline in numbers in the past 50 years. Direct causes of population decline include large numbers shot by orchardists, fragmentation of habitat and the impact of hollow competitors.

6.0 Field Results

6.1 Vegetation

6.1.1 Threatened and Priority Ecological Communities

6.1.2 Commonwealth

No EPBC Act listed vegetation communities occur within the Survey Area.

6.1.3 State

One State-listed TEC occurs within the Survey Area, as identified in the desktop assessment. The TEC FCT26a – *Melaleuca huegelii* – *Melaleuca acerosa* (*systema*) Shrublands on Limestone Ridges occurs at two distinct locations in the Survey Area. This community was confirmed by the presence of the two keystone species *Melaleuca huegelii* and *M. systema*, and the limestone outcropping. The results coincide with ENV (2009) results. This TEC is mapped as MsTd, and was rated as being in predominantly 'Very Good' condition. This community extends over 202 ha and is described in more detail in Table 18.

The TEC FCT18 Shrublands on calcereous silts may have been recorded during the 2016 field survey. ENV (2009) mapped this as potentially occurring within the 2016 mapping code MrGtHg. This community is dominated by *Melaleuca teretifolia* and *M. raphiophylla* over *Gahnia trifida*, which is consistent with some of the species characterising FCT18. A Level 2 flora and vegetation survey incorporating permanent quadrats sampled over multiple seasons would be required to ascertain the presence of this TEC. Quadrat data could then be used to infer a FCT by undertaking data analysis such as similarity indices and hierarchical clustering methods.

The Priority 3 PEC SCP25 – Southern *Eucalyptus gomphocephala*-*Agonis flexuosa* woodlands were recorded on the Cottesloe Complex – central and south (part of the Spearwood complex) at Lake Clifton. This PEC corresponds to parts of AfHcEp, AfXpHg, AfXpHh and EgMhAp where these communities intersect with the Cottesloe or Quindalup complexes. Similarly, another Priority 3 PEC, SCP30b – Quindalup *E. gomphocephala* and/or *A. flexuosa* woodlands that are restricted to the Quindalup system also occur at Lake Clifton. This community corresponds to EgMhAp and parts of AfHcEp.

The Priority 3 PEC SCP29a – Coastal shrublands on shallow sands and SCP29b – *Acacia* shrublands on taller dunes are restricted to the Quindalup dunes system. These PECs are known to occur within the Survey Area (DPaW records) and potentially correspond to ArMsTd. A Level 2 flor and vegetation survey including quadrat sampling over multiple seasons would be required to undertake data analysis to infer these FCTs with confidence. Vegetation communities, their detailed descriptions, and inferred TEC or PEC are presented in Table 18.

6.1.4 Vegetation communities



Two vegetation community maps have previously been developed for the Survey Area including the Freeman *et al.* (2009) broadscale vegetation mapping and the ENV (2009) Clifton Beach Flora and Vegetation Assessments. A review of ENV (2009) indicates that their vegetation map was produced by someone prior to their assessment, however no reference is given and none of the other studies are available for consideration. The two available maps show two extremes of scale for mapping vegetation.



Freeman *et al.* (2009) mapped four broad vegetation groups at Lake Clifton, based on DPaW mapping and FCT mapping. This vegetation map generally coincides with the Heddle *et al.* (1980) vegetation association mapping.



ENV (2009) mapped 68 vegetation communities, capturing a level of detail considered unnecessary for this assessment. On-ground observations and floristic data captured in 63 relevés were used to produce an updated vegetation map at a 1:35,000 scale.


Following the field survey in June 2016, the floristic data captured in relevés were used to inform the vegetation mapping. Hierarchical clustering was undertaken to determine the relationships between relevés and illustrate groupings of similar sites. This led to 15 communities being described in Table 18 and mapped in Figure 8. These vegetation communities are similar to those described in ENV (2009) and Freeman *et al.* (2009).



Table 18 Vegetation communities


Community	Vegetation description	Photograph(s)
Woodland communities		
AfHcEp	<p><i>Agonis flexuosa</i> mid open forest with emergent <i>Eucalyptus gomphocephala</i> over <i>Hibbertia cuneiformis</i>, <i>Xanthorrhoea preissii</i> and <i>Clematis linearifolia</i> mid sparse shrubland over *<i>Euphorbia peplus</i>, *<i>Geranium molle</i>, *and *<i>Trachyandra divaricata</i> low sparse forbland.</p> <p>This community has pockets of rehabilitation. Soils of the community are sand or sandy loam and vegetation condition ranges from 'Good' to 'Very Good' Condition associated largely with the presence of understorey weeds, evidence of disturbance by rabbits and lack of native understorey vegetation in places.</p> <p>Area: 134.89 ha Sites: five relevés (including 2, 3, 4, 13, 39) Species richness: 10 native and 14 weed species Significance: Potential for portions of this community that occur on Cottesloe or Quindalup Complex to represent Priority 3 PECs SCP25 or SCP30b</p>	
AfXpHg	<p><i>Agonis flexuosa</i> and <i>Eucalyptus marginata</i> mid woodland with emergent <i>Eucalyptus gomphocephala</i> over <i>Xanthorrhoea preissii</i>, <i>Hakea lissocarpha</i> and <i>Hardenbergia comptoniana</i> low to tall open shrubland over *<i>Hypochaeris glabra</i> and *<i>Lysimachia arvensis</i> low sparse forbland.</p> <p>Soils of this community were recorded as dark brown sands with loam in places. Vegetation condition was 'Very Good', influenced by the presence of understorey weeds and evidence of previous human disturbance.</p> <p>Area: 11.87 ha Sites: two relevés (1, 62) Species richness: 24 native and six weed species Significance: Potential for portions of this community that occur on Cottesloe complex to represent Priority 3 PEC SCP25</p>	


Community	Vegetation description	Photograph(s)
AfXpHh	<p>Low to mid open to closed forest of <i>Agonis flexuosa</i>, <i>Eucalyptus gomphocephala</i> and occasional <i>Banksia grandis</i> over <i>Xanthorrhoea preissii</i>, <i>Templetonia retusa</i> and occasional <i>Banksia sessilis</i> var. <i>cygnorum</i> tall open shrubland over <i>Hibbertia hypericoides</i> and <i>Macrozamia riedlei</i> sparse to open low shrubland.</p> <p>This vegetation communities has areas of the Declared Pests *<i>Gomphocarpus fruticosus</i> and *<i>Zantedeschia aethiopica</i>. Within the community there are occasional <i>Banksia attenuata</i>, <i>Banksia littoralis</i> and <i>Banksia grandis</i> as well as <i>Eucalyptus petrensis</i> along ecotones and <i>Nuytsia floribunda</i>. The soil type within the community comprised white to brown sand and loam. Vegetation condition ranged between 'Very Good' and 'Excellent' reflecting generally relatively low intensity of weeds and also evidence of disturbance by rabbits.</p> <p>Area: 95.93 ha Sites: eight relevés (8, 9, 10, 11, 23, 24, 25, 30) Species richness: 51 native and 10 weed species Significance: Potential for portions of this community that occur on Cottesloe complex to represent Priority 3 PEC SCP25</p>	
EgMhAp	<p>Isolated tall trees of <i>Eucalyptus gomphocephala</i> over mid woodland of <i>Agonis flexuosa</i> and occasional <i>Santalum acuminatum</i> over <i>Melaleuca huegelii</i> subsp. <i>huegelii</i>, <i>Acacia rostellifera</i> and <i>Clematis linearifolia</i> tall shrubland over <i>Acanthocarpus preissii</i>, *<i>Trachyandra divaricata</i> and *<i>Euphorbia peplus</i> closed low forbland.</p> <p>Soil was a sandy loam, brown in colour reflecting the presence of organic matter. Vegetation condition was recorded as 'Good' due to the presence of weeds, a low diversity of plants and the absence of much native understorey stratum.</p> <p>Area: 17.53 ha Sites: one relevé (18) Species richness: 10 native and four weed species Significance: Potential for this community to represent Priority 3 PECs SCP25 or SCP30b</p>	


Community	Vegetation description	Photograph(s)
EgMsTd	<p><i>Eucalyptus gomphocephala</i> mid woodland over <i>Melaleuca systema</i>, <i>Hibbertia cuneiformis</i> and <i>Xanthorrhoea preissii</i> mid to tall shrubland over *<i>Trachyandra divaricata</i>, *<i>Geranium molle</i> and *<i>Trifolium campestre</i> low forbland.</p> <p>Isolated <i>Acacia rostelifera</i> thickets occur within this community and occasional <i>Eucalyptus platypus</i>.</p> <p>Soil type was brown sand with loam in places. Limestone was recorded at one of the sites within this community. Vegetation condition ranged from 'Good' to 'Very Good' primarily as a result of the presence of understory weeds, lacking native understory species in parts and the occasional presence of planted Eucalypts.</p> <p>Area: 6.50 ha Sites: three relevés (27, 28, 45) Species richness: 22 native and 12 weed species</p>	
EgXpTd	<p><i>Eucalyptus gomphocephala</i>, <i>Agonis flexuosa</i> and <i>Banksia attenuata</i> tall open forest over <i>Xanthorrhoea preissii</i>, <i>Macrozamia riedlei</i> and <i>Hibbertia cuneiformis</i> mid to tall shrubland over *<i>Trachyandra divaricata</i>, *<i>Solanum nigrum</i> and *<i>Geranium molle</i> low isolated forbs.</p> <p>Soils comprised sand with loam and limestone was present at one site. Vegetation condition was mapped as 'Very Good'. Condition was affected by the presence of understory weeds.</p> <p>Area: 26.44 ha Sites: two relevés (15, 22), one opportunistic (20) Species richness: 12 native and six weed species</p>	



Community	Vegetation description	Photograph(s)
Heath and Shrubland communities		
<p>MsTd</p>	<p>Mid to tall heathland to closed heathland of <i>Melaleuca systema</i>, <i>Hibbertia cuneiformis</i> and <i>Templetonia retusa</i> over <i>*Trachyandra divaricata</i>, <i>*Hypochaeris glabra</i> and <i>*Arctotheca calendula</i> low forbland.</p> <p>Sandy loam soils with limestone outcrops. Vegetation condition ranged from 'Good' to 'Excellent', primarily affected by the presence of common weeds and the Declared Pest <i>*Gomphocarpus fruticosus</i>. In the southern portion of the Survey Area the vegetation condition reflects an altered structure resulting from historical linear row clearing. This community contains isolated pockets of mallee trees including <i>Agonis flexuosa</i>, <i>Hakea prostrata</i>, <i>Eucalyptus argutifolia</i> (Threatened), <i>Eucalyptus foecunda</i>, <i>Eucalyptus petrensis</i>, <i>Eucalyptus decipiens</i> and <i>Eucalyptus platypus</i> with occasional <i>Nuytsia floribunda</i>.</p> <p>Area: 202.47 ha Sites: 14 relevés (5, 6, 7, 17, 19, 29, 41, 42, 56, 57, 58, 59, 60, 61), two opportunistic (42b, 63) Species richness: 54 native and 15 weed species Significance: Likely to represent State-listed TEC FCT26a</p>	


Community	Vegetation description	Photograph(s)
ArMsTd	<p><i>Acacia rostellifera</i>, <i>Spyridium globulosum</i> and <i>Clematis linearifolia</i> tall shrubland over <i>Melaleuca systema</i>, <i>Phyllanthus calycinus</i> and <i>Acanthocarpus preissii</i> mid heathland to open heathland over low sparse to closed forbland of <i>*Trachyandra divaricata</i>, <i>*Solanum nigrum</i> and <i>*Geranium molle</i>.</p> <p>Emergent <i>Agonis flexuosa</i> and <i>Eucalyptus platypus</i> in places as well as areas of planted Eucalypts.</p> <p>Soils of this vegetation community were cream to brown sands. Condition ranged from 'Very Good' to 'Excellent'. Areas of lower condition were associated with understorey weeds.</p> <p>Area: 263.51 ha Sites: 13 relevés (sites 31, 32, 43, 54, 34, 35, 48, 49, 50, 52, 53, 46, 47), one opportunistic (site 51) Species richness: 50 native and eight weed species Significance: Potential for portions of this community located on Cottesloe or Quindalup complexes to represent Priority 3 PECs SCP29a and SCP29b, respectively</p>	
AfSgTd	<p>Isolated low trees of <i>Agonis flexuosa</i> over mid to tall shrubland of <i>Spyridium globulosum</i>, <i>Alyxia buxifolia</i> and <i>Acanthocarpus preissii</i> over low sparse forbland of <i>*Trachyandra divaricata</i> and other common annual weeds.</p> <p>Soils underlying this vegetation community are sands and limestone was evident at one site. Vegetation condition was rated as 'Excellent' with relatively minor weed incursion evident.</p> <p>Area: 17.68 ha Sites: two relevés (sites 36, 37) Species richness: 26 native and five weed species</p>	

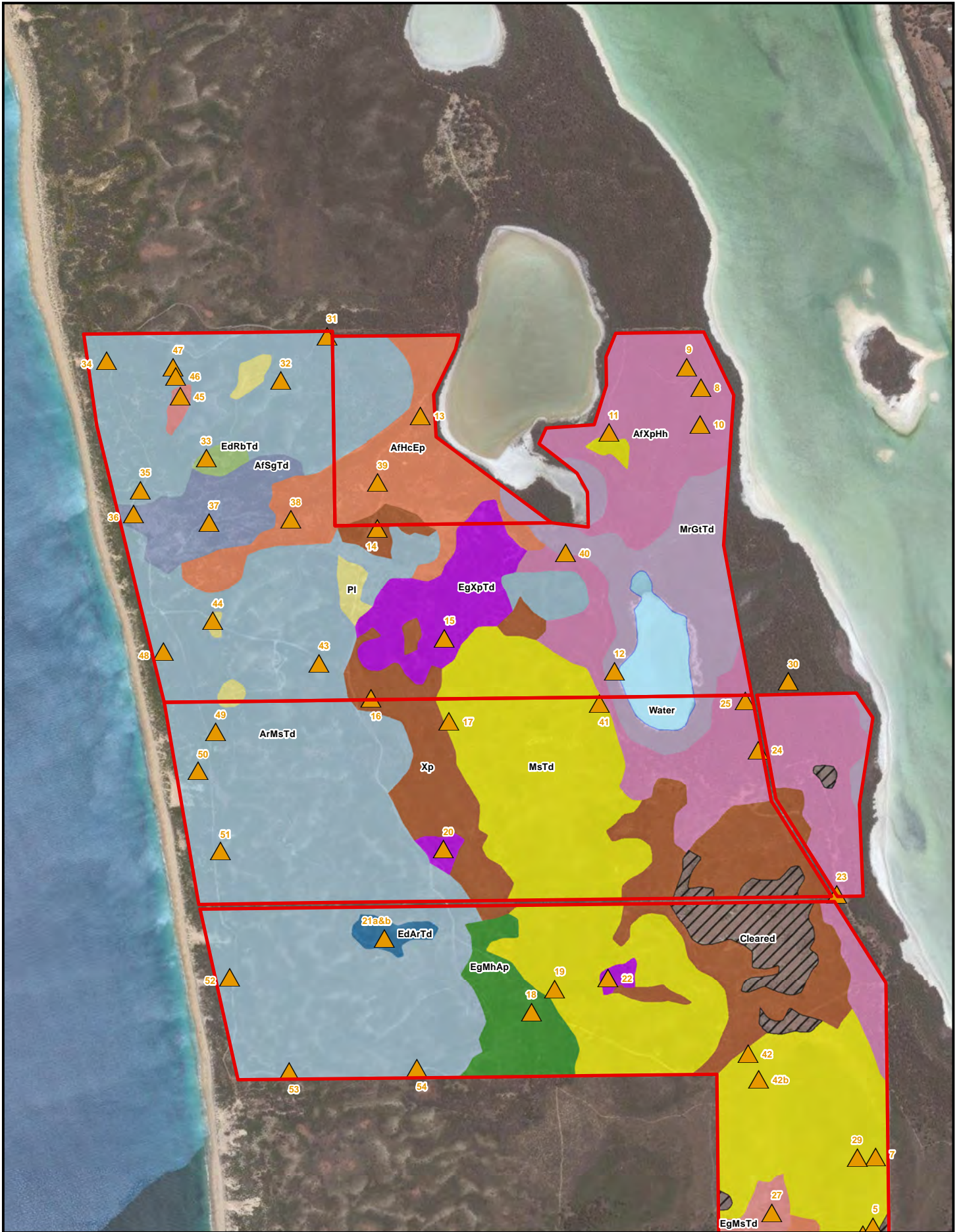
Wetland communities	
MrGtTd	<p><i>Melaleuca raphiophylla</i> and <i>Melaleuca cuticularis</i> low closed forest over <i>Gahnia trifida</i>, <i>Juncus kraussii</i> subsp. <i>australiensis</i> and <i>Lepyrodia drummondiana</i> mid to tall sedgeland over <i>*Trachyandra divaricata</i>, <i>*Geranium molle</i> and <i>*Lysimachia arvensis</i> low isolated forbs.</p> <p>This community captures three distinct zones of riparian vegetation associated with the wetland in the Survey Area. Adjacent to the open water the vegetation is characterised by <i>Melaleuca cuticularis</i> low closed forest over <i>?Threlkeldia diffusa</i>, <i>Sarcocornia blackiana</i> and <i>*Lysimachia arvensis</i> low chenopod shrubland. This community grades to the MrGtTd description as soils become less water where <i>M. cuticularis</i> is supplemented with <i>M. raphiophylla</i>. The third zone, furthest from the water becomes <i>Eucalyptus petrensis</i>, <i>Agonis flexuosa</i> and <i>Eucalyptus gomphocephala</i> mid closed forest over <i>Xanthorrhoea preissii</i>, <i>Templetonia retusa</i> and <i>Melaleuca systena</i> mid open shrubland over <i>Lepyrodia drummondiana</i> and <i>Gahnia trifida</i> tall sedgeland.</p> <p>The soils are black clay loam with some limestone present in places. Vegetation condition was rated as 'Excellent'. The condition is impacted by the presence of some weedy undergrowth and presence of the declared pest <i>*Zantedeschia aethiopica</i>.</p> <p>Area: 39.48 ha Sites: two relevés (12, 40) Species richness: 29 native and six weed species</p>
	

MrGtHg	<p><i>Melaleuca raphiophylla</i> and <i>Melaleuca teretifolia</i> low open forest with occasional <i>Melaleuca lanceolata</i> over <i>Gahnia trifida</i> tall sedgeland over *<i>Hypochaeris glabra</i>, *<i>Dittrichia graveolens</i> and *<i>Lysimachia arvensis</i> low open forbland.</p> <p>This community includes occasional emergent <i>Eucalyptus gomphocephala</i> and <i>Agonis flexuosa</i>.</p> <p>Soil clay loam. Vegetation condition ranged from 'Degraded' to 'Excellent'. Areas of 'Degraded' condition are associated with historic clearing and weed incursion including the declared pest *<i>Gomphocarpus fruticosus</i>.</p> <p>Area: 12.90 ha Sites: two relevés (26, 55) Species richness: nine native and 11 weed species Significance: Potential to represent the State-listed TEC FCT18</p>	
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EdArTd	<p>Wetland fringing vegetation comprising <i>Eucalyptus decipiens</i>, <i>Callitris preissii</i> and <i>Allocasuarina fraseriana</i> low open forest over <i>Acacia rostellifera</i>, <i>Xanthorrhoea preissii</i> and <i>Melaleuca huegelii</i> subsp. <i>huegelii</i> tall shrubland over <i>*Trachyandra divaricata</i>, <i>*Solanum nigrum</i> and <i>*Trifolium campestre</i> low open forbland.</p> <p>Waterbody is a closed rushland dominated by <i>*Typha sp.</i> and <i>Baumea juncea</i>. Some planted Eucalypts surrounding the wetland. Vegetation condition was rated as 'Good' as a result of weeds in the understorey. Soils are sand.</p> <p>Area: 3.37 ha Sites: two relevés (21a, 21b) Species richness: 17 native and four weed species</p>	
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EdRbTd	<p>Wetland fringing vegetation comprising <i>Eucalyptus decipiens</i>, <i>Callitris preissii</i> and <i>Melaleuca lanceolata</i> low open forest over <i>Rhagodia baccata</i> subsp. <i>baccata</i>, <i>Acacia rostellifera</i> and <i>Melaleuca huegelii</i> mid to tall shrubland over <i>*Trachyandra divaricata</i>, <i>*Solanum nigrum</i> and <i>*Geranium molle</i> low forbland.</p> <p>Wetland itself is a closed rushland of <i>Typha</i> sp. And <i>Baumea juncea</i> surrounded by <i>Melaleuca raphiophylla</i>, <i>Allocasuarina fraseriana</i> and Planted Eucalypts. Soil at the site is sand. Vegetation condition was rated as 'Very Good' due to the presence of weeds.</p> <p>Area: 2.11 Sites: one relevé (33) Species richness: 18 native and 3 weed species</p>	
AfDdLg	<p><i>Agonis flexuosa</i> mid woodland with emergent <i>Eucalyptus gomphocephala</i> over <i>Diplolaena dampieri</i>, <i>Alyxia buxifolia</i> and <i>Hibbertia cuneiformis</i> mid to tall open shrubland over <i>Lepidosperma gladiatum</i>, <i>*Trachyandra divaricata</i> and <i>*Geranium molle</i> tall closed sedgeland</p> <p>Area: 0.09 ha Sites: one relevé (38) Species richness: 11 native and five weed species</p>	

Modified communities		
Xp	<p><i>Xanthorrhoea preissii</i> tall shrubland over common weeds.</p> <p>Vegetation condition was rated as 'Good' due to the absence of an over storey and the presence of common weeds. Soils were sand and loam. Scattered limestone was observed in some areas.</p> <p>Area: 85.62 ha Sites: two relevés (14, 16), one opportunistic (59b) Species richness: 10 native and nine weed species</p>	
Cleared	<p>Cleared of native vegetation Area: 40.68 ha</p>	None available
PI	<p>Planted Eucalypts sometimes over sparse native and/or non-native shrubs over common annual weeds such as *<i>Trachyandra divaricata</i>.</p> <p>Area; 5.48 ha Sites: one opportunistic (44)</p>	None available
Water	<p>Water</p> <p>Area: 12.40 ha</p>	None available



PROJECT ID 60100953
 CREATED BY DGF
 APPROVED BY FDW
 LAST MODIFIED 19 AUG 2016

AECOM
 www.aecom.com

DATUM GDA 1994, PROJECTION MGA ZONE 50
 0 150 300 450 600
 metres
 1:20,000 when printed at A4

LEGEND

Survey Area	AfXpHh	EgXpTd
Relevés	AfXpHhHg	MrGtHg
Community	ArMsTd	MrGtTd
Cleared	EdArTd	MsTd
AfDdLg	AfSgTd	PI
AfHcEp	EdRbTd	Water
AfSgTd	EgMhAp	Xp
AfXpHg	EgMsTd	

Vegetation Community Mapping

MAIN ROADS

LAKE CLIFTON BIOLOGICAL ASSESSMENT

Figure 8

Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

6.1.5 Condition

Vegetation condition varied from 'Excellent' to 'Completely Degraded'. A large portion of the vegetation was mapped as 'Excellent', extending over 333 ha (comprising 34 % of the Survey Area). The major contributing factors causing degradation are historical clearing, altered fire regimes and weed invasion.

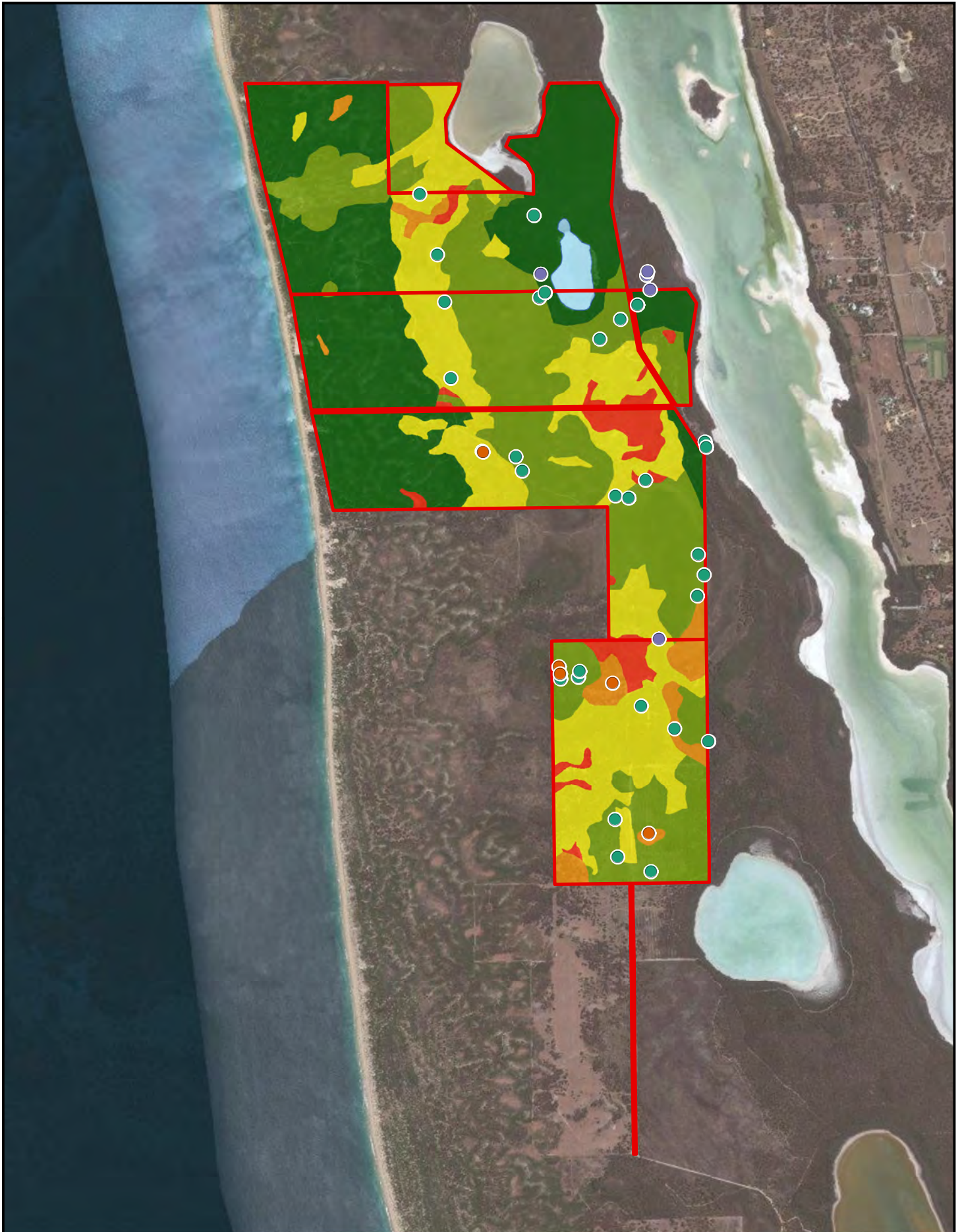
Altered fire regimes may have led to ecological change in Tuart forests within and adjacent to Yalgorup National Park (Bradshaw, 2000; Ward, 2000). Since the Yalgorup National Park was declared protected in 1968, fire frequency declined considerably as a fire exclusion zone was implemented (Longman & Keighery, 2002). Fires are essential for recruitment and persistence of obligate seeder plant species (i.e. *Banksia* species [Australian Government, 2011]).

Weed invasion, particularly invasive species that dominate and displace native vegetation put pressure on land environmental values and impact on biodiversity (Australian Government, 2011). A total of 20 weed species were recorded within 86% of relevés completed. Weeds are considered one of the major threats to the natural environment, destroying native habitats, threatening native plants and animals, and choking our natural systems including rivers and forests (Australian Government, 2016).

Vegetation condition has been mapped in Figure 9 and their relative extent shown in Table 19.

Table 19 Vegetation condition mapped within the Survey Area

Condition Rating	Area (ha)	Percentage of Survey Area (%)
Excellent	333.60	34.10
Very Good	314.87	32.19
Good	241.58	24.70
Degraded	35.13	3.59
Completely Degraded	40.63	4.15



<p>PROJECT ID 60100953 CREATED BY DGF APPROVED BY FDW LAST MODIFIED 19 AUG 2016</p> <p>AECOM www.aecom.com</p> <p>DATUM GDA 1994, PROJECTION MGA ZONE 50</p> <p>0 270 540 810 1,080 metres</p> <p>1:35,000 when printed at A4</p>	<p>LEGEND</p> <p> Survey Area</p> <p>Declared Pest Weeds Locations</p> <ul style="list-style-type: none"> ● <i>Gomphocarpus fruticosus</i> ● <i>Solanum linnaeanum</i> ● <i>Zantedeschia aethiopica</i> <p>Condition</p> <ul style="list-style-type: none"> Water Excellent Very Good Good Degraded Completely Degraded <p><small>Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community</small></p>	<p>Vegetation Condition Mapping</p> <hr/> <p>MAIN ROADS</p> <p><i>LAKE CLIFTON BIOLOGICAL ASSESSMENT</i></p> <p style="text-align: right;">Figure 9</p>
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6.2 Flora

6.2.1 Threatened and Priority flora

One EPBC Act listed species, *Eucalyptus argutifolia*, was confirmed to occur within the Survey Area at one location. At the time of the field survey, no spatial data for *Eucalyptus argutifolia* as mapped by Weston (2003) and ENV (2009) was available, therefore only the DPaW location was visited.

The Priority 3 species *Stylidium maritimum* was confirmed to occur on the sand dunes that extend north to south along the western edge of the Survey Area. No flowers were present at the time of the survey, which affected detection rates. Their distinctive leaves and colour assisted in the accurate identification in the field in the vicinity of ENV (2009) records.

6.2.2 Diversity

A total of 131 species from 85 genera and 48 families were recorded. The total includes 110 (84%) locally native species and 20 (16%) introduced (exotic) or naturalised weed species. A number of planted species were observed however no effort was spent to identify these to species level.

Families with the highest representation are Myrtaceae (17 native, one planted), Fabaceae (14 taxa; 11 native and three introduced) and Proteaceae (11 taxa; nine native and two introduced). The full list of vascular flora species recorded and representative communities in which they occur in are presented in **Appendix E**. Qualitative data recorded from individual quadrats is presented in **Appendix F**.

Diversity for the 2016 survey was lower than previously recorded, with ENV (2009) recording 179 taxa from 53 families and Weston (2003) recording 202 taxa across 65 families. This could be representative of the survey timing and the disturbance of weed invasion.

The ENV (2009) species list was merged with the current species list to provide one comprehensive overview of floristic diversity within the Survey Area (**Appendix G**). Following the merge of species lists, a total of 223 species from 138 genera and 61 families have been recorded. The total includes 161 (72%) locally native species. Of note is the number of Poaceae (grass) species collected previously (22 species) compared to the 2016 survey (two species).



Plate 1 Conservation significant species from left to right: EPBC Act-listed Threatened *Eucalyptus argutifolia*; Priority 3 *Styliidium maritimum*

6.2.3 Weeds

A total of 21 weeds were recorded during the field survey. This included three species listed as Declared Pests under the BAM Act. Details of the three Declared Pests are provided in Table 20 and Plate 2.

Weeds were observed throughout the entire Survey Area. In particular, the extensive spread of *Trachyandra divaricata* and the Declared Pest *Gomphocarpus fruticosus* led to a lower rating of vegetation community condition. The most common weeds recorded within sample sites were *Trachyandra divaricata* (48 sites), *Lysimachia arvensis* (35 sites) and *Solanum nigrum* and *Hypochaeris glabra* (33 sites each). The impacts of weeds have been previously discussed in Section 6.1.5. Examples of weed infestations observed are shown in Plate 3.

A complete list of weeds, their common names, their WA weed strategy rating (CALM, 1999) and the Swan Priority rating (Bettink & Keighery, 2008) is provided in **Appendix H**.



Plate 2 Declared Pests from left to right: *Gomphocarpus fruticosus*, *Solanum linnaeanum* and *Zantedeschia aethiopica*

Table 20 Declared Pests

Taxon	Details	Reproduction and Dispersal ¹	BAM Act Category
<i>Gomphocarpus fruticosus</i> Narrow Leaf Cotton Bush	Widely dispersed throughout the area with only the sand dunes excluded. 30 locations recorded, representing 1,622 individuals. This is a conservative estimate as not all individuals were counted or recorded due to the extent of the infestation.	From seed and suckers from lateral roots closest to the soil surface. Seeds are commonly spread by wind and water.	Declared Pest – C3, s22(2) across entire State.
<i>Solanum linnaeanum</i> Apple of Sodom	Four populations recorded, representing 22 adult plants and two juveniles.	From seed. Seeds do not disperse far from parent plants but fruit may be dragged when prickly fruit get attached to animals.	Declared Pest – C3, s22(2) in Shire of Waroona and Shire of Mandurah
<i>Zantedeschia aethiopica</i> Arum Lily	Recorded at five locations representing 35 juvenile individuals. No flowers present at the time of the survey.	Reproduces from seed and vegetatively via rhizomes and tubers. Seeds dispersed via water movements, birds and other animals. Local spread occurs from rhizomes.	Declared Pest – C3, s22(2) across entire State

1. Details derived from Identic (2016).



Plate 3 Weed invasion from top to bottom left to right: **Trachyandra divaricata* invasion in cleared area; typical weed understory of *Agonis flexuosa* woodlands; **Solanum nigrum* juvenile with **Lysimachia arvensis*.

6.3 Fauna

6.3.1 Fauna species

Forty-two fauna species were recorded during the field survey. This comprised 31 bird, eight mammal, one reptile and two amphibian species. The full species list is presented in **Appendix I**. Of the 42 fauna species, 11 species were of conservation significance. These 11 conservation significant fauna species comprised nine bird and two mammal species. These are listed and discussed in Table 21.

6.3.1.1 Introduced fauna

Six introduced fauna species were recorded at Lake Clifton. These comprised:

- Dog (*Canis lupis familiaris*)
- European Wild Rabbit (*Oryctolagus cuniculus*) Declared Pest - s22(2) (C3 Prohibited)
- House Mouse (*Mus musculus*)
- Red Fox (*Vulpes vulpes*) Declared Pest - s22(2) (C3 Exempt)
- Laughing Kookaburra (*Dacelo novaeguineae*)
- Laughing Turtle-dove (*Streptopelia senegalensis*).

The European Wild Rabbit and the Red Fox are both listed as Declared Pests under the BAM Act. Most species were recorded intermittently during the field survey, identified either by sight, call, scats, den or tracks.

6.3.2 Fauna habitat

Five main fauna habitats (including Cleared Areas) have been defined and mapped within the Survey Area (Table 22 and Figure 10). The delineation of fauna habitats considered the fauna habitat field assessments and the vegetation mapping.

The most common fauna habitat was the mid to tall shrubland / heathland at approximately 57% of the Survey Area. This is a varied habitat that would generally support many of the common species of the area, as recorded during the field survey. It would also be utilised by many of the conservation significant fauna species recorded at Lake Clifton such as Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*), Quenda (*Isoodon obesulus fusciventer*), Nankeen Kestrel (*Falco cenchroides*) and Magpie-lark (*Grallina cyanoleuca*).

The second most common habitat was the *Agonis flexuosa* and Tuart forest. This habitat covered approximately 30% of the Lake Clifton Survey Area. This habitat was also varied but generally contained an open Tuart overstorey over an open to closed *Agonis flexuosa* layer over an open shrub layer. The conservation significant fauna species that would potentially utilise this habitat include Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*), Quenda (*Isoodon obesulus fusciventer*), Western Ring-tail Possum (*Pseudocheirus occidentalis*), Whistling Kite (*Haliastur sphenurus*) and Southern Boobook (*Ninox novaeseelandiae*).

Table 21 Conservation Significant Fauna Recorded during the Field Survey

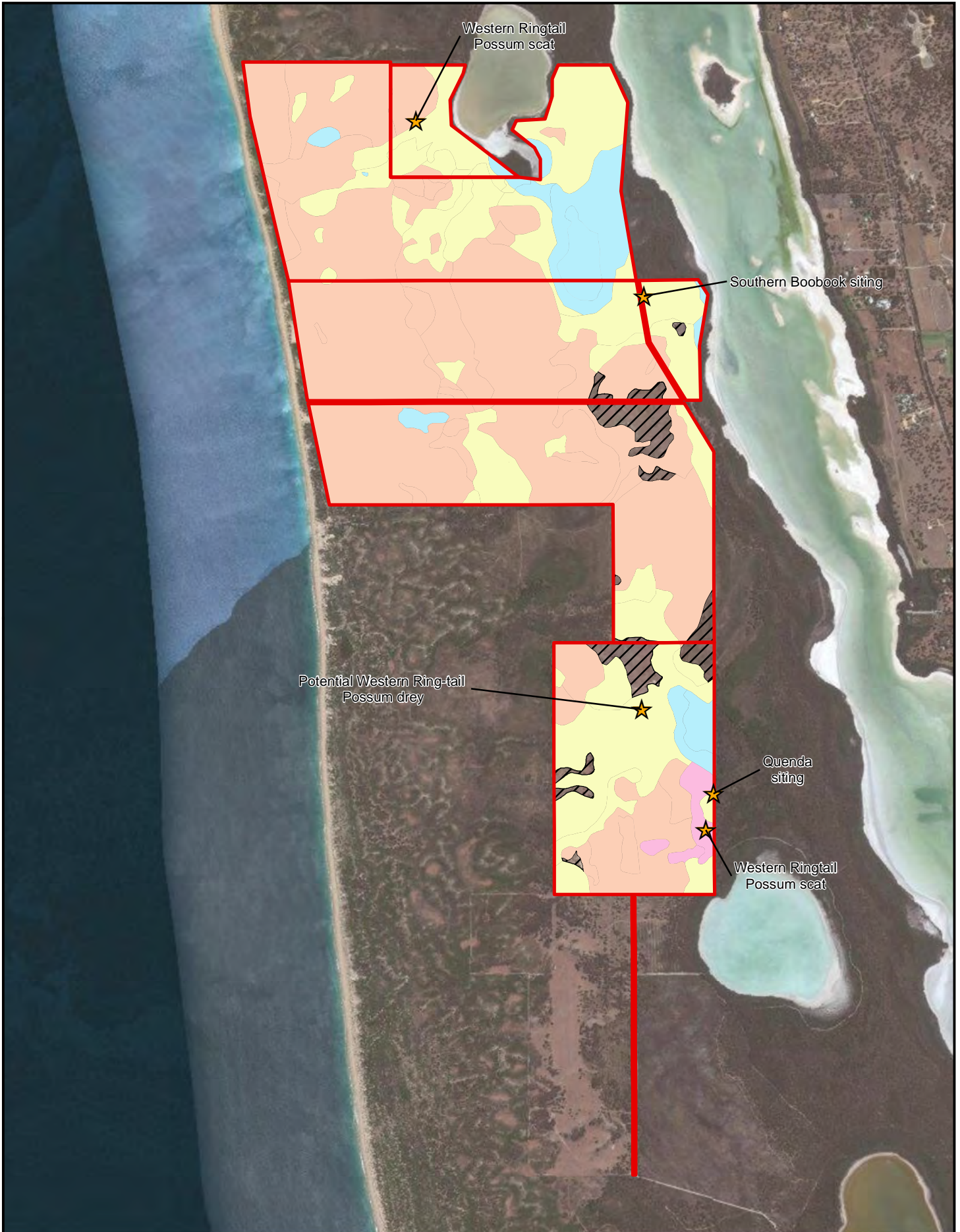
Name	Common Name	Conservation Status		Ecology
		Commonwealth	State	
Birds				
<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	Marine	-	The Fan-tailed Cuckoo is a slender cuckoo with the adult having a yellow eye ring, dark slate-grey back and wings, with a boldly barred black and white under tail. Younger birds are duller and browner in colour. This species is found in all kinds of well wooded habitats from Karri forests to Acacia thickets (Johnstone and Storr, 1998), and can be found in eastern Australia, southern south Australia, Tasmania and the southwest of Western Australia (Pizzey & Knight, 2007). This bird was heard in the woodland habitats of the Project area.
<i>Calyptorhynchus latirostris</i>	Carnaby's Black Cockatoo	E	EN	Refer to Sections 6.3.3.
<i>Circus approximans</i>	Swamp Harrier	Marine	-	The Swamp Harrier is a large slim-bodied raptor with long slender legs and a long, round-tipped tail, rounded at the tip. It is mainly dark brown above and the white rump is prominent. It has an owl-like face mask. The Swamp Harrier feeds mainly on birds and rats (Johnstone and Storr, 1998). The Swamp Harrier inhabits swamps and wetlands, tall grasslands, grain crops, coasts, islands, heathlands, saltmarshes, bracken and bore drains (Pizzey and Knight, 2010). At Lake Clifton this species was recorded flying over the unnamed wetland within the Project area. The Swamp Harrier is widespread in Australasia and the South Pacific.
<i>Falco cenchroides</i>	Nankeen Kestrel	Marine	-	The Nankeen Kestrel is a slender falcon and a relatively small raptor with the upper parts mostly rufous and some dark streaking. The wings are tipped with black and the underparts are pale buff, streaked with black. The under tail is finely barred with black, with a broader black band towards the tip. The Nankeen Kestrel's diet is varied, feeding mainly feeds on small mammals, reptiles, small birds and a variety of insects. Once prey is spotted, the bird drops nearer to the ground until it is close enough to pounce. Preferred habitats of the Nankeen Kestrel are lightly wooded areas and open agricultural areas. A pair of Nankeen Kestrels was observed several times during the survey in the cleared area of the Project area. Nankeen Kestrels are found in most areas of Australia.

Name	Common Name	Conservation Status		Ecology
		Commonwealth	State	
<i>Grallina cyanoleuca</i>	Magpie-lark	Marine	-	The Magpie-lark is a distinctively marked black and white bird with a thin bill and pale irises. The Magpie-lark is predominantly ground-dwelling, where it forages for invertebrates. It utilises most habitats and will be found anywhere there are trees and mud for nest building (Pizzey and Knight, 2010). The Magpie-lark is likely to be found in most of the fauna habitats at Lake Clifton and was recorded multiple times. Magpie-larks are confined to Australasia and found throughout Australia.
<i>Haliastur sphenurus</i>	Whistling Kite	Marine	-	The Whistling Kite is a medium-sized raptor with an almost shaggy appearance. It has a light brown head and underparts, and dark sandy-brown wings with paler undersides. Whistling Kites have been observed feeding on carrion and small birds (Johnstone and Storr, 1998). The Whistling Kite is found in a variety of habitats, usually near water, including woodlands, open country and wetlands (Pizzey and Knight, 2010). It prefers tall trees for nesting. At Lake Clifton, the Whistling Kite was observed perching on a large stag above a Wedge-tailed Eagles nest, and is likely to utilise most of the fauna habitats present. The Whistling Kite is widespread over mainland Australia.
<i>Hirundo neoxena</i>	Welcome Swallow	Marine	-	The Welcome Swallow is blue-black above and light grey on the breast and belly, with rust coloured markings on the forehead, throat and upper breast. It has a long forked tail, with a row of white spots on the individual feathers. The Welcome Swallow feeds on a wide variety of insects, which it acrobatically catches in flight. Welcome Swallows congregate in large flocks when food is abundant. Welcome Swallows frequent a wide variety of habitats with the exception of heavily forested and drier inland areas. Welcome Swallows were observed foraging over the unnamed lake to the northeast of Lake Clifton. Welcome Swallows are widespread in Australia but are scarce in the arid zone (Pizzey and Knight, 2010).

Name	Common Name	Conservation Status		Ecology
		Commonwealth	State	
<i>Ninox novaeseelandiae</i>	Southern Boobook	Marine	-	The Southern Boobook is the smallest and most common owl in Australia. It has dark brown plumage above and rufous-brown below, heavily streaked and spotted with white. The facial disc is brown and its eyes are large and yellowish. Feeding generally occurs at dusk and during the night when the owl flies from its perch to capture flying insects (Pizzey and Knight, 2010) and geckos and small mammals (Johnstone and Storr, 1998). The Southern Boobook is found in a variety of habitats from dense forest to open desert. This owl was recorded twice in the northern woodlands at Lake Clifton, where it was observed flying out of hollows in mature Tuart trees. It may potentially utilise the majority of the fauna habitats. Southern Boobooks are found throughout Australia.
<i>Petrochelidon nigricans</i>	Tree Martin	Marine	-	The Tree Martin is a small dark swallow which is stubbier than a Welcome Swallow, with dull white rump and short tail (Pizzey and Knight, 2010). Tree Martins eat insects which they mainly catch in flight. Tree Martins are found in the air above a range of habitats including open country with large trees, watercourses, rivers and wetlands (Pizzey and Knight, 2010). This bird was observed near the unnamed lake to the northeast of the Project area, and is likely to fly over the majority of the fauna habitats at Lake Clifton. The Tree Martin is widespread throughout Australia.

Name	Common Name	Conservation Status		Ecology
		Commonwealth	State	
Mammals				
<i>Pseudocheirus occidentalis</i>	Western Ringtail Possum	V	EN	The Western Ringtail Possum is a medium sized nocturnal marsupial, weighing up to 1.3 kg and with a body length of approximately 40 cm. It has dark brown fur above with cream to grey fur underneath. This species strong prehensile tail grows to 41 cm long and ends in a white tip (Van Dyck & Strahan, 2008). The possum constructs dreys from fine to medium-sized material collected from overstorey and understorey vegetation. Dreys vary from flimsy or platform-like constructions providing minimal shelter, to elaborate constructions providing substantial protection (de Tores & Rosier, 1997). The Western Ringtail Possum has a patchy distribution in predominantly two areas: near Bunbury to Leeuwin-Naturaliste National Park (with a small translocated subpopulation near Dawesville); and near Albany (Woinarski <i>et al.</i> , 2014). The subpopulation of the Western Ringtail Possum on the SCP are associated with stands of myrtaceous trees (usually Peppermint Tree [<i>Agonis flexuosa</i>]) growing near swamps, water courses or floodplains (DoTE, 2016). The Western Ringtail Possum was indirectly recorded potentially three times, twice through scats collected (33,081.901 172,762.009; 35,048.152 167,945.240) and once through locating a potential drey. Refer to Plate 4 and Figure 10. The Western Ringtail Possum will potentially utilise the woodland habitats that contain <i>Agonis flexuosa</i> .
<i>Isoodon obesulus fusciventer</i>	Quenda, Southern Brown Bandicoot	-	P4	The Quenda has coarse dark grey or yellow brown fur above and creamy-white below, with a short, tapered, dark brown tail. The ears are short and rounded, and the tail is lightly furred. The Quenda is omnivorous, feeding on invertebrates, underground fungi, subterranean plant material, and occasionally on small vertebrates. The Quenda inhabits scrubby, often swampy, vegetation with dense cover up to one metre high. The Quenda was directly sited in the woodland habitat, and is also likely to utilise the heathland and wetland habitats present. The Quenda is widely distributed near the southwest coast from Guilderton north of Perth to east of Esperance. Quenda have a patchy distribution through the Jarrah and Karri forest, the SCP, and inland as far as Hyden (DPaW, 2012).

Note: Species listed as Marine under the EPBC Act are only considered conservation significant when in a Commonwealth marine reserve.





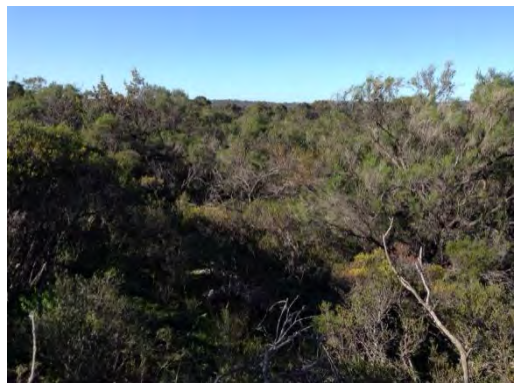





<p>PROJECT ID 60100953 CREATED BY DGF APPROVED BY JL LAST MODIFIED 19 AUG 2016</p> <p>AECOM www.aecom.com</p> <p>DATUM GDA 1994, PROJECTION MGA ZONE 50</p> <p>0 260 520 780 1,040 metres</p> <p>1:33,809 when printed at A4</p>	<p>LEGEND</p> <p> Survey Area</p> <p>★ Fauna Siting</p> <p>Fauna Habitat</p> <ul style="list-style-type: none"> <i>Agonis flexuosa</i> and Jarrah woodland <i>Agonis flexuosa</i> and Tuart forest Cleared Riparian vegetation, constructed ponds and wetlands Shrubland heathland <p><small>Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community</small></p>	<p>Fauna Habitat and Opportunistic Fauna Records</p> <p>MAIN ROADS</p> <p>LAKE CLIFTON BIOLOGICAL ASSESSMENT</p> <p style="text-align: right;">Figure 10</p>
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Plate 4 Potential Ring-tailed Possum drey

Table 22 Fauna habitats of the Survey Area

Fauna Habitat	Description	Conservation Significant Species Potentially Utilising Habitat	Area (ha)	Percentage (%)	Photos	
<p><i>Agonis flexuosa</i> and Tuart forest</p>	<p>This habitat was varied in density of Tuarts and understory, but generally contained an open Tuart overstorey over an open to closed <i>Agonis flexuosa</i> layer over an open shrub layer. Habitat features included:</p> <ul style="list-style-type: none"> • large mature trees were occasionally present, although there were pockets of significantly higher density large, mature trees • hollows within Tuarts were rare to occasionally present • fallen logs of varied sizes were generally common • bare ground was generally rare, as were soil cracks • course and fine litter were generally common • stone presence was varied depending on size, boulders were absent • a cryptogamic crust was generally rare and vines were occasionally present • dense shrubs were absent to occasionally present • proteaceous plant species were generally absent to occasionally present • no water bodies were present. 	<p>Carnaby's Black Cockatoo (<i>Calyptorhynchus latirostris</i>), Quenda (<i>Isoodon obesulus fusciventer</i>), Western Ring-tail Possum (<i>Pseudocheirus occidentalis</i>), Whistling Kite (<i>Haliastur sphenurus</i>), Southern Boobook (<i>Ninox novaeseelandiae</i>), Rainbow Bee-eater (<i>Merops ornatus</i>) and Fan-tailed Cuckoo (<i>Cacomantis flabelliformis</i>).</p>	<p>286.42</p>	<p>29.28</p>		
<p><i>Agonis flexuosa</i> and Jarrah woodland</p>	<p>This habitat generally contained an open Jarrah overstorey over an open to closed <i>Agonis flexuosa</i> layer, over an open shrub / scrub layer. Habitat features included:</p> <ul style="list-style-type: none"> • large mature trees were rare to occasionally present • hollows were rare to occasionally present in mature Jarrah trees • fallen logs of varied sizes were common • bare ground was common, as were soil cracks • course and fine litter were abundant • stone and boulder presence was rare • a cryptogamic crust was generally absent and the presence of vines was occasional • dense shrubs were absent to occasionally present • proteaceous plant species were generally rare • no water bodies were present. 	<p>Carnaby's Black Cockatoo (<i>Calyptorhynchus latirostris</i>), Quenda (<i>Isoodon obesulus fusciventer</i>), Western Ring-tail Possum (<i>Pseudocheirus occidentalis</i>), Whistling Kite (<i>Haliastur sphenurus</i>), Southern Boobook (<i>Ninox novaeseelandiae</i>), Rainbow Bee-eater (<i>Merops ornatus</i>) and Fan-tailed Cuckoo (<i>Cacomantis flabelliformis</i>).</p>	<p>11.80</p>	<p>1.21</p>		
<p>Mid to tall shrubland / heathland</p>	<p>This habitat was varied and generally contained an open to closed shrub / scrub layer with a moderately open groundcover layer. Habitat features included:</p> <ul style="list-style-type: none"> • Large mature trees were generally absent, as were hollows • fallen logs with a diameter less than 30 cm were absent to common • bare ground was occasionally to commonly present, and soil cracks were absent to rare • course and fine litter were rare to common • stone and boulder presence was absent to occasionally present • a cryptogamic crust was generally common • vines were absent to occasionally present • dense shrub presence was absent to common • proteaceous plant species were absent to occasional • no water bodies were present. 	<p>Carnaby's Black Cockatoo (<i>Calyptorhynchus latirostris</i>), Quenda (<i>Isoodon obesulus fusciventer</i>), Whistling Kite (<i>Haliastur sphenurus</i>), Rainbow Bee-eater (<i>Merops ornatus</i>), White-bellied Sea-Eagle (<i>Haliaeetus leucogaster</i>), Lined Skink (<i>Lerista lineata</i>), Graceful Sunmoth (<i>Synemon gratiosa</i>), Nankeen Kestrel (<i>Falco cenchroides</i>), Magpie-lark (<i>Grallina cyanoleuca</i>), Welcome Swallow (<i>Hirundo neoxena</i>), Southern Boobook (<i>Ninox novaeseelandiae</i>) and Tree Martin (<i>Petrochelidon nigricans</i>).</p>	<p>569.18</p>	<p>58.19</p>		

Fauna Habitat	Description	Conservation Significant Species Potentially Utilising Habitat	Area (ha)	Percentage (%)	Photos	
Wetlands and riparian vegetation	<p>This habitat consisted of natural wetlands, constructed pond and associated riparian zones. Habitat features included:</p> <ul style="list-style-type: none"> Large mature trees were generally absent, though some emergent Tuart trees were present in the ecotone areas hollows were not present various sized fallen logs were occasionally to commonly present bare ground was common and soil cracks were rare to occasional course and fine litter were occasional present stone and boulders were either absent or common cryptogamic crust presence was occasional vines were absent to occasionally present dense shrub presence was occasionally recorded proteaceous plant species were generally absent water bodies were present. <p>Note: ENV (2009) noted several other constructed ponds which were have not been represented on Figure 9.</p>	<p>Red-necked Stint (<i>Calidris ruficollis</i>), Hooded Plover (<i>Charadrius rubricollis</i>), Red-capped Plover (<i>Charadrius ruficapillus</i>), Eastern Curlew (<i>Numenius madagascariensis</i>), Common Greenshank (<i>Tringa nebularia</i>), Carnaby's Black Cockatoo (<i>Calyptorhynchus latirostris</i>), Quenda (<i>Isoodon obesulus fusciventer</i>), Whistling Kite (<i>Haliastur sphenurus</i>), Rainbow Bee-eater (<i>Merops ornatus</i>), White-bellied Sea-Eagle (<i>Haliaeetus leucogaster</i>), Nankeen Kestrel (<i>Falco cenchroides</i>), Magpie-lark (<i>Grallina cyanoleuca</i>), Welcome Swallow (<i>Hirundo neoxena</i>), Southern Boobook (<i>Ninox novaeseelandiae</i>) and Tree Martin (<i>Petrochelidon nigricans</i>).</p>	70.35	7.19		
Cleared	Completely degraded and cleared areas.	<p>Whistling Kite (<i>Haliastur sphenurus</i>), Rainbow Bee-eater (<i>Merops ornatus</i>), Nankeen Kestrel (<i>Falco cenchroides</i>), Magpie-lark (<i>Grallina cyanoleuca</i>), Welcome Swallow (<i>Hirundo neoxena</i>), Southern Boobook (<i>Ninox novaeseelandiae</i>) and Tree Martin (<i>Petrochelidon nigricans</i>).</p>	40.46	4.16		

6.3.3 Black Cockatoos

6.3.3.1 Carnaby's Black Cockatoo

Carnaby's Black Cockatoo were heard and / or observed five times during the field survey. They were observed either flying over Lake Clifton, foraging on *Banksia sessilis* within the Lake Clifton Survey Area, or heard in close proximity. The details of these records are presented in Table 23 and locations illustrated on Figure 11.

Table 23 Carnaby's Black Cockatoo observations

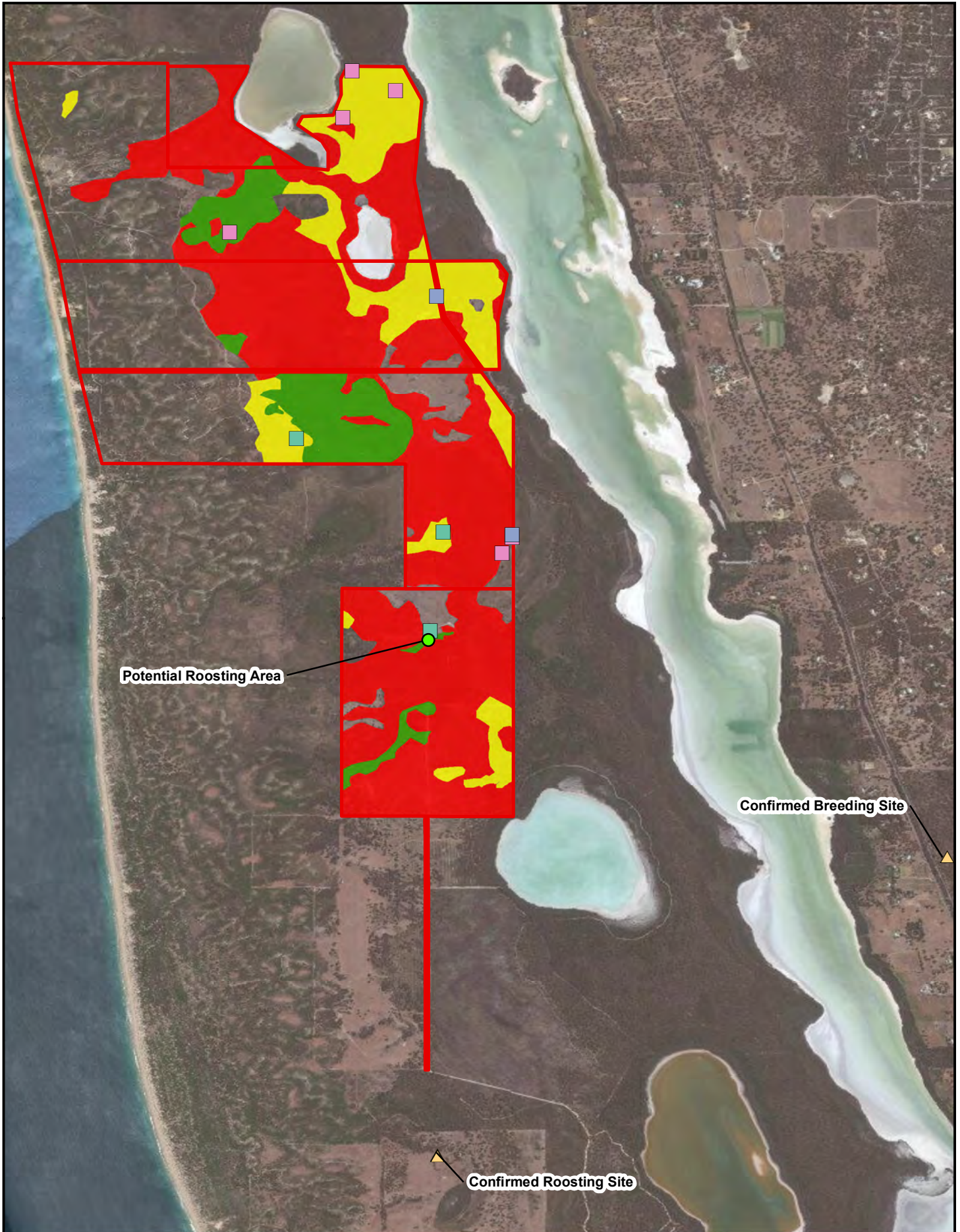
Record ID	Observation	Date	Location (m)	
Opp_13	Multiple birds heard towards the east	21 June 2016	34,578.405	168,899.646
Opp_19	Approx. 35 birds observed feeding on <i>Banksia sessilis</i> and then flying to the southeast	21 June 2016	35,122.715	169,518.519
Opp_43	Multiple birds heard towards the south	23 June 2016	33,728.387	170,338.712
Opp_50	Approx. 10 birds seen flying north	23 June 2016	34,615.686	171,412.419
Opp_55	Approx. 10 birds heard towards the east	24 June 2016	34,660.424	169,637.820

6.3.3.2 Baudin's Black Cockatoo

Baudin's Black Cockatoo was not recorded during the field survey.

6.3.3.3 Forest Red-tailed Black Cockatoo

The Forest Red-tailed Black Cockatoo was not recorded during the field survey or in other previous surveys.



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DATUM GDA 1994, PROJECTION MGA ZONE 50
 0 290 580 870 1,160
 metres
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LEGEND

Survey Area

- Confirmed Black Cockatoo Breeding and Roosting Sites

Carnaby's Black Cockatoo Foraging Habitat

- High (77.84 Ha)
- Valued (129.06 Ha)
- Low (424.85 Ha)

Carnaby's Black Cockatoo Sitings and Records

- Flock Heard
- Flock Observed Foraging
- Flock Seen
- Foraging Evidence

Carnaby's Black Cockatoo Foraging Habitat and Opportunistic Records

MAIN ROADS

LAKE CLIFTON BIOLOGICAL ASSESSMENT

Figure 11

Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

6.3.4 Black Cockatoo foraging habitat quality

6.3.4.1 Carnaby's Black Cockatoo

Lake Clifton contains a significant amount of mature Tuart trees. It does not contain habitats dominated by proteaceous species but does contain moderate areas of Parrot Bush (*Banksia sessilis*) and *Banksia attenuata*, and large areas of non-principle foraging species such as *Xanthorrhoea preissii*. Carnaby's Black Cockatoo was observed foraging on Parrot Bush within the Survey Area on 21 June 2016 and recent evidence of Carnaby's Black Cockatoo foraging was recorded an additional five times during the field survey. Table 24 provides the details regarding these observations, locations illustrated on Figure 11.

Table 24 Potential Carnaby's Black Cockatoo foraging evidence

Record ID	Observation	Date	Location (m)		Plate
Opp_15	Recent torn <i>Banksia sessilis</i> branches	21 June 2016	35,033.239	169,481.237	Plate 5
Opp_28	Recent torn <i>Banksia sessilis</i> branches	22 June 2016	34,078.833	173,104.998	-
Opp_29	Recent torn <i>Banksia sessilis</i> branches and potentially chewed <i>Xanthorrhoea preissii</i> inflorescence	22 June 2016	34,354.716	172,955.873	-
Opp_30	Torn <i>Banksia sessilis</i> branches and potentially chewed <i>Xanthorrhoea preissii</i> inflorescence	22 June 2016	34,019.182	172,754.552	-
Opp_35	Grub foraged from <i>Banksia</i> cone	22 June 2016	33,303.378	171,889.622	Plate 6



Plate 5 Parrot Bush foraged on by Carnaby's Black Cockatoo



Plate 6 Invertebrate foraged from *Banksia* cone, most likely by Carnaby's Black Cockatoo

The Carnaby's Black Cockatoo foraging assessment determined that Lake Clifton contains approximately 632 ha of foraging habitat. This included 77.84 ha of High quality foraging habitat (Plate 7). The complete breakdown of the quality of the foraging habitat is detailed in Table 25 and illustrated on Figure 11. In general, Lake Clifton contains a significant area of Low to Valued Carnaby's Black Cockatoo foraging habitat.

Table 25 Carnaby's Black Cockatoo foraging habitat

Quality	Area (ha)
High	77.84
Quality	0
Valued	129.06
Low	424.85
Total	631.75

**Plate 7 High quality Carnaby's Black Cockatoo foraging habitat**

There is a confirmed Carnaby's Black Cockatoo breeding location within 12 km of the site and there is also a confirmed Carnaby's Black Cockatoo roosting site within 700 m of the southernmost point of the Survey Area (Figure 11). These sites provide further context as to the quality of the foraging habitat in the Survey Area, as per the foraging assessment scoring tool described in Section 4.4.3. The assessment has been included as **Appendix J**.

6.3.4.2 Forest Red-tailed Black Cockatoo

The Survey Area contains a significant number of mature Tuart trees, but does not contain Marri or significant areas of habitat containing Jarrah. No evidence of the Forest Red-tail Black Cockatoo utilising the Survey Area were observed during the field survey.

The Forest Red-tailed Black Cockatoo foraging assessment determined that the Survey Area contains approximately 11.88 ha of High quality foraging habitat (Plate 8). It also contains 202.47 ha of Low quality foraging habitat. The vegetation community MsTd contains up to 10% hakea species which are included in the list of foraging species for the Forest Red-tailed Black Cockatoo. Vegetation community MsTd contained foraging plants near a watering point and near potential breeding habitat. The lack of Marri means this habitat is Low Quality. The breakdown is detailed further in Table 25 and illustrated on Figure 12. The assessment has been included as **Appendix J**.

Table 26 Forest Red-tailed Black Cockatoo foraging habitat

Quality	Area (ha)
High	11.88
Quality	0
Valued	0
Low	202.47
Total	214.35

**Plate 8 High quality Forest Red-tailed Black Cockatoo foraging habitat**



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0 270 540 810 1,080
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LEGEND

Survey Area

Forest Red-tailed Black Foraging Habitat

High (11.88 Ha)

Low (202.56 Ha)

Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Forest Red-tailed Black Cockatoo Foraging Habitat

MAIN ROADS

LAKE CLIFTON BIOLOGICAL ASSESSMENT

Figure 12

6.3.4.3 Baudin's Black Cockatoo

As discussed, Lake Clifton contains a significant amount of mature Tuart trees, but does not contain Marri. It also does not contain habitats dominated by proteaceous species but does contain moderate areas of Parrot Bush (*Banksia sessilis*) and *Banksia attenuata*. However, Lake Clifton is also out of the known foraging area for Baudin's Black Cockatoo and this reflects in the cumulative foraging assessment scores. The Baudin's Black Cockatoo foraging assessment determined that Lake Clifton contains approximately 45 ha of Valued foraging habitat. This is illustrated on Figure 13. The assessment has been included as **Appendix J**.

6.3.5 Breeding habitat

Breeding habitat has been defined as High, Valued or Low quality breeding habitat, depending on the density of mature eucalypt trees within the associated vegetation unit. In total, Lake Clifton contains approximately 294 ha of Black Cockatoo breeding habitat, with approximately 4,000 potentially suitable breeding trees.

High quality breeding habitat generally comprised dense stands of mature Tuart trees (with DBH > 500 cm and containing potentially suitable breeding hollows). Approximately 39 ha of High quality Black Cockatoo breeding habitat was mapped, which equates to approximately 1,400 trees (Plate 9).

Valued breeding habitat was defined as habitat that contained scattered Tuarts (with a DBH > 500 cm and potentially suitable breeding hollows) at a moderate density across a vegetation unit. Approximately 116 ha of Valued breeding habitat was mapped within the Survey Area, which equates to approximately 2,000 trees (Plate 10).

Low quality breeding habitat was defined as habitat that contained scattered Tuarts (with a DBH > 500 cm and potentially suitable breeding hollows) at a low density across a vegetation unit. Approximately 139 ha of Low quality breeding habitat within the Survey Area was mapped, which equates to approximately 400 trees (Plate 11).

Table 27 provides further detail on the breeding habitat assessment and a breeding habitat map has been produced in Figure 14 and raw data is available in **Appendix K**.

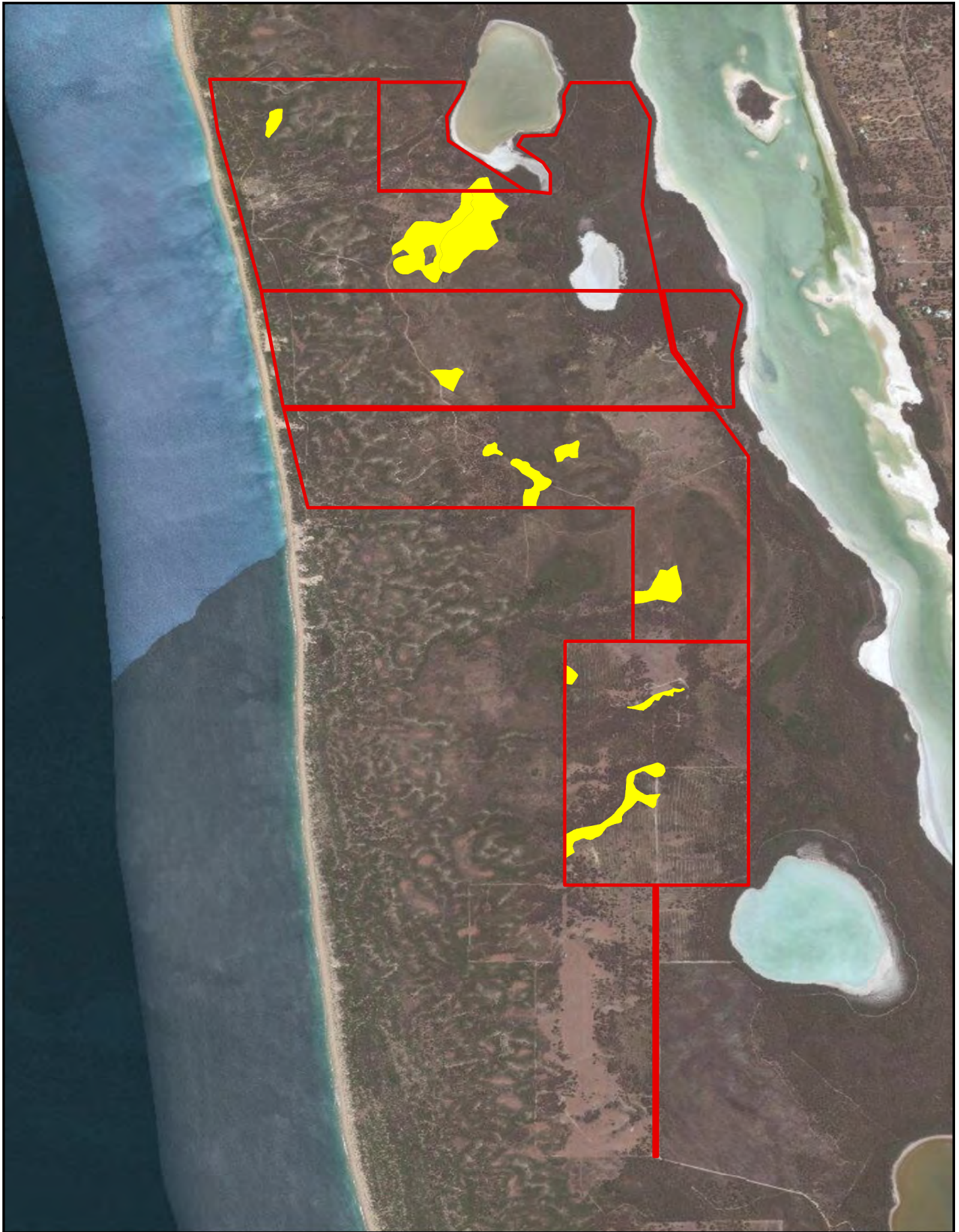
Table 27 Black Cockatoo breeding habitat assessment

Breeding Habitat	Vegetation Unit	Number of Breeding Tree Quadrats	Total Number of Trees within Quadrats	Total Area of Vegetation Units (Ha)	Approximate Number of Trees in Total Vegetation Units
High	Eg and EgXpTd	4	35	39.34	1,400
Valued	EgMsTd and AfXpHh	8	37	116.40	2,100
Low	AfXpHhHg and AfHcEp	7	7	138.63	400
Totals				294.37	3,900

Note: Eg was not defined as a vegetation community during the biological assessments. These areas were stands of mature trees within broader vegetation units that were separated out during the post-field work analysis. This was completed to better represent the Black Cockatoo breeding habitat present at Lake Clifton.



Plate 9 High quality breeding habitat for Baudin's Black Cockatoo



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LEGEND

- Survey Area
- Baudin's Black Cockatoo Foraging Habitat
- Valued (45.09 Ha)

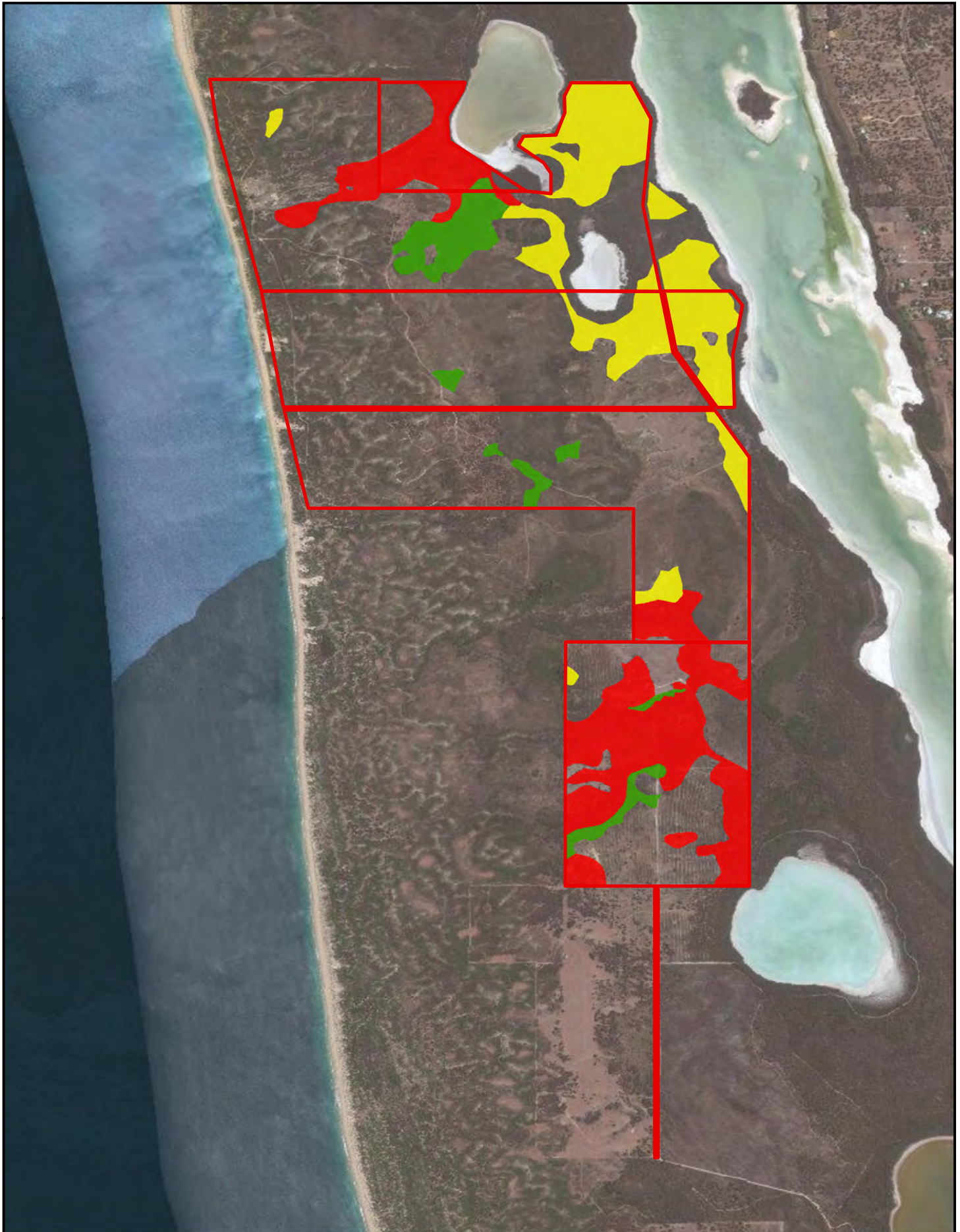
Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Baudin's Black Cockatoo Foraging Habitat

MAIN ROADS

LAKE CLIFTON BIOLOGICAL ASSESSMENT

Figure 13



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DATUM GDA 1994, PROJECTION MGA ZONE 50

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LEGEND

Survey Area

Black Cockatoo Breeding Habitat

- High (38.59 Ha)
- Valued (116.39 Ha)
- Low (138.623 Ha)

Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Geomatics, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Potential Black Cockatoo Breeding Habitat

MAIN ROADS

LAKE CLIFTON BIOLOGICAL ASSESSMENT

Figure 14



Plate 10 Valued breeding habitat



Plate 11 Low quality breeding habitat

In total, 181 *Eucalyptus* trees with a DBH >500 cm were recorded during the assessment. These were recorded either in the breeding habitat assessment quadrats, or opportunistically during the field survey. Of these 181 trees, 40 trees had potential hollows. Hollows are not always easy to identify and assess accurately from the ground. These 40 trees had a total of approximately 104 hollows, with 36 of these being potentially suitable hollows for Black Cockatoos. Some evidence of bees utilising these hollows was observed. Approximately 70% of these trees had little to no fire scarring.

6.3.6 Roosting sites

Both white-tailed Black Cockatoo species roost in or near riparian environments or near other permanent water sources and typically in the tallest trees in the landscape. The Forest Red-tailed Black Cockatoo prefers the edges of forests for roosting (DSEWPaC, 2012). Evidence of roosting usually involves large amounts of bird scat beneath a large, mature tree, with a significant amount of broken branches on the ground. Searches for roosting evidence were undertaken alongside the other Black Cockatoo assessments and no confirmed Black Cockatoo roost sites were identified in the field. However, a potential roost area was identified (Figure 14), which contained large mature Tuarts that were very high in the landscape and with foraging habitat and a freshwater source located in close proximity.

6.3.7 Fauna habitat linkages

Habitat linkages are typically areas or corridors of vegetation that link (larger) areas of fauna habitat. Linkages are important as they enable fauna to move freely between remnant bushland patches, therefore increasing gene-flow between populations. A study conducted by Gilbert *et al.* (1998) found that corridors and/or linkages do maintain species richness in the fragmented landscapes.

The Lake Clifton Survey Area is bordered on the west by the coastline, on the east by Lake Clifton, and to the north and south by Yalgorup National Park. The area provides an important and ecologically valuable linkage between the north and south sections of Yalgorup National Park, ensuring a contiguous corridor of habitat throughout this area.

6.4 Wetlands

6.4.1 Riparian vegetation

Riparian vegetation grows along the banks of waterways extending to the edge of the floodplain (fringing vegetation), including emergent aquatic plants, ground cover plants, shrubs and trees (DoW, 2016). Riparian vegetation was recorded along the fringe of the CCW UFI 3,096.

The riparian vegetation condition was mapped as 'A grade: pristine to slightly disturbed' and 'A1 Pristine' as outlined in the preliminary and detailed assessment methods (Water & Rivers Commission, 1999). A vegetation relevé was completed, dividing the riparian vegetation into two zones including the partially submerged zone and the winter-wet zone.

The partially submerged zone was dominated by *Threlkeldia diffusa* groundcover on inundated clay soils with a fringe of *Melaleuca* paperbark species. The winter-wet zone includes *Gahnia trifida* sedges under a dense *Melaleuca* paperbark closed overstorey. Weeds that were present include low-impact species with cover of less than 0.1%.

A wetland assessment was undertaken in accordance with DPaW (2013) wetland assessment methodology. The preliminary wetland assessment triggered automatic consideration as a conservation wetland for the following parameters:

- Wetland supports breeding, roosting, or refuge site or a critical feeding site for populations of fauna listed by the Australian Government (for example, EPBC Act, migratory bird agreements (such as JAMBA, CAMBA and RoKAMBA) or the State
- Equal to or greater than 90% of the wetland supports vegetation in a good or better condition using the vegetation condition scale.

A secondary evaluation was undertaken which showed that 15 of the attributes scored High value. The outcome was that the Conservation management category is applicable based on the fauna, flora and wetland processes values, attributes and functions. The wetland assessment forms are provided in

Appendix L.

6.4.2 Boundary mapping

The Survey Area intersects four geomorphic wetlands of the SCP, all considered Conservation Category Wetlands (CCWs). Wetland details are provided below. Vegetation within these wetland boundaries is considered in 'Very Good' to 'Excellent' condition. The geomorphic wetlands boundary mapping was considered accurate for depicting wetlands and associated riparian vegetation within the Survey Area.

A total of 65.35 ha of CCW wetland are located within the Survey Area.

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Appendix A

Conservation Categories

Appendix A – Legislative Framework

1.0 Legislation

1.1 Commonwealth

1.1.1 Matters of National Environmental Significance

Matters of National Environmental Significance (MNES) include:

- listed threatened species and ecological communities
- migratory species protected under international agreements
- Ramsar wetlands of international importance
- the Commonwealth marine environment
- world Heritage properties
- national Heritage places
- Great Barrier Reef Marine Park
- a water resource, in relation to coal seam gas development and large coal mining development
- nuclear actions.

If an action is likely to have a significant impact on a MNES this action must be referred to the Minister for the Environment for a decision on whether assessment and approval is required under the EPBC Act.

1.1.2 Flora and fauna

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is Australia’s central piece of environmental legislation which provides for the listing of nationally Threatened native species and ecological communities, native migratory species and marine species. Species at risk of extinction are recognised at a Commonwealth level and are categorised in one of six categories as outlined in Table 1.

Table 1 Categories of Species Listed under Schedule 179 of the EPBC Act (Commonwealth)

Conservation	Code Category
Ex	Extinct Taxa which at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
ExW	Extinct in the Wild Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or 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.
CE	Critically Endangered Taxa which 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.
E	Endangered Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the immediate or near future, as determined in accordance with the prescribed criteria.
V	Vulnerable Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	Conservation Dependent Taxa which at a particular time if, at that time: <ol 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 b. the following subparagraphs are satisfied: <ol style="list-style-type: none"> i. the species is a species of fish

Conservation	Code Category
	<ul style="list-style-type: none"> 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.

1.1.3 Vegetation communities

Communities can be classified as Threatened Ecological Communities (TECs) under the EPBC Act. The EPBC Act protects Australia’s ecological communities by providing for:

- identification and listing of ecological communities as threatened
- development of conservation advice and recovery plans for listed ecological communities
- recognition of key threatening processes
- reduction of the impact of these processes through threat abatement plans.

Categories of Commonwealth listed TECs are described in **Error! Reference source not found..**

Table 2 Categories of TECs that are listed under the EPBC Act

Conservation Code	Category
CE	Critically Endangered If, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future.
E	Endangered If, at that time, it is not critically endangered and is facing a very high risk of extinction in the wild in the near future.
V	Vulnerable If, at that time, it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future.

1.2 Western Australia

1.2.1 EPA Policy and Guidelines

In Western Australia the Environmental Protection Authority represents a independent government authority that are governed by the EP Act. The objective of the EPA is to ‘use its best endeavours to a) protect the environment; and b) to prevent, control and abate pollution and environmental harm.

The EPA have released several guidance and position statements directly relevant to biological assessments undertaken in Western Australia, described in Table 3.

Table 3 EPA Policy and guidelines relevant to biological assessments in Western Australia

Document Title	Short Description
Environmental Protection Authority (EPA) Position Statement No. 2 Environmental Protection of Native Vegetation in Western Australia: Clearing of native vegetation, with particular reference to the agricultural area	Provides guidance on clearing of native vegetation, with particular reference to the agricultural area.
EPA Guidance Statement No. 51 Guidance for the Assessment of Environmental Factors – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia	Provides guidance on the standard of survey required to assist in collecting the appropriate data for decision-making associated with the protection of Western Australia’s terrestrial flora and vegetation and their ecosystems.

Document Title	Short Description
EPA Position Statement No. 3 Terrestrial Biological Surveys as an Element of Biodiversity Protection	Provides guidance on the requirements of biological surveys in Western Australia.
EPA Guidance Statement No. 56 Guidance for the Assessment of Environmental Factors – Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia	Provides guidance on the standard of survey required to assist in collecting the appropriate data for decision-making associated with the protection of Western Australia’s terrestrial fauna.
DPaW and EPA Technical Guide for undertaking Flora and Vegetation Assessments for Environmental Impact Assessment in Western Australia	Guide for ensuring adequate data of appropriate standard are obtained to inform environmental impact assessment applicable to terrestrial vascular flora and vegetation surveys.
DPaW Methodology for the evaluation of specific wetland types on the Swan Coastal Plain, Western Australia	Provides a single methodology for evaluating wetlands on the Swan Coastal Plain.

1.2.2 Flora and fauna

Plants and animals that are considered threatened and need to be specially protected because they are under identifiable threat of extinction are listed under the *Wildlife Conservation Act (WC Act)*. These categories are defined in Table 1. Threatened species are published as Specially Protected under the Wildlife Conservation Act 1950, and listed under Schedules 1 to 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora (which may also be referred to as Declared Rare Flora). The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as outlined in Table 1.

Species that have not yet been adequately surveyed to warrant being listed under Schedule 1 or 2 are added to the Priority Flora or Fauna Lists under Priority 1, 2 or 3. Species that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list for other than taxonomic reasons, are placed in Priority 4 and require regular monitoring. Conservation Dependent species and ecological communities are placed in Priority 5. Categories and definitions of Priority Flora and Fauna species are provided in Table 2.

Table 4 Conservation codes for WA flora and fauna listed under the *Wildlife Conservation Act 1950* updated November 2015

Conservation Code	Category
CR	Critically endangered species Threatened species considered to be facing an extremely high risk of extinction in the wild. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.
EN	Endangered species Threatened species considered to be facing a very high risk of extinction in the wild. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.
VU	Vulnerable species Threatened species considered to be facing a high risk of extinction in the wild. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.
EX	Presumed extinct species Species which have been adequately searched for and there is no reasonable doubt that the

Conservation Code	Category
	last individual has died. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora.
IA	<p>Migratory birds protected under an international agreement</p> <p>Birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Bonn Convention, relating to the protection of migratory birds. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice.</p>

Table 5 Conservation codes for WA flora and fauna (DPaW 2015)

Conservation Code	Category
P1	<p>Priority One – Poorly Known Species</p> <p>Species that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.</p>
P2	<p>Priority Two – Poorly Known Species</p> <p>Species that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.</p>
P3	<p>Priority Three – Poorly Known Species</p> <p>Species that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities 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 localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.</p>
P4	<p>Priority Four – Rare, Near Threatened and other species in need of monitoring</p> <ol style="list-style-type: none"> 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. b. Near Threatened. Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. c. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
P5	<p>Priority Five: Conservation Dependent species</p> <p>Species that are not threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.</p>

1.2.3 Vegetation communities

State listed TECs are not protected under any legislation, rather they are endorsed by the Environment Minister. Categories of TECs are defined in Table 6. Priority Ecological Communities are endorsed by the Environment Minister as having insufficient information available to be considered a TEC, or which are rare but not currently threatened. Categories are described in Table 7.

Table 6 Conservation codes for state-listed Threatened Ecological Communities

Conservation Code	Category
PD	<p>Presumed Totally Destroyed An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future. An Ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant and either of the following applies (A or B): A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats or B) All occurrences recorded within the last 50 years have since been destroyed</p>
CR	<p>Critically Endangered An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated. An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting any one or more of the following criteria (A, B or C): A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and either or both of the following apply (i or ii): i. geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years); ii. modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated. B) Current distribution is limited, and one or more of the following apply (i, ii or iii): i. geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years); ii. there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes; iii. there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).</p>

Conservation Code	Category
EN	<p>Endangered An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future. An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C).</p> <p>A) The geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 70% and either or both of the following apply (i or ii):</p> <ul style="list-style-type: none"> i. the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 20 years); ii. modification throughout its range is continuing such that in the immediate future (within approximately 20 years) the community is unlikely to be capable of being substantially rehabilitated. <p>B) Current distribution is limited, and one or more of the following apply (i, ii or iii):</p> <ul style="list-style-type: none"> i. geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 20 years); ii. there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes; iii. there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. <p>The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 20 years).</p>
VU	<p>Vulnerable An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatened processes continue or begin operating throughout its range. An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C).</p> <p>A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.</p> <p>B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.</p> <p>C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium or long term future because of existing or impending threatening processes.</p>

Table 7 Categories for Priority Ecological Communities

Conservation	Code Category
P1	<p>Priority One: poorly-known ecological communities 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>
P2	<p>Priority Two: poorly-known ecological communities 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 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>
P3	<p>Priority Three: poorly known ecological communities</p> <ul style="list-style-type: none"> 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 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 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, and inappropriate fire regimes. <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>
P4	<p>Priority Four: 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> <ul style="list-style-type: none"> 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. 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 Vulnerable. iii. Ecological communities that have been removed from the list of threatened communities during the past five years.
P5	<p>Priority Five: Conservation Dependent ecological communities. 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

Biosecurity and
Agriculture Management
Act 2007 Classifications

Appendix B Weeds and their Classifications

1.1 The BAM Act

Biosecurity is the management of the risk of animal and plant pests and diseases entering, emerging, establishing or spreading in WA to protect the economy, environment and community. Biosecurity is managed under the *Biosecurity and Agriculture Management Act 2007* (BAM Act) which came into effect 1 May 2013. Exotic animals and plants can become an invasive species if they can establish in new areas where local conditions are favourable for their growth. They usually invade as a result of human activities both accidental and deliberate. These invasive species can often have a damaging impact on the natural environment and agriculture, and therefore requires careful management. The Department of Agriculture and Food, Western Australia (DAFWA) has developed an Invasive Species Program which provides the strategic and operational management of serious weeds and pest animals.

The Minister for Agriculture and Food can declare invasive exotic plants and animals as pests under the BAM Act. These species are listed on the Western Australian Organism List (WAOL) and classified in four categories, explained in Table 1.

Table 1 Legal status of Declared Pests under the BAM Act

Category	Description
Declared Pest, Prohibited – s12	Prohibited organisms are declared pests by virtue of section 22(1), and may only be imported and kept subject to permits. Permit conditions applicable to some species may only be appropriate or available to research organisations or similarly secure institutions.
Declared Pest – s22(2)	Declared pests must satisfy any applicable import requirements when imported, and may be subject to an import permit if they are potential carriers of high-risk organisms. They may also be subject to control and keeping requirements once within Western Australia.
Permitted – s11	Permitted organisms must satisfy any applicable import requirements when imported. They may be subject to an import permit if they are potential carriers of high-risk organisms.
Permitted, Requires Permit – r73	Regulation 73 permitted organisms may only be imported subject to an import permit. These organisms may be subject to restriction under legislation other than the Biosecurity and Agriculture Management Act 2007. Permit conditions applicable to some species may only be appropriate or available to research organisations or similarly secure institutions.
Unlisted – s14	If you are considering importing an unlisted organism/s you will need to submit the name/s for assessment, as unlisted organisms are automatically prohibited entry into WA.

The Minister can declare an organism as a declared pest if there are reasonable grounds for believing that the organism:

- a. has or may have an adverse effect on
 - a. another organism in the area
 - b. human beings in the area
 - c. the environment or part of the environment in an area
 - d. agricultural activities, fishing or pearling activities, or related commercial activities carried on or intended to be carried on in the area.
- b. May have an adverse effect on any of those things if it were present in the area, or if it were present in the area in greater numbers or to a greater extent.

Under the BAM Act declared pests are placed in one of three categories, as explained in Table 2. Many of the declared pest plant species are also on the list of Weeds of National Significance. This list was compiled to prioritise future management and allocation of resources for weed control. Species were selected based on their

invasiveness and impact characteristics, potential and current area of spread and their environmental, industrial or socioeconomic impacts.

Under the BAM Act, local government authorities can prescribe any plant, other than a declared plant, to be a pest plant. Local law can be used to assist in pest plant management by enforcing that the owner or occupier of the land can be held financially responsible for the management of any pest plant.

Department of Parks and Wildlife (DPaW) recognise weeds as one of the most significant threats to biodiversity as they outcompete native species for resources, reduce natural diversity by smothering native plants, displace and replace native plants, and alter fire regimes. DPaW have prioritised their focus on infestations of species considered to be high impact, rapidly invasive and still at a population size that can feasibly be eradicated or contained to a manageable size. DPaW's rankings are provided to help landholders, community groups and private enterprises manage weeds that may impact on the natural environment. Weed species are listed according to the region they occur in and are ranked as very high, high, medium, low, negligible, or further assessment required. Furthermore, an example of management actions that may be appropriate for a species of that ranking is provided (DPaW, 2013b).

Table 2 Control categories for Declared Pests listed under the BAM Act

Category	Definition
C1 Exclusion	Organisms which should be excluded from part or all of Western Australia.
C2 Eradication	Organisms which should be eradicated from part or all of Western Australia.
C3 Management	Organisms that should have some form of management applied that will alleviate the harmful impact of the organism, reduce the numbers or distribution of the organism or prevent or contain the spread of the organism.
Unassigned	Unassigned: Declared pests that are recognised as having a harmful impact under certain circumstances, where their subsequent control requirements are determined by a Plan or other legislative arrangements under the Act.

1.2 Environmental Weeds Strategy of WA

The Environment Weed Strategy of WA (EWSWA) rating is shown along with the BAM Act classification and Environmental Weed Census. The EWSWA ratings identify weeds that pose significant environmental risk based on invasiveness, distribution and environmental impacts. The ratings include:

- High – have all three of the characteristics
- Moderate – have two of the characteristics
- Mild – have one of the characteristics
- Low – not deemed to have any of the characteristics.

1.3 Swan NRM Weed Prioritisation

In 2008 DPaW (at the time Department of Environmental Conservation), rated weeds species in Perth bushland conditions using eight ratings. They were rated according to the risk each species posed on environmental assets in the region based on invasiveness, ecological impact, current and potential distribution and priority for management (CALM, 2008). Ratings included:

- Very High
- High
- Further Assessment Required (FAR)/High
- Moderate/ High
- Moderate
- Low/ Moderate
- Low
- Further Assessment required (FAR).

Appendix C

Curriculum Vitae for Botanists

Floora de Wit Senior Botanist

Qualifications

Postgraduate Diploma in Environmental Management and Impact Assessment (2013) Murdoch

Bachelor of Science in Environmental Biology (Environmental Restoration) - Curtin University of Technology (2005)

Affiliations

Environmental Consultant Association

Publications and Technical Papers

De Wit F, 2014. Seasonality of Flora Surveys in Arid Australia. Paper presented to Goldfields Environmental Management Conference, May 2014

Career History

Floora is a Senior Botanist and Black Cockatoo survey specialist with ten years' experience in the environmental consulting industry. Floora specialises in flora and vegetation assessments and is responsible for planning and executing field surveys and delivering technical reports suitable for supporting environmental approval documentation and/or environmental compliance reports.

In more recent years, Black Cockatoo surveys have become another focus for Floora's expertise. These include Cockatoo foraging quality assessments and potential breeding/roosting surveys. Her familiarity with the Australian Government guidelines for Black Cockatoos ensures the surveys and results are suitable for informing any impact assessment and support approval documentation.

Her botanical history includes level 1 and 2 flora and vegetation assessments, targeted flora and community surveys, weed mapping, wetland assessments and rehabilitation monitoring programs. Her botanical knowledge extends from the Kimberley to Pilbara, through the Goldfields, Wheatbelt, Swan Coastal Plain and Geraldton Sandplains, Jarrah Forest and South Coast. Her extensive field experience allows her to quickly adapt and familiarise with new areas.

Floora has also been involved in several wetland assessments since the release of the updated wetland methodology relevant to the Swan Coastal Plain.

All flora and vegetation assessments are conducted in accordance with EPA Guidance Statement 51 and the DPaW and EPA Flora and Vegetation Technical Guide published in 2015. Where appropriate, suitable methodologies are adapted to suit the project and environmental outcomes. Floora has good relationships with DPaW and State Herbarium staff, allowing her to obtain insights into appropriate best-practice data collection and limitations associated with different WA regions.

Flora and Vegetation Assessments

Main Roads Roe Tonkin Interchange Follow Up Surveys. Targeted *Drakaea elastica* and *Caladenia huegelii* surveys and wetlands assessment undertaken at 3 project areas on Swan Coastal Plain.

Water Corporation, Level 2 F&V Assessment, Caddadup, 2012 and 2015. Team lead. Baseline survey including second season sampling and targeted *Caladenia huegelii* assessment. Floristic Community Analysis was undertaken to ascertain the presence of a PEC and liaison with DPaW discussing *Caladenia* populations and identification. Results of the project informed impact assessment and approval documentation.

Holcim Gosnells Quarry Level 2 F&V Assessment and targeted *Thelymitra* searches at the edge of the Darling Scarp. Team lead including planning, field work, taxonomy, data analysis and technical reporting.

Landcorp Preliminary Ecological Assessments including Level 1 Fauna and F&V for six remote sites including Goomalling, Cervantes, Dalwallinu, Denmark, Bridgetown and Katanning. Team lead including planning, field work, taxonomy, data analysis and technical reporting.

Main Roads Toodyay Biological Assessment. F&V assessment of 60km infrastructure corridor including targeted orchid searches. Team lead including planning, field work, taxonomy, data analysis and technical reporting.

Main Roads Roe and Tonkin Grade Separation Biological Assessments. Team lead for F&V surveys, wetlands assessment and targeted orchid searches. Liaison with DPaW led to the development of suitable search methods and timing. The results will inform impact assessment documentation.

Broome International Airport Biological Investigations. Team lead, data analysis, taxonomist and technical reporting.

Shire of Gingin single-phase Level 2 F&V Assessment. Team leader for conducting a single-phase Level 2 Flora and Vegetation Assessment.

Main Roads Indian Ocean Drive Biological Assessments. Floora was lead author for compiling results from biological investigations in a report suitable for supporting impact assessment and clearing permit compliance documents according to MRWA standards.

Main Roads Bridges (Denmark and Mt Magnet) Level 1 F&V Surveys. Floora was team lead for conducting a Level 1 Flora and Vegetation Assessment and Targeted Surveys in Denmark and surrounds. The results were used to comply to MRWA State-wide clearing permit.

Main Roads Fremantle to Rockingham Controlled Access Highway Level 2 F&V Assessment and targeted surveys. Team leader. The results of the survey informed the Scheme Amendment application.

Department of Industry Square Kilometre Array Biological Assessments. Floora was team leader for a Level 2 Flora and Vegetation Assessment and Targeted Surveys in the remote Murchison bioregion. The ten-day survey expanded across Boolardy Station with results used to inform an environmental constraints map and potential approval documentation required in the future.

Main Roads Neaves Road Upgrade. Detailed flora and vegetation assessment for proposed Neaves Road upgrade. Challenges included mapping TEC buffers, Threatened Flora population boundary mapping, Gibson FCT analysis and discussing all environmental constraints in a local and regional context.

Water Corporation-Perth Northern Pipeline Corridor. Technical lead, conducted ecological surveys including flora and vegetation, wetlands and targeted flora surveys. Project area includes three 120km infrastructure corridors between Forrestfield and Lancelin.

Main Roads Great Northern Highway Upgrade 2014 Ecological investigations for 120km infrastructure corridor in the Kimberleys. The project was delivered successfully and within budget before the end of the financial year.

FMG Nyidinghu project Level 2 flora and vegetation assessment. Team leader for a 2-phase sampling program for the mining tenement and detailed 1-phase surveys for rail spur using a helicopter. Included impact assessment, statistical analysis and mapping for a 18,000 hectare area and 120km infrastructure corridor in East Pilbara.

Landcorp Maitland Environmental Due Diligence. Field team lead for preliminary biological assessment and technical reporting.

Bauxite Alumina Joint Venture Access Strategy. Field lead for baseline F&V assessment and pre-clearance surveys along existing tracks. Technical support and field leader. Considering locations of a disturbance opportunist Priority species, dieback, and track access. Flora and vegetation was mapped and a flora inventory made for all track-side vegetation.

Eneabba to Gindalbie Power Line Level 2 F&V Assessment. Flora and vegetation surveys were conducted in 2008 for the new powerline working for Mattiske Consulting. The decommissioning of the old powerline required further survey work, done on behalf of AECOM. The 150km infrastructure corridor was traversed by vehicle, collecting floristic quadrat data within areas of remnant native vegetation.

Black Cockatoo Surveys

Main Roads Toodyay Road 2015 Black Cockatoo Assessment field team member. The results enabled the client to quantify potential impacts on Black Cockatoo habitat within a defined project area.

Main Roads Fremantle to Rockingham Restricted Access Highway 2014/15 Black Cockatoo potential breeding habitat and foraging quality assessment field team member. The results enabled the client to quantify potential impacts on Black Cockatoo habitat within a defined project area.

Shire of Gingin 2014 Black Cockatoo Assessment field team member. The results of the survey ensured the client met their legislative obligations for referral under the EPBC Act.

Main Roads Indian Ocean Drive 2014 Black Cockatoo foraging quality assessment. The results informed the EPBC Act referral documentation and allowed a more detailed impact assessment on foraging quality to be undertaken.

Western Power Eneabba to Karara Transmission Corridor 2013/14 Black Cockatoo potential breeding and foraging habitat assessment.

Main Roads Neaves 2013 Road Black Cockatoo potential breeding habitat field team member. The results enabled the client to quantify potential impacts on Black Cockatoo habitat within a defined project area.

Main Roads Vasse Bypass 2012 Black Cockatoo field team member for potential breeding habitat assessment. The results enabled the client to quantify potential impacts on Black Cockatoo habitat within a defined project area.

Orchid surveys

Holcim Gosnells Quarry *Thelymitra magnifica* and *Thelymitra stellata* surveys, Oct-Nov 2015.

Main Roads Roe and Tonkin *Drakaea elastica* and *Caladenia huegelii* targeted surveys Aug-Oct 2015.

Main Roads FRCAH *Drakaea elastica* and *Caladenia huegelii* targeted surveys Aug-Oct 2015.

Water Corporation Caddadup *Caladenia huegelii* targeted searches Oct 2015.

Conferences

EIANZ Annual Conference "EIA: Challenging the Status Quo" – 2015

Goldfields Environmental Management Conference 2012 and 2014 (speaker at 2014)

DIG Dieback Conference – 2007 and 2009

Mining in Ecologically Sensitive Landscapes Symposium – 2009

Publications and Technical Papers

De Wit F, 2014. Seasonality of Flora Surveys in Arid Australia. Paper presented to Goldfields Environmental Management Conference, May 2014.

Training

Provide First Aid – St John Ambulance 30 March 2015
aining Here

Languages

English and Dutch

Professional History

2012- Present
AECOM - Senior Botanist

2011 - 2012
Cardno (WA) Pty Ltd - Principal Botanist

2007 - 2010
Mattiske Consulting Pty Ltd - Graduate to Botanical Team Leader

Lyn Van Gorp Environmental Scientist

Qualifications

Bachelor of Environmental Science (Honours)
Majoring in Natural Resource Science
University of Queensland

Affiliations

Golden Key International Honour Society

Awards

University Medallist, University of QLD

Professional History

Aug 2009 – Jul 2012; Jun 2014 - Present
AECOM
Environmental Scientist

Aug 2013 – Jun 2014
Department of Environment Regulation
Environmental Officer

Jul 2012 – Aug 2013
Perth Airport Pty Ltd
Environment & Conservation Advisor

Mar 2009 – Aug 2009
Swan River Trust, Department of Environment &
Conservation, WA
Environmental Officer, Statutory Planning

Nov 2007 – Feb 2008
Rio Tinto, Hunter Valley Operations, NSW
Environmental Services Vacation Student

Feb 2007 – Oct 2007
SunWater, QLD
Volunteer/casual work in Environment Department

Career History

Lyn Van Gorp has more than seven years' experience in environmental management in Australia. Predominantly this work has focused on environmental approvals as well as site environmental management and field operations. Lyn has previously studied the effects of topsoil management on restoration success in mine site rehabilitation at the CRL sand mine on North Stradbroke Island.

Lyn worked in AECOM's environment team from 2009 to 2012 and re-joined the organisation in 2014 after gaining additional experience in the industry and government sectors. She has particular skills in report writing, investigation of environment and heritage issues, and statutory approvals. She also has experience in assessment of environmental risk, community consultation, cultural heritage assessments as well as field environmental assessments and interpretation.

Lyn's field experience is predominantly in flora and vegetation surveys. Additional site and field environmental experience has involved:

- fauna surveys
- groundwater and surface water monitoring
- noise and blast monitoring
- air quality monitoring
- Aboriginal heritage surveys and engagement
- community engagement.

In particular, Lyn possesses site environmental experience gained primarily from her time working at Perth Airport as well as on various construction and operational mine and other sites.

Detailed Experience -***Main Roads Western Australia Great Northern Highway Upgrade, 2016***

Lyn has written the EIA/EMP, PCIA/VMP and Revegetation Plan for upgrade of Great Northern Highway between SLK 2922 and 2930 and associated materials extraction. She is currently preparing the same documents for SLK 2934-2940 and SLK 2941-2950.

Main Roads Western Australia Roe 8 Highway Extension, 2016

Lyn is currently working on the environmental approvals documentation for the Roe 8 Highway Extension project.

Department of Defence rehabilitation and weed monitoring – Cultana Training Area Expansion: Eyre Peninsula, South Australia 2016

Lyn was involved in surveys for the Carrion Flower weed and also monitoring of rehabilitated areas.

Stirling Defence Base Flora and Vegetation survey and Environmental Report, 2016

Lyn undertook vegetation community and condition mapping on Garden Island and contributed to preparation of the Environmental Report for proposed development on the island.

Department of Defence Muehea Bombing Range Environmental Management Plan review, 2015

Lyn undertook a site visit to undertake assessment of current management practices on site.

Ellenbrook Bus Rapid Transit Flora and Vegetation Survey, 2015

Lyn undertook the Level 1 Flora and Vegetation survey for Department of Transport including data analysis and production of report.

Main Roads Western Australia Toodyay Road widening Flora and Vegetation surveys, 2015.

Lyn participated in the Flora and Vegetation survey and Black cockatoo habitat assessment for proposed widening of 52km of Toodyay Road.

Stirling Defence Base Targeted flora surveys, 2015

Lyn undertook targeted searches for priority flora species at the Defence Base.

Department of Transport Woodman Point Flora and Vegetation assessment, 2015

Lyn participated in the flora and vegetation assessment for the Department of Transport Woodman Point boating precinct.

Water Corporation Caddadup Flora and Vegetation assessment and Targeted surveys, 2015

The Water Corporation proposes to duplicate the existing Caddadup water tank. Lyn assisted with the flora and vegetation assessment and targeted threatened and priority flora species searches.

Main Roads Western Australia Victoria Highway Material Pits Revegetation Plan, 2015

Lyn developed the Revegetation Plan for two Material Pits required for submission to the Department of Environment Regulation.

Main Roads Western Australia Roe and Tonkin Highway Interchanges Preliminary Environmental Impact Assessments (PEIAs) and Biological Surveys, 2014-2015

Lyn assisted with the site inspections at five intersections in order to identify the key environmental values that may be impacted by upgrading of these intersections. The results of these site inspections informed the PEIAs for both the Roe and Tonkin Highway intersection upgrade projects.

Lyn has also been involved with data analysis and development of the Biological Survey reports for both of these projects. In 2015, she undertook targeted orchid surveys for both projects.

Main Roads Western Australia Great Northern Highway Rehabilitation Monitoring, 2015

Lyn participated in rehabilitation monitoring at various quarry pits, seeding trial locations and photo monitoring points along Great Northern Highway.

Main Roads Western Australia Pardelup Bridge (502) Vegetation Impact Assessment and EIA/EMP, 2015

Lyn wrote the VIA including assessment against the ten clearing principles and assisted with preparation of the EIA/EMP for replacement of Pardelup Bridge and associated roadworks.

Holcim Gosnells Quarry Targeted Orchid Surveys, 2014 & 2015 and Flora and Vegetation Survey 2015

Lyn undertook targeted surveys for orchids at the Holcim Gosnells Quarry site to assist with approvals for planned extension to the quarry activities. In 2015, she also assisted with the Flora and Vegetation assessment undertaken for a proposed expansion area.

Main Roads Western Australia Yallingup Bridge Desktop Environmental and Heritage Constraints Assessment, 2014

Lyn undertook a desktop assessment of environmental and heritage constraints associated with proposed replacement of Yallingup Bridge.

Main Roads Western Australia, FRCAH Targeted Flora Surveys, Black Cockatoo assessment and EIA, 2014-2015

The Fremantle to Rockingham Controlled Access Highway (FRCAH) has been planned as part of a strategic north-south transport corridor to provide high standard connectivity between important commercial and industrial centres in the Perth South West Metropolitan Corridor.

As part of the biological assessment of the project, Lyn conducted a number of targeted flora surveys within the proposed road corridor including targeted orchid surveys. In addition, Lyn participated in the black cockatoo habitat assessment and assisted with writing of the EIA document for the project.

University of Western Australia Tree Survey, 2014

The University of Western Australia proposes to develop part of their property for university residential land use purposes. Lyn participated in a tree survey to characterise the vegetation located at the site and to identify any potential implications for future development opportunities at the site.

Main Roads Western Australia, Northam-Pithara Road Targeted Flora Survey, 2014

Main Roads are proposing to upgrade a section of the Northam Pithara Road, approximately 24 km in length, to comply with road safety standards and improve site lines. Lyn undertook a targeted flora survey for a number of Commonwealth and State listed species which were identified in previous environmental assessments as potentially occurring within the project area. These species included several salt-lake tolerant orchid species.

In addition to the targeted flora survey, Lyn also assisted with the Level 2 flora and vegetation survey of a section of the road requiring realignment which was not included in previous flora surveys for the project.

Department of Industry, Square Kilometre Array Flora and Vegetation Survey, 2014

The Square Kilometre Array (SKA) Project is the largest ever international radio telescope project, which has been designed to answer key cosmological questions. Lyn participated in the biological survey of the proposed SKA Survey Telescope and Low Frequency Aperture Arrays. The biological assessment consisted of a Level 2 flora and vegetation survey and targeted searches for conservation significant flora species.

Lyn also conducted a land system assessment of the Sherwood land system, which assessed the condition and severity of erosion using the Landscape Function Analysis methodology.

Fortescue Metals Group Solomon Life of Mine Public Environmental Review, 2014

Lyn has assisted with writing the Public Environmental Review document for the proposed extension to the Fortescue Metals Group Solomon mine in the Pilbara.

Roe Highway Extension Property Offset Assessment – Environmental Scientist, Client: Main Roads, 2014

Lyn prepared the Property Offset Assessment report for the proposed Roe Highway Extension, which involved characterisation and comparison of a number of proposed sites to determine suitability as offsets for the environmental impacts of the project. The report enabled Main Roads to identify which proposed properties would be suitable as individual or grouped offsets.



Appendix D

Desktop Fauna Assessment

Appendix D Desktop Fauna Assessment

Name	Common Name	Conservation Code		DPaW Records		Likelihood
		Commonwealth	State	Year	Number	
Birds						
<i>Apus pacificus</i>	Fork-tailed Swift	Migratory / Marine	IA	-	-	May fly over
<i>Ardea alba</i>	Great Egret	Marine	-	-	-	May occur
<i>Ardea ibis</i>	Cattle Egret	Marine	-	-	-	May occur
<i>Arenaria interpres</i>	Ruddy Turnstone	Migratory / Marine	IA	-	-	May occur
<i>Botaurus poiciloptilus</i>	Australasian Bittern	E	EN	-	-	May occur
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	Migratory / Marine	IA	2011	3	May occur
<i>Calidris canutus</i>	Red Knot	E	VU	-	-	May occur
<i>Calidris alba</i>	Sanderling	Migratory / Marine	IA	-	-	May occur
<i>Calidris canutus</i>	Red Knot	E / Migratory / Marine	IA	-	-	May occur
<i>Calidris ferruginea</i>	Curlew Sandpiper	CE / Migratory / Marine	VU / IA	2004	8	May occur
<i>Calidris melanotos</i>	Pectoral Sandpiper	Migratory / Marine	IA	-	-	Unlikely
<i>Calidris ruficollis</i>	Red-necked Stint	Migratory / Marine	IA	2013	72	Likely
<i>Calidris subminuta</i>	Long-toed Stint	Migratory / Marine	IA	-	-	May occur
<i>Calidris tenuirostris</i>	Great Knot	CE / Migratory / Marine	VU / IA	-	-	May occur
<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black Cockatoo	V	VU	2003	6	May occur
<i>Calyptorhynchus baudinii</i>	Baudin's Black Cockatoo	V	EN	1998	1	May occur
<i>Calyptorhynchus latirostris</i>	Carnaby's Black Cockatoo	E	EN	2005	11	Likely
<i>Charadrius leschenaultii</i>	Greater Sand Plover	V	IA	2009	2	May occur
<i>Charadrius mongolus</i>	Lesser Sand Plover, Mongolian Plover	E / Migratory / Marine	EN / IA	-	-	Unlikely
<i>Charadrius rubricollis</i>	Hooded Plover	Marine	P4	2006	1,549	Likely
<i>Charadrius ruficapillus</i>	Red-capped Plover	Marine	-	-	-	Likely
<i>Diomedea epomophora (sensu stricto)</i>	Southern Royal Albatross	V / Migratory / Marine	IA	-	-	Unlikely

Name	Common Name	Conservation Code		DPaW Records		Likelihood
		Commonwealth	State	Year	Number	
<i>Diomedea sanfordi</i>	Northern Royal Albatross	E / Migratory / Marine	EN / IA	-	-	Unlikely
<i>Gallinago megala</i>	Swinhoe's Snipe	Migratory / Marine	IA	-	-	Unlikely
<i>Gallinago stenura</i>	Pin-tailed Snipe	Migratory / Marine	IA	-	-	May occur
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	M	-	-	-	Likely
<i>Himantopus himantopus</i>	Black-winged Stilt	Marine	-	-	-	May occur
<i>Leipoa ocellata</i>	Malleefowl	V	VU	-	-	Unlikely
<i>Limicola falcinellus</i>	Broad-billed Sandpiper	Migratory / Marine	IA	-	-	Unlikely
<i>Limosa lapponica</i>	Bar-tailed Godwit	V	VU	-	-	Unlikely
<i>Limosa limosa</i>	Black-tailed Godwit	Migratory / Marine	-	-	-	Unlikely
<i>Merops ornatus</i>	Rainbow Bee-eater	Marine	-	2012	5	Likely
<i>Motacilla cinerea</i>	Grey Wagtail	Migratory / Marine	IA	-	-	May occur
<i>Natator depressus</i>	Flatback Turtle	V	VU	-	-	Unlikely
<i>Numenius madagascariensis</i>	Eastern Curlew	CE	VU & IA	1998	30	Likely
<i>Numenius minutus</i>	Little Curlew	Migratory / Marine	IA	-	-	May occur
<i>Numenius phaeopus</i>	Whimbrel	Migratory / Marine	IA	-	-	May occur
<i>Pachyptila turtur subantarctica</i>	Fairy Prion (southern)	V	-	-	-	Unlikely
<i>Pandion cristatus</i>	Osprey	Migratory / Marine	IA	-	-	May occur
<i>Philomachus pugnax</i>	Ruff (Reeve)	Migratory / Marine	IA	-	-	May occur
<i>Phascogale tapoatafa subsp. (WAM M434)</i>	South-western Brush-tailed Phascogale	-	VU	1991	1	May occur
<i>Pluvialis fulva</i>	Pacific Golden Plover	Migratory / Marine	-	-	-	Unlikely
<i>Pluvialis squatarola</i>	Grey Plover	Migratory / Marine	IA	2011	3	May occur
<i>Puffinus carneipes</i>	Flesh-footed Shearwater	Migratory / Marine	IA / VU	-	-	Unlikely
<i>Recurvirostra novaehollandiae</i>	Red-necked Avocet	Marine	-	-	-	May occur
<i>Rostratula australis</i>	Australian Painted Snipe	E / Marine	EN	-	-	May occur

Name	Common Name	Conservation Code		DPaW Records		Likelihood
		Commonwealth	State	Year	Number	
<i>Sternula nereis nereis</i>	Australian Fairy Tern	V	VU	-	-	May occur
<i>Thalassarche cauta cauta</i>	Shy Albatross	V / Marine	VU	-	-	Unlikely
<i>Thalassarche cauta steadi</i>	White-capped Albatross	V / Marine	VU	-	-	Unlikely
<i>Tringa brevipes</i>	Grey-tailed Tattler	Migratory / Marine	IA / P4	-	-	Unlikely
<i>Tringa glareola</i>	Wood Sandpiper	Migratory / Marine	IA	-	-	May occur
<i>Tringa nebularia</i>	Common Greenshank	Migratory / Marine	IA	2011	16	Likely
<i>Tringa stagnatilis</i>	Marsh Sandpiper, Little Greenshank	Migratory / Marine	IA			May occur
<i>Tringa totanus</i>	Common Redshank	Migratory / Marine	IA	-	-	May occur
Mammals						
<i>Dasyurus geoffroii</i>	Chuditch, Western Quoll	V	VU	1996	2	May occur
<i>Isoodon obesulus fusciventer</i>	Quenda, Southern Brown Bandicoot	-	P4	2007	6	Likely
<i>Pseudocheirus occidentalis</i>	Western Ringtail Possum	V	EN	2011	3	Likely
Reptiles						
<i>Caretta caretta</i>	Loggerhead Turtle	E / Migratory / Marine	EN / IA	-	-	Unlikely
<i>Chelonia mydas</i>	Green Turtle	V / Migratory / Marine	VU / IA	-	-	Unlikely
<i>Ctenotus ora</i>	Coastal Plains Skink	-	P3	1980	2	Unlikely
<i>Dermochelys coriacea</i>	Leatherback Turtle	E / Migratory / Marine	VU / IA	-	-	Unlikely
<i>Lerista lineata</i>	Lined Skink	-	P3	2007	3	Likely
Invertebrates						
<i>Synemon gratiosa</i>	Graceful Sunmoth	-	P4	2011	27	Likely



Appendix E

Vascular Flora Species by
Community Recorded,
Lake Clifton 2016

Appendix E Vascular Species by Vegetation Community Recorded at Lake Clifton, 2016

Row Labels	AfDdLg	AfHcEp	AfSgTd	AfXpHh	AfXpHg	ArMsTd	EdArTd	EdRbTd	EgMhAp	EgMsTd	EgXpTd	MrGtHg	MrGtTd	MsTd	Xp
Weeds															
<i>?Daucus glochidiatus</i>						X									
<i>Arctotheca calendula</i>		X		X		X				X		X		X	X
<i>Avena barbata</i>														X	
<i>Brassica tournefortii</i>			X							X		X		X	X
<i>Dittrichia graveolens</i>												X		X	X
<i>Euphorbia peplus</i>	X	X							X	X		X		X	
<i>Euphorbia terracina</i>		X													
<i>Geranium molle</i>	X	X		X	X	X		X	X	X	X	X	X	X	X
<i>Hypochaeris glabra</i>		X		X	X	X				X	X	X	X	X	X
<i>Lotus subbiflorus</i>		X			X									X	
<i>Lupinus sp.</i>					X									X	
<i>Lysimachia arvensis</i>		X		X	X	X	X			X	X	X	X	X	X
Poaceae sp.										X					
<i>Solanum nigrum</i>	X	X	X	X		X	X	X	X	X	X	X		X	
<i>Sonchus oleraceus</i>		X													
<i>Trachyandra divaricata</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Trifolium campestre</i>		X	X	X		X	X			X	X	X	X	X	X
<i>Ursinia anthemoides</i>		X													
Declared Pests															
<i>Gomphocarpus fruticosus</i>		X		X						X		X		X	X
<i>Solanum linnaeanum</i>										X					
<i>Zantedeschia aethiopica</i>	X			X									X'		
Conservation Significant															
<i>Stylidium maritimum</i> (P3)						X								X	
<i>Eucalyptus argutifolia</i> (T)														X	
Other															
<i>?Hibbertia cuneiformis</i>						X									
<i>?Threlkeldia diffusa</i>													X		
<i>Acacia cochlearis</i>						X								X	
<i>Acacia cyclops</i>				X										X	X
<i>Acacia littorea</i>			X			X								X	
<i>Acacia pulchella</i>				X										X	
<i>Acacia rostellifera</i>			X	X		X	X	X	X	X				X	
<i>Acacia saligna</i>			X	X		X							X	X	
<i>Acacia truncata</i>			X												
<i>Acanthocarpus preissii</i>	X		X	X		X		X	X	X				X	
<i>Acrotriche cordata</i>			X			X									
<i>Agonis flexuosa</i>	X	X	X	X	X	X	X		X	X	X	X	X	X	X

Appendix E Vascular Species by Vegetation Community Recorded at Lake Clifton, 2016

Row Labels	AfDdLg	AfHcEp	AfSgTd	AfXpHh	AfXpHg	ArMsTd	EdArTd	EdRbTd	EgMhAp	EgMsTd	EgXpTd	MrGtHg	MrGtTd	MsTd	Xp
<i>Hibbertia cuneiformis</i>	x	x	x	x	x	x	x		x	x	x	x		x	
<i>Hibbertia hypericoides</i>				x	x									x	
<i>Hibbertia racemosa</i>				x										x	x
<i>Jacksonia furcellata</i>				x		x								x	
<i>Juncus kraussii</i> subsp. <i>australiensis</i>								x					x		
<i>Kennedia coccinea</i>													x		
<i>Lagenophora huegelii</i>				x									x	x	
<i>Lepidosperma gladiatum</i>	x														
<i>Lepidosperma squamatum</i>						x									
<i>Lepyrodia drummondiana</i>				x									x		
<i>Leucopogon nutans</i>				x		x									
<i>Leucopogon parviflorus</i>	x		x			x	x	x		x	x		x	x	
<i>Leucopogon propinquus</i>				x	x									x	x
<i>Lomandra maritima</i>						x	x							x	
<i>Lomandra micrantha</i>				x	x										x
<i>Loxocarya cinerea</i>														x	
<i>Macrozamia riedlei</i>				x	x						x				
<i>Melaleuca cuticularis</i>													x		
<i>Melaleuca huegelii</i>								x							
<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>			x	x		x	x		x	x			x	x	
<i>Melaleuca lanceolata</i>							x	x				x			
<i>Melaleuca rhapsiophylla</i>								x				x	x		
<i>Melaleuca</i> sp. (<i>huegelii</i> x <i>rhapsiophylla</i>)			x												
<i>Melaleuca systema</i>				x	x	x	x	x		x	x		x	x	x
<i>Melaleuca teretifolia</i>												x			
<i>Nuytsia floribunda</i>				x										x	
<i>Olearia axillaris</i>			x			x							x	x	
<i>Opercularia hispidula</i>				x		x							x		
<i>Orchid</i> sp.			x	x	x	x				x	x		x	x	
<i>Patersonia occidentalis</i>				x											
<i>Pentapeltis peltigera</i>		x													
<i>Phyllanthus calycinus</i>		x	x	x	x	x		x	x	x				x	x
<i>Pimelea ferruginea</i>						x									
<i>Pimelea</i> sp.														x	
Planted <i>Callistemon</i>		x												x	
<i>Poaceae</i> sp.			x	x	x	x								x	
<i>Pterostylis sanguinea</i>				x											
<i>Pyrorchis nigricans</i>				x											
<i>Rhagodia baccata</i> subsp. <i>baccata</i>						x		x		x					

Appendix E Vascular Species by Vegetation Community Recorded at Lake Clifton, 2016

Row Labels	AfDdLg	AfHcEp	AfSgTd	AfXpHh	AfXpHg	ArMsTd	EdArTd	EdRbTd	EgMhAp	EgMsTd	EgXpTd	MrGtHg	MrGtTd	MsTd	Xp
<i>Santalum acuminatum</i>									x	x					
<i>Sarcocornia blackiana</i>													x		
<i>Scaevola crassifolia</i>			x												
<i>Scaevola nitida</i>						x									
<i>Senecio diaschides</i>					x	x				x					x
<i>Solanum symonii</i>	x														x
<i>Spyridium globulosum</i>	x	x	x	x	x	x	x	x		x			x	x	
<i>Stackhousia</i> sp.					x										
<i>Templetonia retusa</i>				x		x		x		x	x		x	x	
<i>Tetragia octandra</i>				x		x									
<i>Threlkeldia diffusa</i>						x									
<i>Thysanotus manglesianus</i>				x	x	x				x			x	x	
<i>Trachymene pilosa</i>			x	x	x	x				x			x	x	
<i>Trymalium ledifolium</i> var. <i>ledifolium</i>						x									
<i>Typha</i> sp.							x	x							
<i>Veronica distans</i>			x			x									
<i>Xanthorrhoea preissii</i>		x		x	x	x	x		x	x	x		x	x	x



Appendix F

Lake Clifton Quadrat
Data

Appendix F Lake Clifton Quadrat Data

Site	1	Location	115.657, -32.814
Observers	LvG and FdW		
Date	21/06/2016		

Topography	Ls	Soil Colour	Dark brown
Bare Ground	15	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	VG

Additional notes:

Weeds, evidence of human presence

Photos:

No Photos

Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus marginata</i>	2000	6	T
	<i>Agonis flexuosa</i>	1200	10	T
	<i>Spyridium globulosum</i>	300	0.5	TS
	<i>Xanthorrhoea preissii</i>	200	7	TS
	<i>Hakea lissocarpha</i>	180	3	TS
	<i>Hibbertia cuneiformis</i>	110	0.5	S
	<i>Leucopogon propinquus</i>	100	0.1	S
	<i>Hakea ruscifolia</i>	50	0.1	S
	<i>Macrozamia riedlei</i>	50	1	S
	<i>Desmocladius flexuosus</i>	40	0.1	H
	<i>Hibbertia hypericoides</i>	40	7	S
	<i>Phyllanthus calycinus</i>	40	0.1	S
	<i>Lomandra micrantha</i>	30	0.1	H
	<i>Stackhousia sp.</i>	30	0.1	H
	<i>Thysanotus manglesianus</i>	20	0.1	H
*	<i>Trachyandra divaricata</i>	20	0.1	W
*	<i>Lupinus sp.</i>	10	0.01	W
*	<i>Lysimachia arvensis</i>	4	0.1	W
	<i>Trachymene pilosa</i>	3	0.2	H
*	<i>Lotus subbiflorus</i>	2	0.5	W
*	<i>Hypochaeris glabra</i>	1	2	W
	<i>Drosera erythrorhiza</i>	0.5	0.01	H
	<i>Clematis pubescens</i>	0	0.1	V
	<i>Hardenbergia comptoniana</i>	0	0.1	V

Site	2	Location	115.652, -32.809
Observers	FdW & LvG		
Date	21/06/2016		

Topography	Ls-ms	Soil Colour	Brown
Bare Ground	2	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	G

Additional notes:

Understorey weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	1600	2	T
	<i>Agonis flexuosa</i>	1200	40	T
	<i>Hibbertia cuneiformis</i>	200	3	TS
	<i>Xanthorrhoea preissii</i>	150	2	TS
*	<i>Trachyandra divaricata</i>	40	15	W
*	<i>Euphorbia terracina</i>	20	0.1	W

Site	3	Location	115.654, -32.806
Observers	LvG and FdW		
Date	21/06/2016		

Topography	Ls	Soil Colour	Brown
Bare Ground	5	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	G

Additional notes:

Understorey weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	2200	6	T
	<i>Agonis flexuosa</i>	1000	4	T
	<i>Spyridium globulosum</i>	200	1	TS
	<i>Hibbertia cuneiformis</i>	100	3	TS
	<i>Xanthorrhoea preissii</i>	100	2	S
	<i>Phyllanthus calycinus</i>	40	0.4	S
*	<i>Trachyandra divaricata</i>	30	20	W
*	<i>Ursinia anthemoides</i>	10	1	W
*	<i>Euphorbia peplus</i>	5	40	W
*	<i>Lysimachia arvensis</i>	5	1	W
*	<i>Solanum nigrum</i>	5	10	W
*	<i>Sonchus oleraceus</i>	5	2	W
	<i>Clematis linearifolia</i>	0	0.1	V

Site	4	Location	115.652, -32.806
Observers	LvG and FdW		
Date	21/06/2016		

Topography	Ls	Soil Colour	Brown
Bare Ground	4	Condition	Moist
Cryptogram	Yes	Fire	10+
Soil Type	Sand	Condition	G

Additional notes:

Understorey weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	3000	1	T
	<i>Agonis flexuosa</i>	1200	40	T
	<i>Hibbertia cuneiformis</i>	200	6	TS
	<i>Xanthorrhoea preissii</i>	100	0.5	S
*	<i>Arctotheca calendula</i>	10	0.1	W
*	<i>Lotus subbiflorus</i>	10	2	W
*	<i>Euphorbia peplus</i>	5	20	W
*	<i>Geranium molle</i>	5	60	W
*	<i>Lysimachia arvensis</i>	5	1	W
	<i>Pentapeltis peltigera</i>	5	5	H
*	<i>Sonchus oleraceus</i>	5	2	W
	<i>Clematis linearifolia</i>	0	0.5	V

Site	5	Location	115.657, -32.799
Observers	LvG and FdW		
Date	21/06/2016		

Topography	Ms	Soil Colour	Brown
Bare Ground	1	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	VG

Additional notes:

Weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	400	0.1	TS
	<i>Hakea prostrata</i>	250	3	TS
	<i>Spyridium globulosum</i>	220	0.2	TS
	<i>Hakea trifurcata</i>	200	0.5	TS
* DP	<i>Gomphocarpus fruticosus</i>	170	1.5	W
	<i>Xanthorrhoea preissii</i>	150	1	S
	<i>Templetonia retusa</i>	120	1	S
	<i>Melaleuca systema</i>	60	40	S
	<i>Leucopogon parviflorus</i>	50	1	S
	<i>Hibbertia cuneiformis</i>	40	0.1	S
*	<i>Trachyandra divaricata</i>	30	60	W
*	<i>Geranium molle</i>	2	1	W
*	<i>Hypochaeris glabra</i>	1	0.5	W
	<i>Cassityha racemosa</i>	0	0.1	V
	<i>Clematis linearifolia</i>	0	0.2	V

Site	6	Location	115.657, -32.799
Observers	LvG and FdW		
Date	21/06/2016		

Topography	Ms	Soil Colour	Brown
Bare Ground	10	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	VG

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus decipiens</i>	800	30	T
	<i>Eucalyptus petrensis</i>	350	10	T
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	300	0.5	TS
	<i>Spyridium globulosum</i>	230	1	TS
	<i>Agonis flexuosa</i>	200	0.5	TS
	<i>Melaleuca systema</i>	200	1	TS
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	200	0.2	TS
	<i>Templetonia retusa</i>	180	1	TS
	<i>Xanthorrhoea preissii</i>	160	3	S
	<i>Hibbertia cuneiformis</i>	100	0.5	S
	<i>Hibbertia hypericoides</i>	80	0.1	S
	<i>Melaleuca systema</i>	70	0.2	S
	<i>Senecio diaschides</i>	30	0.1	H
*	<i>Trachyandra divaricata</i>	30	5	W
*	<i>Lotus subbiflorus</i>	10	0.5	W
*	<i>Geranium molle</i>	2	2	W
	<i>Clematis linearifolia</i>	0	0.3	V

Site	7	Location	115.657, -32.796
Observers	LvG and FdW		
Date	21/06/2016		

Topography	Ms	Soil Colour	Brown
Bare Ground	.5	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand loam	Condition	VG

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	250	10	TS
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	240	3	TS
	<i>Spyridium globulosum</i>	240	8	TS
	<i>Hakea prostrata</i>	220	0.1	TS
* DP	<i>Gomphocarpus fruticosus</i>	120	0.1	W
	<i>Hibbertia cuneiformis</i>	80	1	S
	<i>Melaleuca systema</i>	80	40	S
	<i>Leucopogon propinquus</i>	60	0.1	S
	<i>Templetonia retusa</i>	60	1	S
	<i>Grevillea preissii</i> subsp. <i>preissii</i>	50	0.2	S
	<i>Leucopogon parviflorus</i>	40	1	S
	<i>Drosera macrantha</i>	30	0.1	H
*	<i>Trachyandra divaricata</i>	30	5	W
	<i>Hibbertia racemosa</i>	20	0.1	S
	<i>Banksia dallanneyi</i>	10	0.1	S
*	<i>Solanum nigrum</i>	10	1	W
*	<i>Geranium molle</i>	2	2	W
*	<i>Lysimachia arvensis</i>	2	1	W

Cons	Taxon	Ht/cm	%A	Form
*	<i>Hypochaeris glabra</i>	1	0.4	W
*	<i>Lotus subbiflorus</i>	1	0.5	W
	<i>Clematis linearifolia</i>	0	1	V

Site	8	Location	115.650, -32.768
Observers	LvG and FdW		
Date	22/06/2016		

Topography	Ls	Soil Colour	White to brown
Bare Ground	0	Condition	Dry
Cryptogram	N/A	Fire	10+
Soil Type	Sand loam	Condition	E

Additional notes:

Low intensity weeds, rabbits

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	900	5	T
	<i>Agonis flexuosa</i>	700	40	T
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	400	6	TS
dead	<i>Banksia grandis</i>	300	0.5	T
	<i>Xanthorrhoea preissii</i>	250	2	TS
	<i>Spyridium globulosum</i>	230	2	TS
	<i>Melaleuca systema</i>	220	0.5	TS
	<i>Hakea ruscifolia</i>	160	0.1	S
	<i>Hakea lissocarpha</i>	140	0.2	S
	<i>Templetonia retusa</i>	100	3	S
	<i>Hibbertia hypericoides</i>	40	20	S
	<i>Macrozamia riedlei</i>	40	0.2	S
	<i>Acanthocarpus preissii</i>	30	0.1	H
	<i>Leucopogon propinquus</i>	30	0.1	S
	<i>Lomandra micrantha</i>	30	0.2	H
	<i>Opercularia hispidula</i>	30	0.1	H
	<i>Drosera macrantha</i>	20	0.01	H
	<i>Hibbertia racemosa</i>	20	0.1	S

Cons	Taxon	Ht/cm	%A	Form
	<i>Desmodium flexuosus</i>	15	0.1	H
*	<i>Lysimachia arvensis</i>	5	0.1	W
	<i>Trachymene pilosa</i>	5	0.1	H
	<i>Lagenophora huegelii</i>	1	0.1	H
	<i>Orchid sp.</i>	1	0.01	H
	<i>Drosera erythrorhiza</i>	0.5	0.2	H
	<i>Cassytha racemosa</i>	0	0.1	V
	<i>Hardenbergia comptoniana</i>	0	0.1	V

Site	9	Location	115.649, -32.768
Observers	LvG and FdW		
Date	22/06/2016		

Topography	Ls to ms	Soil Colour	Brown to white
Bare Ground	1	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	E

Additional notes:

Rabbits

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	700	20	T
	<i>Agonis flexuosa</i>	600	50	T
	<i>Eucalyptus petrensis</i>	600	2	T
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	250	10	TS
	<i>Jacksonia furcellata</i>	250	0.2	S
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	240	4	TS
	<i>Templetonia retusa</i>	240	8	TS
	<i>Melaleuca systema</i>	200	1	TS
	<i>Xanthorrhoea preissii</i>	200	0.5	TS
	<i>Hakea lissocarpha</i>	100	0.1	S
	<i>Acacia pulchella</i>	50	0.1	S
	<i>Hibbertia hypericoides</i>	50	25	S
	<i>Macrozamia riedlei</i>	50	0.2	S
	<i>Grevillea preissii</i> subsp. <i>preissii</i>	40	0.1	S
Juvenile	<i>Hibbertia cuneiformis</i>	40	0.1	S
	<i>Leucopogon propinquus</i>	40	0.2	S
	<i>Pyrorchis nigricans</i>	40	0.01	H
	<i>Acacia cyclops</i>	30	0.1	S

Cons	Taxon	Ht/cm	%A	Form
	<i>Desmocladius flexuosus</i>	20	0.1	H
	<i>Lomandra micrantha</i>	20	0.1	H
dead	<i>Banksia dallanneyi</i>	10	0.1	S
	<i>Orchid sp.</i>	6	0.01	H
	<i>Trachymene pilosa</i>	5	0.1	H
	<i>Lagenophora huegelii</i>	1	0.1	H
	<i>Drosera erythrorhiza</i>	0.5	0.2	H

Site	10	Location	115.650, -32.770
Observers	LvG and FdW		
Date	22/06/2016		

Topography	Ls	Soil Colour	Grey
Bare Ground	5	Condition	Dry
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	E

Additional notes:

Rabbits, low intensity weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	1400	10	T
	<i>Agonis flexuosa</i>	900	35	T
	<i>Xanthorrhoea preissii</i>	250	10	TS
	<i>Banksia littoralis</i>	240	2	T
	<i>Templetonia retusa</i>	230	5	TS
	<i>Jacksonia furcellata</i>	220	0.1	TS
	<i>Acacia saligna</i>	200	0.1	TS
	Planted urn	180	0.1	S
	<i>Goodenia pulchella</i>	100	0.1	?W
	<i>Acacia pulchella</i>	80	0.1	S
	<i>Hakea lissocarpha</i>	60	0.1	S
	<i>Hibbertia hypericoides</i>	60	3	S
	<i>Macrozamia riedlei</i>	50	0.2	S
	<i>Drosera macrantha</i>	30	0.2	H
	<i>Lepyrodia drummondiana</i>	30	0.1	Sedge
	<i>Leucopogon propinquus</i>	30	0.1	S
	<i>Lomandra micrantha</i>	30	0.2	H
	<i>Patersonia occidentalis</i>	30	0.1	H

Cons	Taxon	Ht/cm	%A	Form
Juvenile	<i>Spyridium globulosum</i>	30	0.1	S
	<i>Drosera macrantha</i>	20	0.01	H
	<i>Opercularia hispidula</i>	15	0.1	H
*	<i>Lysimachia arvensis</i>	2	0.1	W
	<i>Trachymene pilosa</i>	2	0.2	H
	<i>Lagenophora huegelii</i>	1	0.1	H
	<i>Drosera erythrorhiza</i>	0.5	0.1	H
*	<i>Hypochaeris glabra</i>	0.5	0.1	W
	<i>Cassutha racemosa</i>	0	0.01	V
	<i>Hardenbergia comptoniana</i>	0	0.1	V

Site	11	Location	115.646, -32.770
Observers	LvG and FdW		
Date	22/06/2016		

Topography	Flat	Soil Colour	Light brown
Bare Ground	N/A	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	E

Additional notes:

Barely any weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	1500	20	T
	<i>Agonis flexuosa</i>	1400	30	T
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	300	1	TS
	<i>Xanthorrhoea preissii</i>	300	10	TS
	<i>Melaleuca systema</i>	200	5	TS
	<i>Hemiandra pungens</i>	200	0.1	S
	<i>Templetonia retusa</i>	150	5	TS
	<i>Acacia pulchella</i>	80	0.1	S
	<i>Drosera macrantha</i>	80	0.01	H
	<i>Hibbertia hypericoides</i>	80	10	S
	<i>Macrozamia riedlei</i>	80	0.5	S
	<i>Hakea lissocarpha</i>	60	0.2	S
	<i>Lomandra micrantha</i>	30	0.1	H
	<i>Desmocladius flexuosus</i>	15	0.02	H
	<i>Opercularia hispidula</i>	10	0.1	H
	<i>Orchid</i> sp.	10	0.01	H
	<i>Spyridium globulosum</i>	10	0.1	S
	<i>Lagenophora huegelii</i>	5	0.1	H

Cons	Taxon	Ht/cm	%A	Form
*	<i>Lysimachia arvensis</i>	5	0.02	W
	<i>Trachymene pilosa</i>	5	0.02	H
*	<i>Hypochaeris glabra</i>	1	0.02	W
	<i>Drosera erythrorhiza</i>	0.5	0.1	H
	<i>Cassytha racemosa</i>	0	0.01	V
	<i>Hardenbergia comptoniana</i>	0	0.02	V

Site	12	Location	115.646, -32.779
Observers	LvG and FdW		
Date	22/06/2016		

Topography	Wetland	Soil Colour	Black
Bare Ground	0	Condition	Waterlogged
Cryptogram	N/A	Fire	10+
Soil Type	Clay loam	Condition	E

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	1600	5	T
	<i>Eucalyptus petrensis</i>	1500	30	T
	<i>Melaleuca cuticularis</i>	550	80	T
	<i>Banksia littoralis</i>	500	2	T
	<i>Melaleuca raphiophylla</i>	500	10	T
	<i>Melaleuca systema</i>	200	5	TS
	<i>Templetonia retusa</i>	180	5	TS
	<i>Xanthorrhoea preissii</i>	170	8	TS
	<i>Juncus kraussii subsp. australiensis</i>	130	15	Sedge

Cons	Taxon	Ht/cm	%A	Form
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	130	2	S
	<i>Gahnia trifida</i>	120	30	Sedge
	<i>Opercularia hispidula</i>	40	0.1	H
	<i>Lepyrodia drummondiana</i>	30	0.5	Sedge
*	<i>Trachyandra divaricata</i>	30	0.1	W
DP	<i>Zantedeschia aethiopica</i>	20	0.1	W
	<i>Sarcocornia blackiana</i>	20	15	H
	<i>Thysanotus manglesianus</i>	20	0.01	H
	<i>Agonis flexuosa</i>	10	30	T
*	<i>Geranium molle</i>	10	0.1	W
*	<i>Lysimachia arvensis</i>	10	0.02	W
	<i>Orchid</i> sp.	7	0.01	H
	<i>Trachymene pilosa</i>	7	0.02	H
*	<i>Trifolium campestre</i>	5	0.01	W
	<i>Lagenophora huegelii</i>	5	0.1	H
	? <i>Threlkeldia diffusa</i>	5	20	H
	<i>Clematis linearifolia</i>	0	0.1	H
	<i>Clematis pubescens</i>	0	2	V
	<i>Kennedia coccinea</i>	0	0.2	H

Site	13	Location	115.638, -32.769
Observers	LvG and FdW		
Date	22/06/2016		

Topography	Hilltop	Soil Colour	Brown
Bare Ground	5	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	G

Additional notes:

Rabbits, weeds, no understorey

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	800	35	T
	<i>Planted Callistemon</i>	300	0.1	S
* DP	<i>Gomphocarpus fruticosus</i>	190	0.5	W
	<i>Xanthorrhoea preissii</i>	130	0.5	S
	<i>Hibbertia cuneiformis</i>	120	3	S
*	<i>Trachyandra divaricata</i>	40	20	W
*	<i>Solanum nigrum</i>	15	0.1	W
*	<i>Trifolium campestre</i>	5	0	W
*	<i>Geranium molle</i>	5	5	W
*	<i>Arctotheca calendula</i>	2	0.01	W
	<i>Clematis linearifolia</i>	0	0.5	V

Site	14	Location	115.636, -32.773
Observers	LvG and FdW		
Date	22/06/2016		

Topography	Ms	Soil Colour	Brown
Bare Ground	4	Condition	Moist
Cryptogram	Yes	Fire	10+
Soil Type	Sandy loam	Condition	G

Additional notes:

Weeds, maybe missing all trees

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus platypus</i>	500	0.1	T
	<i>Acacia cyclops</i>	400	1	TS
	<i>Agonis flexuosa</i>	400	5	T
	<i>Xanthorrhoea preissii</i>	250	50	TS
* DP	<i>Gomphocarpus fruticosus</i>	100	0.1	W
	<i>Melaleuca systema</i>	70	25	S
	<i>Leucopogon propinquus</i>	60	0.1	S
	<i>Hakea prostrata</i>	50	5	S
*	<i>Trachyandra divaricata</i>	40	5	W
	<i>Phyllanthus calycinus</i>	20	0.2	S
*	<i>Arctotheca calendula</i>	5	0.01	W
*	<i>Trifolium campestre</i>	5	0.2	W
*	<i>Geranium molle</i>	2	1	W
*	<i>Hypochaeris glabra</i>	2	0.2	W
*	<i>Lysimachia arvensis</i>	2	0.02	W
*	<i>Brassica tournefortii</i>	0.1	0.01	W

Site	15	Location	115.639, -32.777
Observers	LvG and FdW		
Date	22/06/2016		

Topography	Ms	Soil Colour	Brown
Bare Ground	N/A	Condition	Moist
Cryptogram	N/A	Fire	N/A
Soil Type	Sandy loamy	Condition	VG

Additional notes:

Vg to excellent, weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	2700	20	T
	<i>Agonis flexuosa</i>	900	20	T
	<i>Xanthorrhoea preissii</i>	250	35	TS
	<i>Hibbertia cuneiformis</i>	150	1	S
	<i>Macrozamia riedlei</i>	100	2	S
*	<i>Trachyandra divaricata</i>	30	0.05	W
*	<i>Solanum nigrum</i>	20	0.05	W
	<i>Orchid sp.</i>	10	0.01	H
	<i>Banksia attenuata</i>	8	20	T
*	<i>Trifolium campestre</i>	5	0.02	W
*	<i>Geranium molle</i>	5	0.02	W
*	<i>Lysimachia arvensis</i>	5	0.01	W
*	<i>Hypochaeris glabra</i>	1	0.02	W
	<i>Drosera erythrorhiza</i>	0.5	0.01	H
	<i>Hardenbergia comptoniana</i>	0	1	V

Site	16	Location	115.636, -32.780
Observers	LvG and FdW		
Date	22/06/2016		

Topography	Ms	Soil Colour	Brown
Bare Ground	1	Condition	Dry
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	G

Additional notes:

Lacking tree stratum

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Xanthorrhoea preissii</i>	200	50	TS
	<i>Lomandra micrantha</i>	50	0.02	H
*	<i>Dittrichia graveolens</i>	45	0	W
	<i>Melaleuca systema</i>	30	0.1	S
*	<i>Trachyandra divaricata</i>	30	1	W
	<i>Hibbertia racemosa</i>	15	0	S
*	<i>Trifolium campestre</i>	5	0.01	W
*	<i>Lysimachia arvensis</i>	5	0.02	W
*	<i>Geranium molle</i>	2	0.02	W
*	<i>Hypochaeris glabra</i>	1	0.5	W
*	<i>Brassica tournefortii</i>	0.1	0.01	W

Site	17	Location	115.639, -32.781
Observers	LvG and FdW		
Date	22/06/2016		

Topography	Ms	Soil Colour	Black brown
Bare Ground	N/A	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand loam	Condition	G

Additional notes:

Weeds, declared pests

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Melaleuca huegelii subsp. huegelii</i>	250	2	TS
	<i>Xanthorrhoea preissii</i>	200	7	TS
* DP	<i>Gomphocarpus fruticosus</i>	170	5	W
	<i>Hibbertia cuneiformis</i>	100	3	S
	<i>Melaleuca systema</i>	100	75	S
	<i>Templetonia retusa</i>	80	2	S
	<i>Pimelea sp.</i>	70	0.01	H
*	<i>Trachyandra divaricata</i>	40	5	W
	<i>Leucopogon propinquus</i>	20	0.01	S
*	<i>Arctotheca calendula</i>	2	0.01	W
*	<i>Geranium molle</i>	2	0.02	W
*	<i>Hypochaeris glabra</i>	1	1	W
	<i>Clematis linearifolia</i>	0	1	V

Site	18	Location	115.642, -32.791
Observers	LvG and FdW		
Date	23/06/2016		

Topography	Dune crest	Soil Colour	Brown
Bare Ground	0	Condition	Dry
Cryptogram	N/A	Fire	10+
Soil Type	Sand loam with lots of organic matter	Condition	G

Additional notes:

Weeds, low diversity and missing understorey stratum

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Acacia rostelifera</i>	600	10	TS
	<i>Agonis flexuosa</i>	600	10	T
	<i>Santalum acuminatum</i>	300	1	T
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	250	20	TS
	<i>Xanthorrhoea preissii</i>	200	0.2	S
	<i>Acanthocarpus preissii</i>	80	20	H
	<i>Hibbertia cuneiformis</i>	80	4	S
	<i>Phyllanthus calycinus</i>	50	0.1	S

Cons	Taxon	Ht/cm	%A	Form
*	<i>Trachyandra divaricata</i>	50	30	W
*	<i>Euphorbia peplus</i>	20	7	W
*	<i>Solanum nigrum</i>	20	2	W
	<i>Eucalyptus gomphocephala</i>	15	5	T
*	<i>Geranium molle</i>	10	1	W
	<i>Clematis linearifolia</i>	0	40	V

Site	19	Location	115.643, -32.790
Observers	LvG and FdW		
Date	23/06/2016		

Topography	Ls	Soil Colour	Grey
Bare Ground	0	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand loam	Condition	VG

Additional notes:

Ground stratum all weeds

Can hear cockatoos

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus foecunda</i>	500	50	T
	<i>Spyridium globulosum</i>	400	5	TS
	<i>Hakea prostrata</i>	250	0.1	TS
* DP	<i>Gomphocarpus fruticosus</i>	200	0.1	W
	<i>Xanthorrhoea preissii</i>	200	7	TS
	<i>Planted Callistemon</i>	170	0.01	S
	<i>Melaleuca systema</i>	160	10	TS
	<i>Hibbertia cuneiformis</i>	100	3	S

Cons	Taxon	Ht/cm	%A	Form
	<i>Hibbertia hypericoides</i>	90	5	S
	<i>Leucopogon parviflorus</i>	60	0.1	S
	<i>Templetonia retusa</i>	60	3	S
*	<i>Trachyandra divaricata</i>	50	0.2	W
	<i>Senecio diaschides</i>	15	1	H
	<i>Loxocarya cinerea</i>	10	0.01	H
	<i>Orchid sp.</i>	10	0.01	H
*	<i>Solanum nigrum</i>	7	0.2	W
*	<i>Lysimachia arvensis</i>	5	0.02	W
*	<i>Geranium molle</i>	2	0.2	W
	<i>Trachymene pilosa</i>	2	0.2	H
*	<i>Hypochaeris glabra</i>	1	1	W
	<i>Lagenophora huegelii</i>	1	0.01	H
*	<i>Arctotheca calendula</i>	0.5	0.1	W
	<i>Clematis linearifolia</i>	0	15	V
	<i>Hardenbergia comptoniana</i>	0	0.1	V

Site	20	Location	115.639, -32.785
Observers	LvG and FdW		
Date	23/06/2016		

Topography	Ms	Soil Colour	Brown
Bare Ground	5	Condition	Dry
Cryptogram	N/A	Fire	10+
Soil Type	Sand loam	Condition	G

Additional notes:

Weeds no native understorey

Euc gomph over xanth preissii over weeds

Photos:



Site	21	Location	115.636, -32.788
Observers	LvG and FdW		
Date	23/06/2016		

Topography	Dune swale	Soil Colour	Brown to white
Bare Ground	N/A	Condition	Dry
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	G

Additional notes:

Weed understorey

21a is wetland with types surrounded by euc decipiens and callitris over xanth

Photos:



Wetland Taxon

Cons	Taxon	Ht/cm	%A	Form
	<i>Allocasuarina fraseriana</i>	800	1	T
	<i>Eucalyptus decipiens</i>	700	25	T
	<i>Callitris preissii</i>	600	15	T
	<i>Acacia rostellifera</i>	350	30	TS
	<i>Xanthorrhoea preissii</i>	300	20	TS
	<i>Agonis flexuosa</i>	200	2	TS
	<i>Melaleuca huegelii subsp. huegelii</i>	200	1	TS
	<i>Hibbertia cuneiformis</i>	130	0.1	S

Cons	Taxon	Ht/cm	%A	Form
	<i>Melaleuca systema</i>	100	1	S
	<i>Leucopogon parviflorus</i>	50	0.1	S
*	<i>Trachyandra divaricata</i>	50	20	W
	<i>Lomandra maritima</i>	30	5	H
	<i>Spyridium globulosum</i>	20	0.05	S
*	<i>Solanum nigrum</i>	15	0.05	W
*	<i>Trifolium campestre</i>	5	0.05	W
*	<i>Lysimachia arvensis</i>	5	0.02	W
	<i>Clematis linearifolia</i>	0	0.2	V

Adjacent Vegetation

Cons	Taxon	Ht/cm	%A	Form
	<i>Acacia rostellifera</i>	500	10	TS
	<i>Melaleuca lanceolata</i>	500	8	TS
	<i>Eucalyptus sp. (planted)</i>	400	5	T
	<i>Agonis flexuosa</i>	300	1	TS
	<i>Typha sp.</i>	200	80	Sedge
	<i>Baumea juncea</i>	180	10	Sedge
	<i>Leucopogon parviflorus</i>	80	0.02	S

Site	22	Location	115.646, -32.790
Observers	LvG and FdW		
Date	23/06/2016		

Topography	Ms	Soil Colour	Light brown
Bare Ground	0	Condition	Dry
Cryptogram	N/A	Fire	10+
Soil Type	Sand loam	Condition	VG

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	2500	15	T
	<i>Xanthorrhoea preissii</i>	250	75	TS
	<i>Leucopogon parviflorus</i>	150	0	S
	<i>Templetonia retusa</i>	100	0	S
	<i>Melaleuca systema</i>	60	0	S
*	<i>Trachyandra divaricata</i>	40	0.5	W
*	<i>Solanum nigrum</i>	15	0.5	W
*	<i>Geranium molle</i>	10	1	W
*	<i>Trifolium campestre</i>	5	0.02	W
*	<i>Lysimachia arvensis</i>	5	0.05	W
*	<i>Hypochaeris glabra</i>	1	1	W

Site	23	Location	115.656, -32.787
Observers	LvG and FdW		
Date	27/06/2016		

Topography	Ls	Soil Colour	Brown
Bare Ground	0	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand loam	Condition	VG

Additional notes:

Understorey weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	2000	15	T
	<i>Banksia grandis</i>	900	2	T
	<i>Banksia attenuata</i>	700	5	T
	<i>Eucalyptus petrensis</i>	700	5	T
	<i>Nuytsia floribunda</i>	600	0	T
	<i>Agonis flexuosa</i>	500	40	T
* DP	<i>Gomphocarpus fruticosus</i>	300	6	W
	<i>Xanthorrhoea preissii</i>	250	7	TS
	<i>Hibbertia cuneiformis</i>	150	0.1	S
	<i>Macrozamia riedlei</i>	100	2	S
*	<i>Trachyandra divaricata</i>	60	5	W
*	<i>Solanum nigrum</i>	15	0.2	W
	<i>Orchid sp.</i>	10	0.01	H
*	<i>Trifolium campestre</i>	5	0.1	W
*	<i>Geranium molle</i>	5	0.2	W
*	<i>Lysimachia arvensis</i>	5	0.2	W
	<i>Trachymene pilosa</i>	5	0.1	H
*	<i>Hypochoeris glabra</i>	1	0.1	W

Cons	Taxon	Ht/cm	%A	Form
	<i>Cassytha racemosa</i>	0	0.02	V
	<i>Clematis pubescens</i>	0	2	V
	<i>Hardenbergia comptoniana</i>	0	0.05	V

Site	24	Location	115.652, -32.782
Observers	LvG and FdW		
Date	23/06/2016		

Topography	Flat	Soil Colour	Black, dark brown
Bare Ground	N/A	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand, loamy	Condition	VG

Additional notes:

Weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	1500	20	T
	<i>Agonis flexuosa</i>	900	60	T
	<i>Banksia grandis</i>	400	0.05	T
	<i>Xanthorrhoea preissii</i>	150	4	S
	<i>Templetonia retusa</i>	120	0.2	S
* DP	<i>Gomphocarpus fruticosus</i>	110	1	W
	<i>Macrozamia riedlei</i>	90	2	S
	<i>Hibbertia cuneiformis</i>	60	0.1	S
	<i>Poaceae sp.</i>	15	0.02	W
	<i>Orchid sp.</i>	10	0.01	H
	<i>Thysanotus manglesianus</i>	10	0.01	H
*	<i>Trifolium campestre</i>	5	0.1	W
*	<i>Geranium molle</i>	5	0.02	W
*	<i>Lysimachia arvensis</i>	5	0.1	W
	<i>Orchid sp.</i>	5	0.01	H
	<i>Trachymene pilosa</i>	5	0.1	H
*	<i>Hypochaeris glabra</i>	1	0.1	W
	<i>Lagenophora huegelii</i>	1	0.05	H

Cons	Taxon	Ht/cm	%A	Form
	<i>Drosera erythrorhiza</i>	0.5	0.01	H
	<i>Clematis pubescens</i>	0	10	V

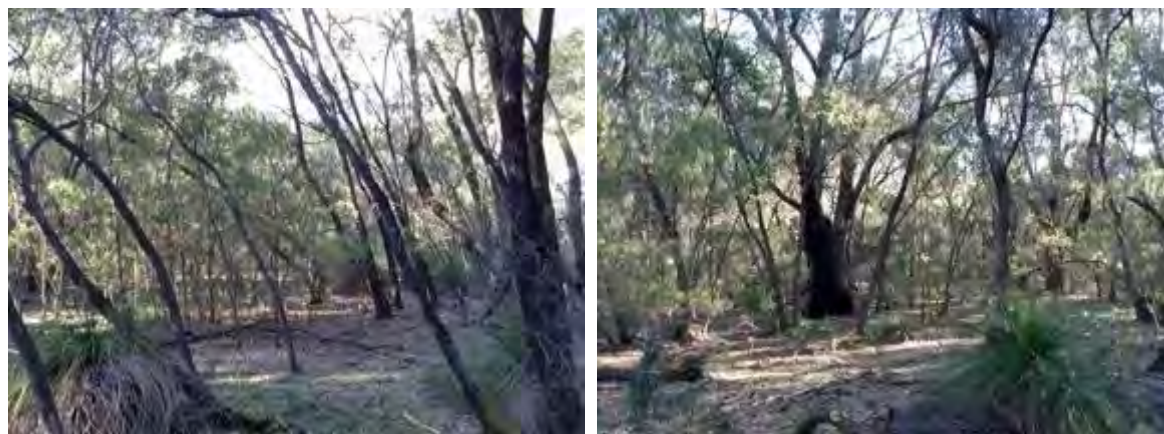
Site	25	Location	115.652, -32.780
Observers	LvG and FdW		
Date	23/06/2016		

Topography	Flat	Soil Colour	Dark brown, grey
Bare Ground	N/A	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loamy	Condition	VG

Additional notes:

Weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	1500	15	T
	<i>Agonis flexuosa</i>	1200	60	T
	<i>Banksia grandis</i>	800	0	T
	<i>Xanthorrhoea preissii</i>	220	10	TS
	<i>Macrozamia riedlei</i>	150	7	S
	<i>Templetonia retusa</i>	120	0.5	S
DP	<i>Zantedeschia aethiopica</i>	30	0.02	W
	<i>Orchid sp.</i>	10	0.01	H
	<i>Poaceae sp.</i>	10	0.01	W
*	<i>Solanum nigrum</i>	10	0.05	W
	<i>Thysanotus manglesianus</i>	10	0.02	H
	<i>Trachymene pilosa</i>	10	0.1	H
*	<i>Lysimachia arvensis</i>	5	0.1	W
*	<i>Hypochaeris glabra</i>	1	0.05	W
	<i>Lagenophora huegelii</i>	1	0.01	H
	<i>Clematis pubescens</i>	0	7	V
	<i>Hardenbergia comptoniana</i>	0	0.02	V

Site	26	Location	115.656, -32.808
Observers	LvG and FdW		
Date	23/06/2016		

Topography	Wetlad	Soil Colour	Black
Bare Ground	N/A	Condition	N/A
Cryptogram	N/A	Fire	10+
Soil Type	Loam	Condition	D

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	1900	2	T
	<i>Agonis flexuosa</i>	400	2	TS
	<i>Melaleuca teretifolia</i>	300	25	TS
	<i>Melaleuca raphiophylla</i>	300	10	TS
* DP	<i>Gomphocarpus fruticosus</i>	200	2	W
	<i>Gahnia trifida</i>	150	25	Sedge
*	<i>Dittrichia graveolens</i>	30	5	W
	<i>Hibbertia cuneiformis</i>	30	0.1	S
*	<i>Trachyandra divaricata</i>	2	1	W
*	<i>Arctotheca calendula</i>	2	2	W
*	<i>Brassica tournefortii</i>	2	2	W
*	<i>Trifolium campestre</i>	2	2	W
*	<i>Euphorbia peplus</i>	2	2	W
*	<i>Geranium molle</i>	2	2	W
*	<i>Hypochaeris glabra</i>	2	2	W
*	<i>Lysimachia arvensis</i>	2	2	W
*	<i>Solanum nigrum</i>	2	2	W

Site	27	Location	115.653, -32.798
Observers	LvG and FdW		
Date	24/06/2016		

Topography	Ls	Soil Colour	Dark brown
Bare Ground	0	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Loam sand	Condition	G

Additional notes:

Weeds, lacks native understorey

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	1600	20	T
	<i>Santalum acuminatum</i>	450	0	T
	<i>Spyridium globulosum</i>	350	0	TS
	<i>Xanthorrhoea preissii</i>	250	25	TS
	<i>Hakea prostrata</i>	200	1	TS
	<i>Melaleuca systema</i>	150	5	S
*	<i>Poaceae sp.</i>	80	0.02	W
*	<i>Trachyandra divaricata</i>	60	60	W
*	<i>Lysimachia arvensis</i>	10	0.05	W
*	<i>Trifolium campestre</i>	5	0.1	W
*	<i>Geranium molle</i>	5	0.1	W
	<i>Trachymene pilosa</i>	5	0.02	H
*	<i>Hypochaeris glabra</i>	1	0.02	W
*	<i>Arctotheca calendula</i>	0.5	0.02	W
*	<i>Brassica tournefortii</i>	0.1	0.01	W
	<i>Cassytha racemosa</i>	0	0.02	V
	<i>Clematis linearifolia</i>	0	7	V

Site	28	Location	115.647, -32.804
Observers	LvG and FdW		
Date	24/06/2016		

Topography	Ls	Soil Colour	Dark brown
Bare Ground	N/A	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	VG

Additional notes:

Weed understorey lacking native trees and shrubs

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	1600	20	T
	<i>Acacia rostellifera</i>	400	20	TS
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	350	0.01	TS
	<i>Agonis flexuosa</i>	300	0	T
	<i>Melaleuca systema</i>	250	30	TS
* DP	<i>Gomphocarpus fruticosus</i>	200	0.02	W
	<i>Hibbertia cuneiformis</i>	200	7	TS
	<i>Xanthorrhoea preissii</i>	170	2	TS
DP	<i>Solanum linnaeanum</i>	100	1	W
	<i>Templetonia retusa</i>	100	0.2	S
*	<i>Trachyandra divaricata</i>	70	10	W
*	<i>Arctotheca calendula</i>	10	2	W
*	<i>Brassica tournefortii</i>	10	2	W
*	<i>Trifolium campestre</i>	10	2	W
*	<i>Euphorbia peplus</i>	10	2	W
*	<i>Geranium molle</i>	10	2	W
*	<i>Hypochaeris glabra</i>	10	2	W
*	<i>Lysimachia arvensis</i>	10	2	W

Cons	Taxon	Ht/cm	%A	Form
*	<i>Solanum nigrum</i>	10	2	W
	<i>Clematis linearifolia</i>	0	30	V

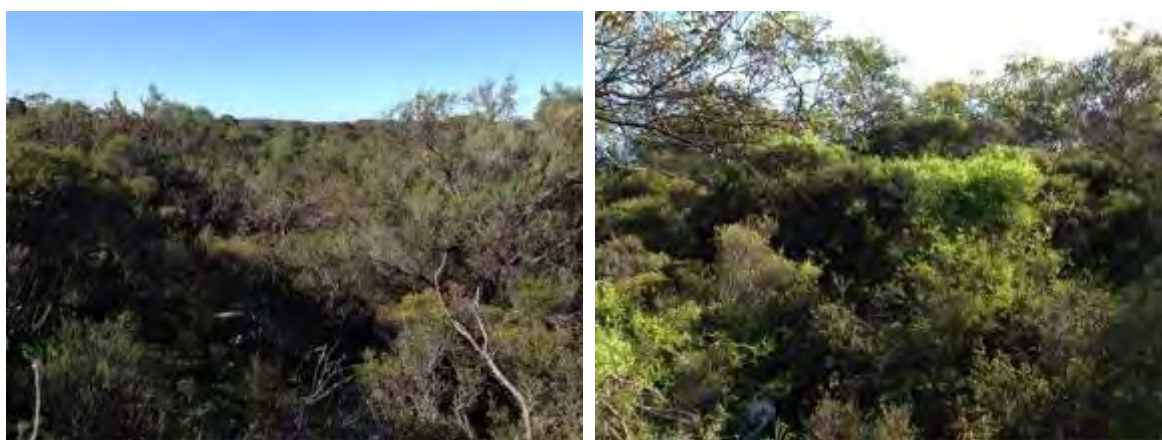
Site	29	Location	115.656, -32.796
Observers	LvG and FdW		
Date	27/06/2016		

Topography	Us sand dunes with limestone	Soil Colour	Brown
Bare Ground	1	Condition	Dry
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	VG

Additional notes:

Ground cover weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
T	<i>Eucalyptus argutifolia</i>	500	7	T
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	300	5	TS
	<i>Eucalyptus foecunda</i>	250	2	T
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	250	20	TS
	<i>Spyridium globulosum</i>	200	1	TS
	<i>Hakea prostrata</i>	150	0.5	S
	<i>Melaleuca systema</i>	150	50	TS
	<i>Templetonia retusa</i>	150	5	TS
	<i>Hibbertia cuneiformis</i>	130	5	S
	<i>Leucopogon parviflorus</i>	70	0	S
*	<i>Trachyandra divaricata</i>	70	1	W
	<i>Grevillea preissii</i> subsp. <i>preissii</i>	60	2	S
	<i>Banksia dallanneyi</i>	20	0.02	S
*	<i>Geranium molle</i>	15	5	W
*	<i>Solanum nigrum</i>	15	10	W
*	<i>Trifolium campestre</i>	10	0.5	W
*	<i>Lysimachia arvensis</i>	10	20	W
	<i>Orchid</i> sp.	10	0.01	H

Cons	Taxon	Ht/cm	%A	Form
*	<i>Arctotheca calendula</i>	5	5	W
	<i>Trachymene pilosa</i>	5	0.02	H
*	<i>Hypochaeris glabra</i>	1	2	W
	<i>Clematis linearifolia</i>	0	7	V
	<i>Hardenbergia comptoniana</i>	0	0.2	V

Site	30	Location	115.654, -32.779
Observers	LvG and FdW		
Date	27/06/2016		

Topography	Ls	Soil Colour	Orange to brown
Bare Ground	2	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand some loam	Condition	E

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	800	10	T
	<i>Agonis flexuosa</i>	700	60	T
	<i>Banksia grandis</i>	400	0	T
	<i>Acacia rostellifera</i>	300	0	TS
	<i>Xanthorrhoea preissii</i>	250	8	TS
	<i>Acacia pulchella</i>	170	0.1	S
* DP	<i>Gomphocarpus fruticosus</i>	170	0	W
	<i>Hakea ruscifolia</i>	160	0	S
	<i>Templetonia retusa</i>	150	6	S
	<i>Macrozamia riedlei</i>	100	1	S
	<i>Hibbertia hypericoides</i>	90	12	S
	<i>Phyllanthus calycinus</i>	50	0	S
	<i>Lomandra micrantha</i>	40	0.01	S
	<i>Tetraria octandra</i>	40	0.01	Sedge
	<i>Hibbertia racemosa</i>	30	0.02	S
	<i>Leucopogon propinquus</i>	30	0.01	S
	<i>Leucopogon nutans</i>	20	0	S
	<i>Pterostylis sanguinea</i>	20	0	H

Cons	Taxon	Ht/cm	%A	Form
*	<i>Lysimachia arvensis</i>	10	0.2	W
	<i>Thysanotus manglesianus</i>	10	0	H
*DP	<i>Zantedeschia aethiopica</i>	10	0	W
	<i>Trachymene pilosa</i>	5	0.2	H
*	<i>Hypochaeris glabra</i>	1	0.2	W
*	<i>Arctotheca calendula</i>	0.5	0	W
	<i>Drosera erythrorhiza</i>	0.5	0.02	V
	<i>Clematis pubescens</i>	0	0	V
	<i>Hardenbergia comptoniana</i>	0	0	V
	<i>Drosera macrantha</i>		0.01	V

Site	31	Location	115.634, -32.766
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Sand dune	Soil Colour	Light brown, yellowy
Bare Ground	5	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	VG

Additional notes:

Weeds some are patches

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus sp. (planted)</i>	400	1	T
	<i>Eucalyptus platypus</i>	400	1	T
	<i>Acacia rostellifera</i>	300	20	TS
	<i>Melaleuca huegelii subsp. huegelii</i>	240	18	TS
	<i>Banksia sessilis var. cygnorum</i>	200	1	TS
	<i>Hakea prostrata</i>	150	0	TS
	<i>Melaleuca systema</i>	100	15	S
	<i>Hibbertia cuneiformis</i>	70	4	S
	<i>Phyllanthus calycinus</i>	70	0.5	S

Cons	Taxon	Ht/cm	%A	Form
*	<i>Trachyandra divaricata</i>	50	80	W
	<i>Leucopogon parviflorus</i>	40	0.5	S
	<i>Templetonia retusa</i>	40	0.5	S
	<i>Acanthocarpus preissii</i>	30	3	S
*	<i>Geranium molle</i>	20	0.2	W
*	<i>Solanum nigrum</i>	10	5	W
	<i>Clematis linearifolia</i>	0	10	V

Site	32	Location	115.632, -32.768
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Sand dune	Soil Colour	Brown
Bare Ground	2	Condition	Dry
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Ground cover weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Acacia rostellifera</i>	350	35	TS
	<i>Spyridium globulosum</i>	200	2	TS
	<i>Melaleuca systema</i>	150	20	S
*	<i>Trachyandra divaricata</i>	70	5	W
	<i>Hibbertia cuneiformis</i>	60	0.1	S
	<i>Acanthocarpus preissii</i>	50	20	S
	<i>Phyllanthus calycinus</i>	50	2	S
	<i>Leucopogon parviflorus</i>	40	0.5	S
	<i>Lomandra maritima</i>	40	20	H
	<i>Tetraria octandra</i>	20	0.02	Sedge
*	? <i>Daucus glochidiatus</i>	15	5	W
	<i>Senecio diaschides</i>	15	0.01	H
*	<i>Solanum nigrum</i>	10	0.01	W
*	<i>Trifolium campestre</i>	7	0.02	W
	<i>Orchid sp.</i>	7	0.02	H
	<i>Trachymene pilosa</i>	3	0.01	H
	<i>Clematis linearifolia</i>	0	20	V
	<i>Veronica distans</i>	0	0.01	V

Site	33	Location	115.629, -32.771
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Wetland swale	Soil Colour	Yellow white grey
Bare Ground	5	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	VG

Additional notes:

Weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus decipiens</i>	600	30	T
	<i>Allocasuarina fraseriana</i>	500	0.2	T
	<i>Callitris preissii</i>	400	15	T
	<i>Eucalyptus sp. (planted)</i>	400	5	T
	<i>Melaleuca lanceolata</i>	400	5	T
	<i>Melaleuca raphiophylla</i>	400	1	T
	<i>Acacia rostelifera</i>	300	1	TS
	<i>Eucalyptus sp. (planted)</i>	300	1	T
	<i>Acacia rostelifera</i>	250	10	TS

Cons	Taxon	Ht/cm	%A	Form
	<i>Melaleuca huegelii</i>	250	8	TS
	<i>Templetonia retusa</i>	230	0.5	S
	<i>Spyridium globulosum</i>	200	4	TS
	<i>Typha sp.</i>	200	80	Sedge
	<i>Alyxia buxifolia</i>	100	0.2	S
	<i>Juncus kraussii subsp. australiensis</i>	100	2	Sedge
	<i>Rhagodia baccata subsp. baccata</i>	100	15	V
	<i>Melaleuca systema</i>	80	1	S
	<i>Leucopogon parviflorus</i>	60	0.2	S
	<i>Acanthocarpus preissii</i>	50	3	S
	<i>Phyllanthus calycinus</i>	50	1	S
*	<i>Trachyandra divaricata</i>	30	50	W
*	<i>Solanum nigrum</i>	10	2	W
*	<i>Geranium molle</i>	5	0.5	W

Site	34	Location	115.625, -32.767
Observers	LvG and FdW		
Date	28/06/2016		

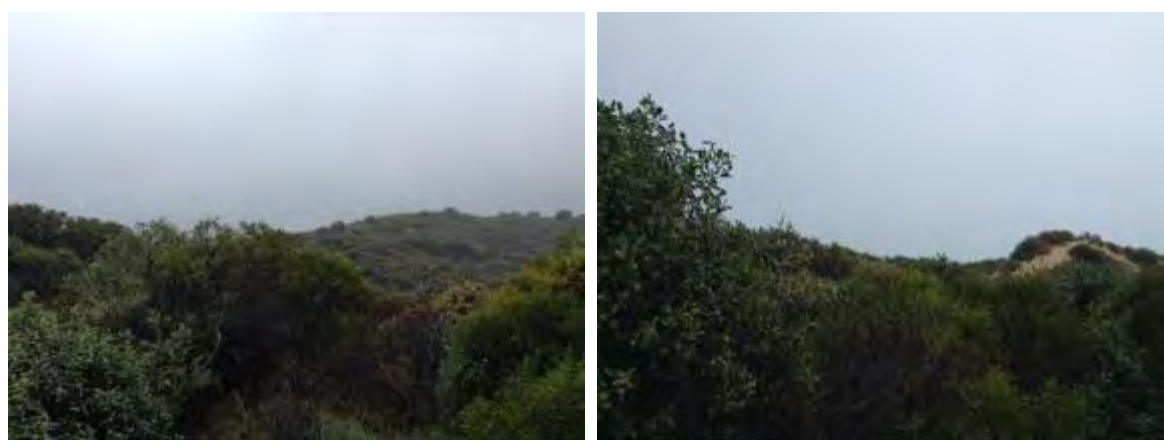
Topography	Sand dune	Soil Colour	Cream
Bare Ground	1	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	VG

Additional notes:

Ground cover weeds

Done from car, torrential rain

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	350	15	TS
	<i>Acacia rostellifera</i>	300	20	TS
	<i>Spyridium globulosum</i>	300	20	TS
	<i>Acacia saligna</i>	200	0	TS
	<i>Olearia axillaris</i>	160	0.5	S
	<i>Anthocercis littorea</i>	150	0	S
	<i>Melaleuca systema</i>	150	0	S
	<i>Phyllanthus calycinus</i>	80	13	S
	<i>Acanthocarpus preissii</i>	40	30	S
*	<i>Trachyandra divaricata</i>	40	5	W
*	<i>Solanum nigrum</i>	5	0.2	W
	<i>Trachymene pilosa</i>	5	0.5	H

Site	35	Location	115.626, -32.772
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Sand dune crest and upper slope	Soil Colour	Cream
Bare Ground	10	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	400	40	T
	<i>Spyridium globulosum</i>	300	10	TS
	<i>Alyxia buxifolia</i>	200	10	S
	<i>Acacia rostelifera</i>	170	15	TS
	<i>Olearia axillaris</i>	150	5	S
	<i>Acanthocarpus preissii</i>	100	10	S
	<i>Diplolaena dampieri</i>	100	7	S
	<i>Hibbertia cuneiformis</i>	80	2	S
*	<i>Trachyandra divaricata</i>	70	7	W
	<i>Scaevola nitida</i>	40	0.5	S
	<i>Phyllanthus calycinus</i>	30	0.5	S
*	<i>Solanum nigrum</i>	15	0.5	W
	<i>Senecio diaschides</i>	10	0.1	H
	<i>Trachymene pilosa</i>	5	0.05	H
	<i>Clematis pubescens</i>	0	0.1	V

Site	36	Location	115.626, -32.773
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Sand dune Swale	Soil Colour	Cream
Bare Ground	10	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Less *Trachyandra divaricata*A

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	450	2	T
	<i>Eucalyptus lehmannii</i>	400	2	T
	<i>Melaleuca sp. (huegelii x raphiophylla)</i>	320	1	TS
	<i>Spyridium globulosum</i>	270	15	TS
	<i>Olearia axillaris</i>	250	3	TS
	<i>Alyxia buxifolia</i>	200	5	S
	<i>Acacia rostellifera</i>	100	4	TS
	<i>Diplolaena dampieri</i>	100	4	S
*	<i>Trachyandra divaricata</i>	80	6	W
	<i>Acacia truncata</i>	70	0	S
	<i>Eucalyptus decipiens</i>	70	2	T
	<i>Leucopogon parviflorus</i>	70	1	S
	<i>Acanthocarpus preissii</i>	60	10	S
	<i>Acrotriche cordata</i>	60	0	S
	<i>Phyllanthus calycinus</i>	60	1	S
	<i>Acacia littorea</i>	50	3	S
	<i>Melaleuca huegelii subsp. huegelii</i>	50	1	S
	<i>Carpobrotus virescens</i>	10	2	H
*	<i>Brassica tournefortii</i>	0.1	0.01	W

Site	37	Location	115.629, -32.773
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Sand dune swale	Soil Colour	Cream
Bare Ground	5	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Photos:

No Photos

Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	450	3	T
	<i>Acacia saligna</i>	400	1	TS
	<i>Olearia axillaris</i>	300	0.5	TS
	<i>Spyridium globulosum</i>	250	3	TS
	<i>Alyxia buxifolia</i>	200	30	S
	<i>Hibbertia cuneiformis</i>	190	5	S
	<i>Hemiandra pungens</i>	150	0.5	S
	<i>Acacia littorea</i>	100	3	S
	<i>Acanthocarpus preissii</i>	70	3	S
*	<i>Trachyandra divaricata</i>	70	1	W
	<i>Acrotriche cordata</i>	60	5	S
	<i>Leucopogon parviflorus</i>	60	5	S
	<i>Scaevola crassifolia</i>	40	0.1	S
	<i>Veronica distans</i>	35	0.02	V
	<i>Poaceae sp.</i>	15	0.01	W
	<i>Orchid sp.</i>	10	0.01	H
*	<i>Solanum nigrum</i>	10	0.1	W
*	<i>Trifolium campestre</i>	7	0.02	W
	<i>Trachymene pilosa</i>	5	0.01	H
	<i>Clematis pubescens</i>	0	0	V
	<i>Hardenbergia comptoniana</i>	0	0.01	V

Site	38	Location	115.632, -32.773
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Dune Swale and drainage	Soil Colour	Cream
Bare Ground	0	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	VG

Additional notes:

Understorey weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	1300	3	T
	<i>Agonis flexuosa</i>	1000	20	T
	<i>Spyridium globulosum</i>	320	1	TS
	<i>Solanum symonii</i>	220	1	TS
	<i>Alyxia buxifolia</i>	170	4	S
	<i>Lepidosperma gladiatum</i>	120	50	Sedge
	<i>Diplolaena dampieri</i>	100	10	S
	<i>Hibbertia cuneiformis</i>	100	3	S
	<i>Leucopogon parviflorus</i>	80	0.5	S
*	<i>Trachyandra divaricata</i>	80	20	W
	<i>Acanthocarpus preissii</i>	50	1	S
*DP	<i>Zantedeschia aethiopica</i>	30	0.01	W
*	<i>Geranium molle</i>	20	1	W
*	<i>Euphorbia peplus</i>	15	0.5	W
*	<i>Euphorbia peplus</i>	10	0.2	W
*	<i>Solanum nigrum</i>	10	0.02	W
	<i>Clematis linearifolia</i>	0	7	V

Site	39	Location	115.636, -32.772
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Flat	Soil Colour	Brown
Bare Ground	4	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand loam	Condition	G

Additional notes:

Understorey weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus sp. (planted)</i>	600	3	T
	<i>Agonis flexuosa</i>	500	20	T
	<i>Xanthorrhoea preissii</i>	300	4	TS
	<i>Hibbertia cuneiformis</i>	120	4	S
*	<i>Trachyandra divaricata</i>	80	10	W
*	<i>Euphorbia peplus</i>	20	3	W
*	<i>Geranium molle</i>	15	3	W
*	<i>Solanum nigrum</i>	15	0.5	W
*	<i>Hypochaeris glabra</i>	1	0.2	W

Site	40	Location	115.644, -32.774
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Wetland	Soil Colour	Black with grey
Bare Ground	1	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	650	2	T
	<i>Agonis flexuosa</i>	600	85	T
	<i>Melaleuca raphiophylla</i>	250	1	T
	<i>Acacia saligna</i>	220	1	TS
	<i>Gahnia trifida</i>	150	2	Sedge
	<i>Juncus kraussii subsp. australiensis</i>	130	95	Sedge
	<i>Olearia axillaris</i>	120	0.5	H
	<i>Haemodorum sp.</i>	120	0.01	S
	<i>Leucopogon parviflorus</i>	100	1	S
	<i>Spyridium globulosum</i>	100	1	S
*	<i>Trachyandra divaricata</i>	70	0.5	W
*	<i>Geranium molle</i>	15	0.05	W
*	<i>Lysimachia arvensis</i>	10	0.05	W
	<i>Orchid sp.</i>	10	0.02	H
	<i>Trachymene pilosa</i>	5	0.02	H
*	<i>Hypochaeris glabra</i>	1	0.02	W
	<i>Hardenbergia comptoniana</i>	0	0.02	V

Site	41	Location	115.645, -32.780
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Ms	Soil Colour	Brown
Bare Ground	1	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	E

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	500	3	TS
	<i>Eucalyptus foecunda</i>	350	5	T
	<i>Acacia rostelifera</i>	300	0	TS
	<i>Xanthorrhoea preissii</i>	300	3	TS
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	270	60	S
* DP	<i>Gomphocarpus fruticosus</i>	250	0.8	W
	<i>Melaleuca systena</i>	170	15	S
	<i>Templetonia retusa</i>	170	15	S
	<i>Leucopogon parviflorus</i>	90	0.2	S

Cons	Taxon	Ht/cm	%A	Form
*	<i>Trachyandra divaricata</i>	70	7	W
	<i>Hibbertia cuneiformis</i>	30	0.1	S
	<i>Thysanotus manglesianus</i>	20	0.01	H
	<i>Poaceae sp.</i>	15	0	W
*	<i>Arctotheca calendula</i>	10	0.2	W
*	<i>Euphorbia peplus</i>	10	0.2	W
*	<i>Geranium molle</i>	10	0.5	W
*	<i>Solanum nigrum</i>	10	0.5	W
*	<i>Trifolium campestre</i>	5	0.1	W
*	<i>Lysimachia arvensis</i>	5	0.5	W
	<i>Orchid sp.</i>	5	0	H
*	<i>Hypochaeris glabra</i>	1	0.2	W
	<i>Clematis linearifolia</i>	0	0.2	V
	<i>Clematis pubescens</i>	0	0.2	V
	<i>Hardenbergia comptoniana</i>	0	0.2	V

Site	42a	Location	115.652, -32.793
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Hilltop	Soil Colour	Brown
Bare Ground	1	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand loam	Condition	VG

Additional notes:

Still weeds present

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	400	0.5	T
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	250	7	TS
	<i>Xanthorrhoea preissii</i>	200	0.2	TS
* DP	<i>Gomphocarpus fruticosus</i>	170	1	W
	<i>Hakea prostrata</i>	150	1	S
	<i>Templetonia retusa</i>	150	3	S
	<i>Melaleuca systema</i>	120	7	S
	<i>Melaleuca systema</i>	100	55	S
*	<i>Trachyandra divaricata</i>	80	3	W
	<i>Pimelea</i> sp.	40	0.01	S
	<i>Hibbertia racemosa</i>	30	0.01	S
*	<i>Trifolium campestre</i>	10	0.5	W
*	<i>Geranium molle</i>	10	0.1	W
*	<i>Hypochaeris glabra</i>	1	0.1	W
	<i>Lagenophora huegelii</i>	1	0.1	H
	<i>Clematis linearifolia</i>	0	0.5	V

Site	42b	Location	115.652, -32.794
Observers	LvG and FdW		
Date	28/06/2016		

Topography	N/A	Soil Colour	N/A
Bare Ground	N/A	Condition	N/A
Cryptogram	N/A	Fire	N/A
Soil Type	N/A	Condition	N/A

Additional notes:

Isolated stands of *Euc foecunda*

Photos:



Site	43	Location	115.633, -32.778
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Sand dune us	Soil Colour	Brown
Bare Ground	4	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Some weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Acacia rostellifera</i>	350	30	TS
	<i>Melaleuca systema</i>	130	6	S
	<i>Xanthorrhoea preissii</i>	130	2	S
	<i>Hibbertia cuneiformis</i>	120	1	S
	<i>Acanthocarpus preissii</i>	80	0.1	S
	<i>Spyridium globulosum</i>	80	0.01	S
	<i>Leucopogon parviflorus</i>	70	0.5	S
	<i>Phyllanthus calycinus</i>	70	7	S
*	<i>Trachyandra divaricata</i>	70	2	W
	<i>Lomandra maritima</i>	30	6	H
*	<i>Arctotheca calendula</i>	10	0.1	W
	<i>Orchid sp.</i>	10	0.01	H
*	<i>Solanum nigrum</i>	10	0.2	W
	<i>Thysanotus manglesianus</i>	10	0.1	H
*	<i>Lysimachia arvensis</i>	5	0.5	W
	<i>Trachymene pilosa</i>	5	0.1	H
*	<i>Hypochoeris glabra</i>	1	0.1	W
	<i>Clematis linearifolia</i>	0	4	V
	<i>Hardenbergia comptoniana</i>	0	0.1	V

Site	44	Location	115.629, -32.777
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Wetland	Soil Colour	N/A
Bare Ground	N/A	Condition	N/A
Cryptogram	N/A	Fire	10+
Soil Type	N/A	Condition	VG

Additional notes:

Planted and weeds dominate ground cover. Drainage line, planted Eucalypts, Grevillea and Acacia over *Trachyandra divaricata*. Some natives (*Hibbertia cuneiformis*, *Acanthocarpus preissii*, *Xanthorrhoea preissii*).

Photos:



Site	45	Location	115.628, -32.769
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Dune Swale	Soil Colour	Brown
Bare Ground	10	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	VG

Additional notes:

Weeds, eucalypts are planted

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	800	30	T
	<i>Eucalyptus platypus</i>	800	1	T
	<i>Acacia rostellifera</i>	210	1	TS
	<i>Spyridium globulosum</i>	150	3	TS
	<i>Hibbertia cuneiformis</i>	120	0.5	S
	<i>Melaleuca systema</i>	100	10	S
	<i>Rhagodia baccata subsp. baccata</i>	100	5	V
*	<i>Trachyandra divaricata</i>	70	20	W
	<i>Leucopogon parviflorus</i>	40	0.5	S

Cons	Taxon	Ht/cm	%A	Form
	<i>Phyllanthus calycinus</i>	40	0.1	S
	<i>Acanthocarpus preissii</i>	20	0.1	S
*	<i>Geranium molle</i>	15	0.1	W
	<i>Orchid sp.</i>	10	0.01	H
	<i>Senecio diaschides</i>	10	0.01	H
	<i>Thysanotus manglesianus</i>	10	0.05	H
*	<i>Trifolium campestre</i>	5	0.05	W
	<i>Trachymene pilosa</i>	3	0.05	H
	<i>Cassutha racemosa</i>	0	0.01	V
	<i>Clematis linearifolia</i>	0	1	V

Site	46	Location	115.628, -32.768
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Sand dune us	Soil Colour	Cream
Bare Ground	2	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Dark green is dense spyridium. More open is more diverse understorey

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	400	5	T
	<i>Eucalyptus platypus</i>	400	8	T
	<i>Spyridium globulosum</i>	250	60	TS
	<i>Leucopogon parviflorus</i>	150	1	S
	<i>Olearia axillaris</i>	120	1	S
	<i>Acrotriche cordata</i>	100	1	S
	<i>Comesperma ?flavum</i>	90	0.02	S
	<i>Trymalium ledifolium var. ledifolium</i>	90	0.1	S
	<i>Acacia littorea</i>	80	0.5	S

Cons	Taxon	Ht/cm	%A	Form
	<i>Alyxia buxifolia</i>	80	1	S
	<i>Templetonia retusa</i>	80	0.5	S
	<i>Lomandra maritima</i>	70	30	H
	<i>Acanthocarpus preissii</i>	60	3	S
	<i>Melaleuca systema</i>	60	1	S
	<i>Lepidosperma squamatum</i>	50	0.1	Sedge
	<i>Phyllanthus calycinus</i>	50	0.5	S
P3	<i>Stylidium maritimum</i>	30	0.05	H
	<i>Desmocladius flexuosus</i>	20	0.05	H
*	<i>Trifolium campestre</i>	5	0.1	W
	<i>Trachymene pilosa</i>	5	10	H
	<i>Cassutha racemosa</i>	0	0.1	V

Site	47	Location	115.627, -32.768
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Sand dune crest	Soil Colour	Cream
Bare Ground	15	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	200	2	TS
	<i>Spyridium globulosum</i>	100	4	TS
	<i>Templetonia retusa</i>	100	5	S
	<i>Jacksonia furcellata</i>	90	0.1	S
	<i>Acrotriche cordata</i>	80	5	S
	<i>Leucopogon parviflorus</i>	70	1	S
	<i>Melaleuca systema</i>	70	5	S
	<i>Acacia cochlearis</i>	60	5	S
	<i>Acanthocarpus preissii</i>	60	10	S
	<i>Trymalium ledifolium</i> var. <i>ledifolium</i>	50	0.1	S
	<i>Hemiandra pungens</i>	30	4	S
	<i>Pimelea ferruginea</i>	30	0.8	S
P3	<i>Stylidium maritimum</i>	30	0.1	H
	<i>Acacia littorea</i>	20	0.5	S
	<i>Veronica distans</i>	20	0.01	V
	<i>Lomandra maritima</i>	20	9	H
	<i>Cryptandra mutila</i>	5	0.01	S
	<i>Cassytha racemosa</i>	0	0.5	V

Site	48	Location	115.627, -32.778
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Dune swale	Soil Colour	Cream
Bare Ground	3	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	400	6	T
	<i>Acacia rostellifera</i>	300	5	TS
	<i>Acacia rostellifera</i>	200	15	TS
	<i>Alyxia buxifolia</i>	200	1	TS
	<i>Spyridium globulosum</i>	200	1	TS
	<i>Diplolaena dampieri</i>	170	50	S
	<i>Leucopogon parviflorus</i>	150	0.5	S
	<i>Acanthocarpus preissii</i>	100	30	S
	<i>Opercularia hispidula</i>	100	0.2	S

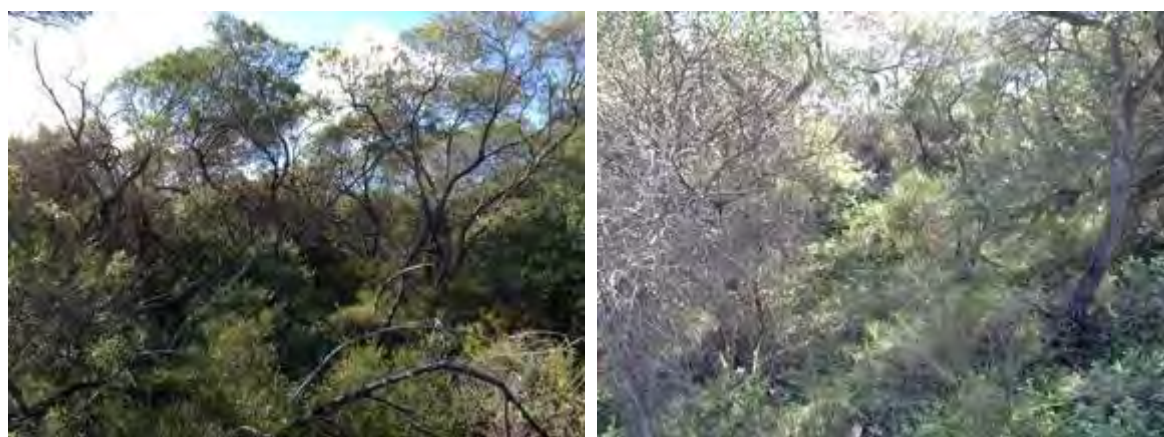
Cons	Taxon	Ht/cm	%A	Form
	<i>Rhagodia baccata subsp. baccata</i>	90	2	S
	<i>Phyllanthus calycinus</i>	80	1	S
*	<i>Trachyandra divaricata</i>	80	10	W
	<i>Lepidosperma squamatum</i>	40	0.01	Sedge
*	<i>Solanum nigrum</i>	15	5	W
	<i>Orchid sp.</i>	10	0.01	H
	<i>Senecio diaschides</i>	10	0.1	H
	<i>Trachymene pilosa</i>	5	0.1	H
	<i>Clematis linearifolia</i>	0	2	V
	<i>Clematis pubescens</i>	0	1	V

Site	49	Location	115.629, -32.781
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Sand dune ms	Soil Colour	Cream
Bare Ground	2	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	450	2	T
	<i>Acacia rostellifera</i>	400	30	TS
	<i>Spyridium globulosum</i>	300	30	TS
	<i>Acacia rostellifera</i>	200	0.2	TS
	<i>Acanthocarpus preissii</i>	120	25	S
	<i>Melaleuca systema</i>	120	5	S
	<i>Leucopogon parviflorus</i>	100	3	S
	<i>Phyllanthus calycinus</i>	90	8	S
*	<i>Trachyandra divaricata</i>	80	4	W
	<i>Tetraria octandra</i>	40	0.1	Sedge
	<i>Hibbertia cuneiformis</i>	20	0.2	S
	<i>Leucopogon nutans</i>	20	0.1	S
	<i>Lomandra maritima</i>	20	0.1	H
*	<i>Solanum nigrum</i>	15	1	W
	<i>Orchid sp.</i>	10	0.01	H
	<i>Poaceae sp.</i>	10	0.02	G
	<i>Senecio diaschides</i>	10	0.02	H
*	<i>Trifolium campestre</i>	5	0.01	W

Cons	Taxon	Ht/cm	%A	Form
	<i>Trachymene pilosa</i>	5	0.02	H
	<i>Hardenbergia comptoniana</i>	0	0.1	V

Site	50	Location	115.628, -32.782
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Sand dune us	Soil Colour	Cream
Bare Ground	4	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Spyridium globulosum</i>	300	20	TS
	<i>Acacia rostellifera</i>	250	0	TS
	<i>Olearia axillaris</i>	250	2	TS
	<i>Alyxia buxifolia</i>	230	3	S
	<i>Rhagodia baccata subsp. baccata</i>	210	2	V
	<i>Diplolaena dampieri</i>	190	20	S
	<i>Threlkeldia diffusa</i>	160	0.5	H
	<i>Acanthocarpus preissii</i>	100	1	S
	<i>Melaleuca systema</i>	90	0.5	S
*	<i>Trachyandra divaricata</i>	70	0.1	W
	<i>Phyllanthus calycinus</i>	60	0.2	S
	<i>Leucopogon parviflorus</i>	50	0	S
	<i>Tetragia octandra</i>	40	0.1	Sedge
*	<i>Geranium molle</i>	15	0.02	W
	<i>Senecio diaschides</i>	15	0.02	H
*	<i>Solanum nigrum</i>	15	0.8	W
	<i>Trachymene pilosa</i>	5	0.02	H
	<i>Cassytha racemosa</i>	0	0.5	V
	<i>Hardenbergia comptoniana</i>	0	1.5	V

Site	51	Location	115.629, -32.785
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Sand dune crest	Soil Colour	Cream
Bare Ground	40	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Rabbits

Photos:



Site	52	Location	115.629, -32.790
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Sand dune ms	Soil Colour	Brown
Bare Ground	5	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Acacia rostellifera</i>	350	25	TS
	<i>Spyridium globulosum</i>	275	10	TS
	<i>Alyxia buxifolia</i>	170	0.5	S
	<i>Olearia axillaris</i>	170	1	S
	<i>Rhagodia baccata subsp. baccata</i>	120	8	V
	<i>Acanthocarpus preissii</i>	80	5	SS
	<i>Hibbertia cuneiformis</i>	80	0.2	S
	<i>Phyllanthus calycinus</i>	80	6	S
*	<i>Trachyandra divaricata</i>	70	8	W
	<i>Melaleuca systena</i>	60	1	S
	<i>Leucopogon parviflorus</i>	50	1	S
	<i>Tetraria octandra</i>	30	0.02	Sedge
	<i>Veronica distans</i>	25	0.01	V
	<i>Threlkeldia diffusa</i>	20	0.1	H
	<i>Opercularia hispidula</i>	20	0.1	H
	<i>Orchid sp.</i>	15	0.01	H
	<i>Senecio diaschides</i>	15	0.02	H
*	<i>Lysimachia arvensis</i>	5	0	W
*	<i>Solanum nigrum</i>	5	0.1	W

Cons	Taxon	Ht/cm	%A	Form
	<i>Trachymene pilosa</i>	5	0.01	H
	<i>Clematis linearifolia</i>	0	2	V

Site	53	Location	115.632, -32.793
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Sand dune ms	Soil Colour	Brown
Bare Ground	3	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	VG

Additional notes:

Some weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	500	15	T
	<i>Spyridium globulosum</i>	240	8	TS
	<i>Acacia rostellifera</i>	220	8	TS
	<i>Acacia saligna</i>	200	0.5	TS
	<i>Rhagodia baccata subsp. baccata</i>	160	1	V
	<i>Hibbertia cuneiformis</i>	130	8	S
	<i>Melaleuca systena</i>	100	10	S
	<i>Acanthocarpus preissii</i>	80	5	S
*	<i>Trachyandra divaricata</i>	70	10	W

Cons	Taxon	Ht/cm	%A	Form
	<i>Leucopogon parviflorus</i>	60	0.1	S
	<i>Phyllanthus calycinus</i>	50	7	S
	<i>Lomandra maritima</i>	30	0.2	H
*	<i>Arctotheca calendula</i>	15	0.1	W
*	<i>Geranium molle</i>	15	0.1	W
	<i>Orchid sp.</i>	10	0.01	H
*	<i>Solanum nigrum</i>	10	1	W
*	<i>Trifolium campestre</i>	5	0.02	W
*	<i>Lysimachia arvensis</i>	5	0.05	W
	<i>Trachymene pilosa</i>	5	0.02	H
	<i>Cassytha racemosa</i>	0	0.1	V
	<i>Clematis linearifolia</i>	0	0.5	V
	<i>Hardenbergia comptoniana</i>	0	1	V

Site	54	Location	115.637, -32.793
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Sand dune ms	Soil Colour	Cream
Bare Ground	7	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Bare areas of weeds only in sight

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	350	0.5	T
	<i>Acacia rostellifera</i>	300	25	TS
	<i>Acanthocarpus preissii</i>	80	3	S
	<i>Cryptandra mutila</i>	80	0.02	S
	<i>Templetonia retusa</i>	60	2	S
	<i>Leucopogon parviflorus</i>	50	0.1	S
	<i>Melaleuca systema</i>	50	30	S
	<i>Phyllanthus calycinus</i>	50	8	S
	<i>Lepidosperma squamatum</i>	40	0	Sedge
*	<i>Trachyandra divaricata</i>	40	1	W
	<i>Lomandra maritima</i>	30	20	H
	<i>Orchid sp.</i>	10	0.01	H
*	<i>Arctotheca calendula</i>	5	0.2	W
*	<i>Trifolium campestre</i>	5	0.2	W
*	<i>Lysimachia arvensis</i>	5	0.2	W
	<i>Trachymene pilosa</i>	5	0.2	H
	<i>Clematis linearifolia</i>	0	2	V

Site	55	Location	115.657, -32.807
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Wetland	Soil Colour	Black brown
Bare Ground	3	Condition	Waterlogged
Cryptogram	N/A	Fire	10+
Soil Type	Loam	Condition	VG

Additional notes:

Weeds, lacking structure

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Melaleuca teretifolia</i>	230	10	TS
	<i>Melaleuca raphiophylla</i>	230	30	TS
	<i>Melaleuca lanceolata</i>	200	3	TS
	<i>Gahnia trifida</i>	160	60	Sedge
*	<i>Trachyandra divaricata</i>	50	2	W
*	<i>Dittrichia graveolens</i>	30	2	W
*	<i>Arctotheca calendula</i>	5	2	W
*	<i>Trifolium campestre</i>	5	3	W
*	<i>Geranium molle</i>	5	1	W
*	<i>Hypochaeris glabra</i>	5	5	W
*	<i>Lysimachia arvensis</i>	5	3	W
*	<i>Brassica tournefortii</i>	0.1	1	W
	<i>Clematis linearifolia</i>	0	1	V

Site	56	Location	115.654, -32.811
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Ms	Soil Colour	Light brown
Bare Ground	5	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	VG

Additional notes:

Rows of cleared veg

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Acacia cyclops</i>	500	5	TS
	<i>Banksia sessilis var. cygnorum</i>	500	8	TS
	<i>Hakea prostrata</i>	300	10	S
	<i>Xanthorrhoea preissii</i>	200	30	TS
	<i>Hakea ruscifolia</i>	180	1	S
	<i>Spyridium globulosum</i>	180	2	TS
	<i>Solanum symonii</i>	160	1	TS
	<i>Hibbertia cuneiformis</i>	100	5	S
	<i>Templetonia retusa</i>	100	15	S
	<i>Acacia pulchella</i>	80	0.05	S
	<i>Melaleuca systema</i>	80	15	S
*	<i>Trachyandra divaricata</i>	70	1	W
	<i>Desmocladius flexuosus</i>	50	0.01	H
	<i>Phyllanthus calycinus</i>	50	0.5	S
	<i>Hibbertia hypericoides</i>	40	4	S
	<i>Astroloma pallidum</i>	30	0.02	S
*	<i>Avena barbata</i>	30	0.1	W
	<i>Hibbertia racemosa</i>	30	0.1	S

Cons	Taxon	Ht/cm	%A	Form
*	<i>Geranium molle</i>	20	1	W
*	<i>Euphorbia peplus</i>	10	1	W
*	<i>Solanum nigrum</i>	10	0.2	W
*	<i>Arctotheca calendula</i>	5	0.5	W
*	<i>Lysimachia arvensis</i>	5	1	W
*	<i>Hypochaeris glabra</i>	1	4	W
*	<i>Brassica tournefortii</i>	0.1	1	W
	<i>Clematis linearifolia</i>	0	2	V

Site	57	Location	115.648, -32.804
Observers	LvG and FdW		
Date	30/06/2016		

Topography	Secondary dune crest	Soil Colour	Orange
Bare Ground	4	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	VG

Additional notes:

Altered structure from linear row clearing

Photos:



Cons	Taxon	Ht/cm	%A	Form
	Acacia saligna	500	1	TS
	Agonis flexuosa	450	5	T
	Agonis flexuosa	300	3	T
	Banksia sessilis var. cygnorum	270	0.2	TS
	Acacia littorea	200	2	S
	Hakea prostrata	200	0.2	TS
	Spyridium globulosum	200	15	TS
	Templetonia retusa	200	4	TS
	Hibbertia cuneiformis	180	8	S
	Hibbertia cuneiformis	180	8	S
	Olearia axillaris	170	4	S
	Xanthorrhoea preissii	170	0.5	S
	Alyxia buxifolia	130	1	S
* DP	Gomphocarpus fruticosus	120	0.01	W
	Melaleuca systema	120	50	S
	Jacksonia furcellata	110	0.5	S
	Acacia cochlearis	80	8	S
	Melaleuca systema	80	4	S

Cons	Taxon	Ht/cm	%A	Form
	<i>Leucopogon parviflorus</i>	70	2	S
	<i>Phyllanthus calycinus</i>	70	1	S
	<i>Phyllanthus calycinus</i>	70	4	S
*	<i>Trachyandra divaricata</i>	70	0.4	W
*	<i>Trachyandra divaricata</i>	70	7	W
	<i>Acanthocarpus preissii</i>	60	3	S
	<i>Acacia cyclops</i>	40	0	S
	<i>Lomandra maritima</i>	20	0.5	H
P3	<i>Stylidium maritimum</i>	20	0.5	H
	<i>Carpobrotus virescens</i>	15	0.5	H
	<i>Desmodium flexuosus</i>	15	0.2	H
*	<i>Euphorbia peplus</i>	15	1	W
	Poaceae sp.	15	0.1	G
*	<i>Geranium molle</i>	10	1	W
	<i>Hibbertia racemosa</i>	10	0	S
	<i>Senecio dioschides</i>	10	0.01	H
*	<i>Solanum nigrum</i>	10	0.2	W
*	<i>Arctotheca calendula</i>	5	0.5	W
*	<i>Lysimachia arvensis</i>	5	0.2	W
*	<i>Solanum nigrum</i>	5	0.2	W
*	<i>Hypochaeris glabra</i>	1	1	W
*	<i>Brassica tournefortii</i>	0.1	0.5	W
	<i>Clematis linearifolia</i>	0	2	V
	<i>Hardenbergia comptoniana</i>	0	0.5	V

Site	58	Location	115.648, -32.802
Observers	LvG and FdW		
Date	30/06/2016		

Topography	Ms	Soil Colour	Orange
Bare Ground	1	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	VG

Additional notes:

Clearing of rows

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Acacia saligna</i>	500	1	TS
	<i>Nuytsia floribunda</i>	450	4	T
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	270	0.2	TS
	<i>Hakea prostrata</i>	200	0.2	TS
	<i>Templetonia retusa</i>	200	4	TS
	<i>Hibbertia cuneiformis</i>	180	8	S
	<i>Xanthorrhoea preissii</i>	170	0.5	S
* DP	<i>Gomphocarpus fruticosus</i>	120	0.01	W
	<i>Melaleuca systena</i>	120	50	S
	<i>Phyllanthus calycinus</i>	70	4	S
*	<i>Trachyandra divaricata</i>	70	7	W
	<i>Acacia cyclops</i>	40	0	S
*	<i>Euphorbia peplus</i>	15	1	W
	<i>Poaceae</i> sp.	15	0.1	G
*	<i>Geranium molle</i>	10	1	W
	<i>Hibbertia racemosa</i>	10	0	S
*	<i>Solanum nigrum</i>	10	0.2	W
*	<i>Arctotheca calendula</i>	5	0.5	W

Cons	Taxon	Ht/cm	%A	Form
*	<i>Lysimachia arvensis</i>	5	0.2	W
*	<i>Hypochaeris glabra</i>	1	1	W
*	<i>Brassica tournefortii</i>	0.1	0.5	W
	<i>Clematis linearifolia</i>	0	2	V

Site	59	Location	115.651, -32.813
Observers	LvG and FdW		
Date	30/06/2016		

Topography	Ms	Soil Colour	Brown
Bare Ground	1	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand loam	Condition	VG

Additional notes:

Row clearing, weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus decipiens</i>	800	0.1	T
	<i>Agonis flexuosa</i>	500	5	T
	<i>Nuytsia floribunda</i>	450	0	T
	<i>Banksia sessilis var. cygnorum</i>	350	5	TS
	<i>Hakea prostrata</i>	350	4	TS
* DP	<i>Gomphocarpus fruticosus</i>	200	2	W
	<i>Templetonia retusa</i>	200	10	TS
	<i>Xanthorrhoea preissii</i>	200	10	TS
	<i>Hibbertia cuneiformis</i>	170	15	S
	<i>Melaleuca systema</i>	130	30	S
	<i>Leucopogon parviflorus</i>	120	0.2	
*	<i>Trachyandra divaricata</i>	70	30	W
*	<i>Solanum nigrum</i>	60	3	W
	<i>Hibbertia racemosa</i>	40	0.2	S
*	<i>Euphorbia peplus</i>	10	10	W
*	<i>Euphorbia peplus</i>	10	10	W
*	<i>Lupinus sp.</i>	10	0	W
*	<i>Brassica tournefortii</i>	1	0	W

Cons	Taxon	Ht/cm	%A	Form
*	<i>Hypochaeris glabra</i>	1	1	W
	<i>Trachymene pilosa</i>	1	0.01	H
*	<i>Arctotheca calendula</i>	0.5	1	W
	<i>Clematis linearifolia</i>	0	0.5	V

Site	60	Location	
Observers	LvG and FdW		
Date	30/06/2016		

Topography		Soil Colour	
Bare Ground		Condition	
Cryptogram		Fire	
Soil Type		Condition	

Additional notes:

Photos:

Cons	Taxon	Ht/cm	%A	Form
	<i>Hakea prostrata</i>	270	6	TS
	<i>Templetonia retusa</i>	220	10	TS
	<i>Banksia sessilis var. cygnorum</i>	200		TS
	<i>Acacia cochlearis</i>	170	0.5	S
* DP	<i>Gomphocarpus fruticosus</i>	150	0.2	W
	<i>Hibbertia cuneiformis</i>	150	10	S
	<i>Melaleuca systema</i>	120	40	S
*	<i>Trachyandra divaricata</i>	70	7	W
	<i>Phyllanthus calycinus</i>	60	0.2	S
	<i>Hibbertia racemosa</i>	50	0.2	S
*	<i>Dittrichia graveolens</i>	30	0	W
*	<i>Euphorbia peplus</i>	10	1	W
*	<i>Lupinus sp.</i>	10	0.1	W
*	<i>Brassica tournefortii</i>	1	0	W
*	<i>Hypochaeris glabra</i>	1	1	W
	<i>Trachymene pilosa</i>	1	0.01	H
*	<i>Arctotheca calendula</i>	0.5	1	W

Site	61	Location	115.653, -32.817
Observers	LvG and FdW		
Date	30/06/2016		

Topography	Us	Soil Colour	Brown
Bare Ground	0	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	VG

Additional notes:

Cleared rows, weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus decipiens</i>	600	0	T
	<i>Agonis flexuosa</i>	350	1	T
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	270	4	TS
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	220	3	TS
	<i>Spyridium globulosum</i>	200	0	TS
	<i>Templetonia retusa</i>	200	10	TS
* DP	<i>Gomphocarpus fruticosus</i>	150	0.2	W
	<i>Hibbertia cuneiformis</i>	120	8	S
	<i>Melaleuca systena</i>	120	50	S
	<i>Xanthorrhoea preissii</i>	110	0.5	S
* DP	<i>Gomphocarpus fruticosus</i>	100	0.1	W
	<i>Leucopogon parviflorus</i>	100	0.5	
	<i>Phyllanthus calycinus</i>	80	1	S
*	<i>Trachyandra divaricata</i>	60	7	W
	<i>Grevillea preissii</i> subsp. <i>preissii</i>	40	0.1	S
*	<i>Dittrichia graveolens</i>	30	0	W
	<i>Hibbertia racemosa</i>	30	0	S
	<i>Senecio diaschides</i>	15	0.01	H

Cons	Taxon	Ht/cm	%A	Form
	<i>Hakea prostrata</i>	10	0.02	S
	<i>Poaceae sp.</i>	10	0.02	G
*	<i>Geranium molle</i>	5	0.5	W
*	<i>Hypochaeris glabra</i>	5	0.5	W
*	<i>Lysimachia arvensis</i>	5	0.5	W
*	<i>Arctotheca calendula</i>	0.5	0.05	W
*	<i>Brassica tournefortii</i>	0.1	0.1	W

Site	62	Location	115.655, -32.815
Observers	LvG and FdW		
Date	30/06/2016		

Topography	Ls	Soil Colour	Dark brown
Bare Ground	0	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Loam sand	Condition	VG

Additional notes:

Cleared rows, weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	1800	2	T
	<i>Agonis flexuosa</i>	1100	40	T
	<i>Eucalyptus marginata</i>	700	20	T
	<i>Xanthorrhoea preissii</i>	190	5	S
	<i>Hibbertia cuneiformis</i>	140	8	S
	<i>Macrozamia riedlei</i>	100	1	S
	<i>Melaleuca systema</i>	100	0.2	S
	<i>Hibbertia hypericoides</i>	80	3	
	<i>Hakea lissocarpha</i>	60	1	S
	<i>Senecio diaschides</i>	30	0.01	H
*	<i>Geranium molle</i>	10	0.02	W
	<i>Orchid sp.</i>	10	0.01	H
	<i>Poaceae sp.</i>	10	0.02	G
*	<i>Lysimachia arvensis</i>	5	0.05	W
*	<i>Hypochaeris glabra</i>	1	0.02	W
	<i>Hardenbergia comptoniana</i>	0	2	V

Site	63	Location	115.653, -32.813
Observers	LvG and FdW		
Date	30/06/2016		

Topography	Us to ms	Soil Colour	Brown
Bare Ground	N/A	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	VG

Additional notes:

Cleared rows

Mosaic of varying densities of species captured in this site. Trees often clustered or isolated single occurrences. *Mel huegelii* on crests, *xanth pressii* on lower slopes.

Photos:



Cons	Taxon	Ht/cm	%A	Form
*	<i>Trifolium campestre</i>	5		W
*	<i>Brassica tournefortii</i>	0.1		W
	<i>Clematis linearifolia</i>	0		V
	<i>Agonis flexuosa</i>			T
*	<i>Arctotheca calendula</i>			W
	<i>Banksia sessilis</i> var. <i>cygnorum</i>			TS
*	<i>Dittrichia graveolens</i>			W
*	<i>Euphorbia peplus</i>			W
*	<i>Geranium molle</i>			W
* DP	<i>Gomphocarpus fruticosus</i>			W
	<i>Grevillea preissii</i> subsp. <i>preissii</i>			S
	<i>Hakea prostrata</i>			S
	<i>Hibbertia racemosa</i>			S
	<i>Hibbertia cuneiformis</i>			S
*	<i>Hypochaeris glabra</i>			W
	<i>Leucopogon parviflorus</i>			
*	<i>Lysimachia arvensis</i>			W

Cons	Taxon	Ht/cm	%A	Form
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>			TS
	<i>Melaleuca systema</i>			S
	<i>Phyllanthus calycinus</i>			S
	<i>Poaceae</i> sp.			G
	<i>Lepidosperma squamatum</i>			Sedge
	<i>Spyridium globulosum</i>			TS
	<i>Templetonia retusa</i>			S
*	<i>Trachyandra divaricata</i>			W
	<i>Xanthorrhoea preissii</i>			TS



Appendix G

Vascular Flora Species
List, 2016

Appendix G Vascular Flora Species List for Lake Clifton including ENV (2009) and the 2016 Survey

Family	Weed	Taxon	AECOM	ENV (2009)
Aizoaceae		* <i>Carpobrotus edulis</i>		X
		<i>Carpobrotus virescens</i>	X	
		<i>Tetragonia decumbens</i>		X
Anthericaceae		<i>Dichopogon</i> sp.		X
Apiaceae		? <i>Daucus glochidiatus</i>	X	
		<i>Daucus glochidiatus</i>		X
		<i>Hydrocotyle tetragonocarpa</i>		X
		<i>Pentapeltis peltigera</i>	X	
Apocynaceae		<i>Alyxia buxifolia</i>	X	X
		* <i>Gomphocarpus fruticosus</i>	X	X
Araceae		* <i>Zantedeschia aethiopica</i>	X	
Araliaceae		<i>Trachymene pilosa</i>	X	X
Asparagaceae		<i>Acanthocarpus preissii</i>	X	X
		<i>Lomandra maritima</i>	X	X
		<i>Lomandra micrantha</i>	X	
		<i>Lomandra suaveolens</i>		X
		<i>Thysanotus manglesianus</i>	X	
Asphodelaceae		* <i>Trachyandra divaricata</i>	X	X
Asteraceae		? <i>Senecio pinnatifolius</i> var. <i>latilobus</i>		X
		* <i>Arctotheca calendula</i>	X	X
		<i>Asteridea pulverulenta</i>		X
		* <i>Cirsium vulgare</i>		X
		* <i>Conyza</i> sp.		X
		* <i>Dittrichia graveolens</i>	X	
		* <i>Hypochaeris glabra</i>	X	X
		<i>Lagenophora huegelii</i>	X	
		<i>Leptorhynchos scaber</i>		X
		<i>Olearia axillaris</i>	X	X
		<i>Podolepis gracilis</i>		X
		<i>Senecio diaschides</i>	X	
		<i>Senecio pinnatifolius</i> var. <i>latilobus</i>		X
		<i>Senecio pinnatifolius</i> var. <i>pinnatifolius</i>		X
		* <i>Sonchus asper</i>		X
		* <i>Sonchus oleraceus</i>	X	X
		* <i>Ursinia anthemoides</i>	X	
Brassicaceae		* <i>Brassica tournefortii</i>	X	
		* <i>Cakile maritima</i>		X
		* <i>Heliophila pusilla</i>		X
Campanulaceae		* <i>Wahlenbergia capensis</i>		X
Caryophyllaceae		* <i>Cerastium glomeratum</i>		X
		* <i>Petrorhagia dubia</i>		X
		* <i>Polycarpon tetraphyllum</i>		X
Casuarinaceae		<i>Allocasuarina fraseriana</i>	X	X
Celastraceae		<i>Stackhousia</i> sp.	X	
Chenopodiaceae		<i>Rhagodia baccata</i> subsp. <i>baccata</i>	X	X
		<i>Sarcocornia blackiana</i>	X	

Appendix G Vascular Flora Species List for Lake Clifton including ENV (2009) and the 2016 Survey

Family	Weed	Taxon	AECOM	ENV (2009)
		<i>Threlkeldia diffusa</i>	X	X
Crassulaceae		<i>Crassula colorata</i>		X
		<i>Crassula colorata</i> var. <i>acuminata</i>		X
	*	<i>Crassula glomerata</i>		X
		<i>Crassula</i> sp.		X
Cupressaceae		<i>Callitris preissii</i>	X	
Cyperaceae		<i>Baumea articulata</i>		X
		<i>Baumea juncea</i>	X	
		<i>Baumea vaginalis</i>		X
		<i>Ficinia nodosa</i>		X
		<i>Gahnia trifida</i>	X	X
	*	<i>Isolepis marginata</i>		X
		<i>Lepidosperma ?pubisquameum</i>		X
		<i>Lepidosperma gladiatum</i>	X	X
		<i>Lepidosperma squamatum</i>	X	
		<i>Lepyrodia drummondiana</i>	X	
		<i>Tetraria octandra</i>	X	X
Dilleniaceae		<i>Hibbertia cuneiformis</i>	X	X
		<i>Hibbertia huegelii</i>		X
		<i>Hibbertia hypericoides</i>	X	X
		<i>Hibbertia racemosa</i>	X	X
Droseraceae		<i>Drosera erythrorhiza</i>	X	
		<i>Drosera macrantha</i>	X	
Ericaceae		<i>Acrotriche cordata</i>	X	X
		<i>Astroloma pallidum</i>	X	
		<i>Conostephium pendulum</i>		X
		<i>Leucopogon nutans</i>	X	
		<i>Leucopogon parviflorus</i>	X	X
		<i>Leucopogon propinquus</i>	X	X
Euphorbiaceae		* <i>Euphorbia paralias</i>		X
	*	<i>Euphorbia peplus</i>	X	
	*	<i>Euphorbia terracina</i>	X	
		? <i>Monotaxis</i> sp.		X
Fabaceae		<i>Acacia cochlearis</i>	X	X
		<i>Acacia cyclops</i>	X	X
		<i>Acacia littorea</i>	X	
		<i>Acacia pulchella</i>	X	X
		<i>Acacia rostellifera</i>	X	X
		<i>Acacia saligna</i>	X	X
		<i>Acacia truncata</i>	X	X
		<i>Hardenbergia comptoniana</i>	X	X
		<i>Jacksonia furcellata</i>	X	X
		<i>Kennedia coccinea</i>	X	
	*	<i>Lotus angustissimus</i>		X
	*	<i>Lotus subbiflorus</i>	X	X
	*	<i>Lupinus</i> sp.	X	
		<i>Mellilotus albus</i>		X
		<i>Mellilotus indicus</i>		X
		<i>Templetonia retusa</i>	X	X
	*	<i>Trifolium campestre</i>	X	X
	*	<i>Trifolium campestre</i> var. <i>campestre</i>		X
	*	<i>Trifolium fragiferum</i> var. <i>fragiferum</i>		X
	*	<i>Trifolium</i> sp.		X

Appendix G Vascular Flora Species List for Lake Clifton including ENV (2009) and the 2016 Survey

Family	Weed	Taxon	AECOM	ENV (2009)
Fumariaceae		* <i>Fumaria</i> sp.		X
Geraniaceae		* <i>Geranium molle</i>	X	X
		<i>Geranium retrorsum</i>		X
Goodeniaceae		<i>Goodenia pulchella</i>	X	
		<i>Scaevola crassifolia</i>	X	X
		<i>Scaevola nitida</i>	X	
Haemodoraceae		<i>Conostylis candidans</i> subsp. <i>calcicola</i>		X
		<i>Haemodorum</i> sp.	X	
Iridaceae		<i>Patersonia occidentalis</i>	X	
Juncaceae		<i>Juncus kraussii</i> subsp. <i>australiensis</i>	X	X
		<i>Juncus pallidus</i>		X
Lamiaceae		<i>Hemiandra pungens</i>	X	X
Lauraceae		<i>Cassytha racemosa</i>	X	
		<i>Cassytha</i> sp.		X
Lobeliaceae		<i>Isotoma hypocrateriformis</i>		X
		<i>Isotoma hypocrateriformis</i> var. <i>hypocrateriformis</i>		X
		<i>Lobelia tenuior</i>		X
Loranthaceae		<i>Nuytsia floribunda</i>	X	X
Myrtaceae		<i>Agonis flexuosa</i>	X	X
		<i>Eucalyptus argutifolia</i> (T)	X	X
		<i>Eucalyptus decipiens</i>	X	X
		<i>Eucalyptus foecunda</i>	X	X
		<i>Eucalyptus gomphocephala</i>	X	X
		<i>Eucalyptus lehmannii</i>	X	
		<i>Eucalyptus ?marginata</i>		X
		<i>Eucalyptus marginata</i>	X	
		<i>Eucalyptus marginata</i> subsp. <i>marginata</i>		X
		<i>Eucalyptus ?petrensis</i>		X
		<i>Eucalyptus petrensis</i>	X	X
		<i>Eucalyptus platypus</i>	X	X
		* <i>Eucalyptus</i> sp. (planted)	X	X
		<i>Melaleuca cuticularis</i>	X	X
		<i>Melaleuca huegelii</i>	X	X
		<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	X	
		<i>Melaleuca lanceolata</i>	X	
		<i>Melaleuca raphiophylla</i>	X	X
		<i>Melaleuca</i> sp. (<i>huegelii</i> x <i>raphiophylla</i>)	X	
		<i>Melaleuca systema</i>	X	X
		<i>Melaleuca teretifolia</i>	X	X
		<i>Melaleuca viminea</i> subsp. <i>viminea</i>		X
Oleaceae		* <i>Olea europaea</i>		X
Orchidaceae		<i>Microtis media</i> subsp. <i>media</i>		X
		Orchid sp.	X	
		<i>Pterostylis sanguinea</i>	X	
		<i>Pyrorchis nigricans</i>	X	
		? <i>Thelymitra</i> sp.		X
Orobanchaceae		* <i>Bartsia trixago</i>		X

Appendix G Vascular Flora Species List for Lake Clifton including ENV (2009) and the 2016 Survey

Family	Weed	Taxon	AECOM	ENV (2009)
		* <i>Orobanche minor</i>		X
Oxalidaceae		* <i>Oxalis pes-caprae</i>		X
		* <i>Oxalis</i> sp.		X
Phyllanthaceae		<i>Phyllanthus calycinus</i>	X	X
		<i>Poranthera microphylla</i>		X
Plantaginaceae		<i>Veronica distans</i>	X	
Planted		<i>Planted Callistemon</i>	X	
Poaceae		* <i>Aira caryophyllea</i>		X
		* <i>Aira praecox</i>		X
		* <i>Aira</i> sp.		X
		<i>Austrodanthonia caespitosa</i>		X
		<i>Austrodanthonia</i> sp.		X
		<i>Austrostipa flavescens</i>		X
		* <i>Avena barbata</i>	X	
		* <i>Avena barbata</i>		X
		* <i>Briza minor</i>		X
		<i>Bromus arenarius</i>		X
		* <i>Bromus diandrus</i>		X
		* <i>Bromus hordeaceus</i>		X
		* <i>Cynodon dactylon</i>		X
		* <i>Desmazeria rigida</i>		X
		* <i>Holcus setiger</i>		X
		* <i>Hordeum geniculatum</i>		X
		* <i>Hordeum leporinum</i>		X
		* <i>Lolium rigidum</i>		X
		<i>Poa drummondiana</i>		X
		* Poaceae sp.	X	X
		<i>Spinifex hirsutus</i>		X
		* <i>Vulpia muralis</i>		X
		* <i>Vulpia myuros</i>		X
Polygalaceae		<i>Comesperma ?flavum</i>	X	
Portulacaceae		<i>Calandrinia ?brevipedata</i>		X
Primulaceae		* <i>Lysimachia arvensis</i>	X	X
		<i>Samolus junceus</i>		X
Proteaceae		<i>Banksia attenuata</i>	X	X
		<i>Banksia dallanneyi</i> var. <i>dallanneyi</i>	X	
		<i>Banksia grandis</i>	X	X
		<i>Banksia littoralis</i>	X	X
		<i>Banksia sessilis</i> var. <i>cygnorum</i>	X	X
		<i>Grevillea preissii</i> subsp. <i>preissii</i>	X	X
		<i>Grevillea</i> sp.		X
		<i>Hakea costata</i>		X
		<i>Hakea lissocarpa</i>	X	X
		<i>Hakea prostrata</i>	X	X
		<i>Hakea ruscifolia</i>	X	
		<i>Hakea trifurcata</i>	X	
Ranunculaceae		<i>Clematis linearifolia</i>	X	
		<i>Clematis pubescens</i>	X	X
		<i>Ranunculus</i> sp.		X
Restionaceae		<i>Desmocladius flexuosus</i>	X	

Appendix G Vascular Flora Species List for Lake Clifton including ENV (2009) and the 2016 Survey

Family	Weed	Taxon	AECOM	ENV (2009)
		<i>Loxocarya cinerea</i>	X	
Rhamnaceae		<i>Cryptandra mutila</i>	X	
		<i>Spyridium globulosum</i>	X	X
		<i>Trymalium ledifolium</i> var. <i>ledifolium</i>	X	X
Rubiaceae		* <i>Galium murale</i>		X
		* <i>Sherardia arvensis</i>		X
		<i>Opercularia hispidula</i>	X	X
		<i>Opercularia vaginata</i>		X
Rutaceae		<i>Diplolaena dampieri</i>	X	X
		<i>Diplolaena drummondii</i>		X
Santalaceae		<i>Santalum acuminatum</i>	X	X
Scrophulariaceae		* <i>Dischisma arenarium</i>		X
Solanaceae		<i>Anthocercis littorea</i>	X	
		* <i>Solanum linnaeanum</i>	X	
		* <i>Solanum nigrum</i>	X	X
		<i>Solanum symonii</i>	X	X
Stylidiaceae		<i>Stylidium bulbiferum</i>		X
		<i>Stylidium maritimum</i> (P3)	X	X
Thymelaeaceae		<i>Pimelea ferruginea</i>	X	
		<i>Pimelea</i> sp.	X	
Typhaceae		<i>Typha orientalis</i>		X
		<i>Typha</i> sp.	X	
Utricaceae		<i>Parietaria debilis</i>		X
Xanthorrhoeaceae		<i>Xanthorrhoea preissii</i>	X	X
Zamiaceae		<i>Macrozamia riedlei</i>	X	X
Zygophyllaceae		<i>Zygophyllum ?angustifolium</i>		X
		<i>Zygophyllum fruticosum</i>		X



Appendix H

Weed Species and their
Significance Recorded
at Lake Clifton, 2016

Appendix H Weed Species and their Significance Recorded at Lake Clifton, 2016

Taxon	No. of Occurrences in Sites	EWSWA Rating	Swan Priority Rating
<i>Arctotheca calendula</i>	22	Moderate	H
<i>Asphodelus fistulosus</i>	2	Mild	FAR
<i>Avena barbata</i>	1		VH
<i>Brassica tournefortii</i>	14	High	H
<i>Dittrichia graveolens</i>	6		M
<i>Euphorbia peplus</i>	17	Moderate	H
<i>Euphorbia terracina</i>	1	High	VH
<i>Geranium molle</i>	37	Low	M
<i>Gomphocarpus fruticosus</i>	20	Moderate	M
<i>Hypochaeris glabra</i>	33		H
<i>Lotus subbiflorus</i>	4		U
<i>Lupinus sp.</i>	3	High	U
<i>Lysimachia arvensis</i>	35		FAR
<i>Poaceae sp.</i>	1		
<i>Solanum linnaeanum</i>	1	Moderate	H
<i>Solanum nigrum</i>	33		M
<i>Sonchus oleraceus</i>	3		FAR
<i>Trachyandra divaricata</i>	48	Mild	FAR
<i>Trifolium campestre</i>	24		FAR
<i>Ursinia anthemoides</i>	1		M
<i>Zantedeschia aethiopica</i>	2	High	VH

EWSWA represents the Environmental Weed Strategy for Western Australia CALM 1999)

Swan Rating derived from Swan Environmental Weed Assessment (2008)

Ratings include VH-Very High, H-High, FAR-Further Assessment Required, M-Moderate, U-Unknown



Appendix I

Fauna Species
Recorded during the
Field Survey

Appendix I Fauna Species Recorded During the Field Survey

Name	Common Name	Conservation Status	
		Commonwealth	State
Birds			
<i>Anas superciliosa</i>	Pacific Black Duck	-	-
<i>Anhinga novaehollandiae</i>	Australasian Darter	-	-
<i>Anthochaera carunculata</i>	Red Wattlebird	-	-
<i>Artamus cinereus</i>	Black-faced Woodswallow	-	-
<i>Aquila audax</i>	Wedge-tailed Eagle	-	-
<i>Barnardius zonarius semitorquatus</i>	Twenty-eight Parrot	-	-
<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	Marine	-
<i>Calyptorhynchus latirostris</i>	Carnaby's Black Cockatoo	E	EN
<i>Circus approximans</i>	Swamp Harrier	Marine	-
<i>Corvus coronoides</i>	Australian Raven	-	-
<i>Cracticus tibicen</i>	Australian Magpie	-	-
<i>Dacelo novaeguineae</i>	Laughing Kookaburra*	-	-
<i>Dicaeum hirundinaceum</i>	Mistletoebird	-	-
<i>Dromaius novaehollandiae</i>	Emu	-	-
<i>Eolophus roseicapilla</i>	Galah	-	-
<i>Falco cenchroides</i>	Nankeen Kestrel	Marine	-
<i>Fulica atra</i>	Eurasian Coot	-	-
<i>Gerygone fusca</i>	Western Gerygone	-	-
<i>Grallina cyanoleuca</i>	Magpie-lark	Marine	-
<i>Haliastur sphenurus</i>	Whistling Kite	Marine	-
<i>Hieraaetus morphnoides</i>	Little Eagle	-	-
<i>Hirundo neoxena</i>	Welcome Swallow	Marine	-
<i>Microeca fascinans</i>	Jacky Winter	-	-
<i>Ninox novaeseelandiae</i>	Southern Boobook	Marine	-
<i>Pachycephala pectoralis</i>	Golden Whistler	-	-
<i>Petrochelidon nigricans</i>	Tree Martin	Marine	-
<i>Phaps chalcoptera</i>	Common Bronzewing	-	-
<i>Rhipidura albiscapa</i>	Grey Fantail	-	-
<i>Rhipidura leucophrys</i>	Willie Wagtail	-	-
<i>Streptopelia senegalensis</i>	Laughing Turtle-dove*	-	-
<i>Tadorna tadornoides</i>	Australian Shelduck	-	-

Name	Common Name	Conservation Status	
		Commonwealth	State
Mammals			
<i>Canis lupis familiaris</i>	Dog*	-	-
<i>Macropus fuliginosus</i>	Western Grey Kangaroo	-	-
<i>Mus musculus</i>	House Mouse*		
<i>Isoodon obesulus fusciventer</i>	Quenda, Southern Brown Bandicoot	-	P4
<i>Oryctolagus cuniculus</i>	European Wild Rabbit*	-	-
<i>Pseudocheirus occidentalis</i>	Western Ringtail Possum	V	EN
<i>Trichosurus vulpecula</i>	Common Brushtail Possum	-	-
<i>Vulpes vulpes</i>	Red Fox*	-	-
Reptiles			
<i>Tiliqua rugosa rugosa</i>	Southwestern Bobtail	-	-
Amphibians			
<i>Limnodynastes dorsalis</i>	Banjo Frog	-	-
<i>Litoria adelaidensis</i>	Slender Tree Frog	-	-

Note: Species listed as Marine under the EPBC Act are only considered conservation significant when in a Commonwealth marine reserve.



Appendix J

Black Cockatoo Foraging Assessment

Carnaby's Black Cockatoo Foraging Assessment

Site	Initial Score	Is within the Swan Coastal Plain	Contains trees known to be used for breeding	Primarily comprises Marri	Contains trees with breeding potential	Known to be a large or key roosting site	Within 6km of a known night roost	Is <12km from known breeding location	Is <2km from a watering point	Greater than 6km from known roosting site	No other foraging habitat within 6 km	Is >12km from known breeding location	Minimal marri and less than 20% prots cover	More Than 2km from Watering Point	Disease present	Final Score
1	1	3	0	0	0	0	1	1	0	0	0	0	-3	-1	0	2
2	2	3	0	0	0	0	1	1	0	0	0	0	-3	-1	0	3
3	2	3	0	0	2	0	1	1	1	0	0	0	-3	0	0	7
4	2	3	0	0	0	0	0	1	1	-1	0	0	-3	0	0	3
5	2	3	0	0	2	0	1	1	1	0	0	0	-3	0	0	7
6	2	3	0	0	0	0	1	1	1	0	0	0	-3	0	0	5
7	1	3	0	0	0	0	1	1	1	0	0	0	-3	0	0	4
8	1	3	0	0	0	0	1	1	0	0	0	0	-3	-1	0	2
9	1	3	0	0	2	0	1	1	0	0	0	0	-3	-1	0	4
10	1	3	0	0	2	0	1	1	0	0	0	0	-3	-1	0	4
11	1	3	0	0	0	0	1	1	1	0	0	0	-3	0	0	4
12	2	3	0	0	2	0	1	1	1	0	0	0	-3	0	0	7
13	2	3	0	0	0	0	1	1	1	0	0	0	-3	0	0	5
14	7	3	0	0	2	0	0	1	1	-1	0	0	-3	0	0	10
15	1	3	0	0	0	0	0	1	1	-1	0	0	-3	0	0	2
16	2	3	0	0	0	0	1	1	1	0	0	0	-3	0	0	5
17	1	3	0	0	0	0	0	1	1	-1	0	0	-3	0	0	2
18	1	3	0	0	0	0	1	1	1	0	0	0	-3	0	0	4
19	1	3	0	0	0	0	1	1	1	0	0	0	-3	0	0	4
20	2	3	0	0	2	0	0	1	1	-1	0	0	-3	0	0	5
21	2	3	0	0	2	0	0	1	1	-1	0	0	-3	0	0	5
22	1	3	0	0	0	0	1	1	1	0	0	0	-3	0	0	4
23	2	3	0	0	0	0	1	1	1	0	0	0	-3	0	0	5
24	1	3	0	0	0	0	1	1	1	0	0	0	-3	0	0	4
25	2	3	0	0	2	0	1	1	1	0	0	0	-3	0	0	7
26	1	3	0	0	2	0	1	1	0	0	0	0	-3	-1	0	4
27	1	3	0	0	2	0	1	1	0	0	0	0	-3	-1	0	4
28	1	3	0	0	2	0	1	1	0	0	0	0	-3	-1	0	4
29	7	3	0	0	2	0	0	1	1	-1	0	0	-3	0	0	10
30	7	3	0	0	2	0	0	1	1	-1	0	0	-3	0	0	10
31	7	3	0	0	2	0	1	1	1	0	0	0	-3	0	0	12
32	2	3	0	0	2	0	0	1	1	0	0	0	-3	-1	0	5
33	2	3	0	0	0	0	1	1	0	0	0	0	-3	-1	0	3
34	2	3	0	0	0	0	1	1	0	0	0	0	-3	-1	0	3
35	1	3	0	0	0	0	1	1	1	0	0	0	-3	0	0	4

Forest Red-tailed Black Cockatoo Foraging Assessment

Site	Initial Score	Jarrah and/or Marri shows good recruitment	Contains trees known to be used for breeding	Primarily contains Marri and/or Jarrah	Contains trees with breeding potential	Known to be a large or key roosting site	Within 6km of a known night roost	Is <12km from known breeding location	Is <2km from a watering point	Greater than 6km from known roosting site	No other foraging habitat within 6 km	Is >12km from known breeding location	More Than 2km from Watering Point	Minimal marri	Disease present	Final Score
26	10	3	0	2	2	0	0	0	0	-1	0	-1	-1	-3	0	11
27	10	3	0	2	2	0	0	0	0	-1	0	-1	-1	-3	0	11
28	10	3	0	2	2	0	0	0	0	-1	0	-1	-1	-3	0	11

Baudin's Black Cockatoo Foraging Assessment

Site	Initial Score	Is within known foraging area	Contains trees known to be used for breeding	Primarily comprise s Marri	Contains trees with breeding potential	Known to be a large or key roosting site	Within 6km of a known night roost	Is <12km from known breeding location	Is <2km from a watering point	Greater than 6km from known roosting site	No other foraging habitat within 6km	Is >12km from known breeding location	Minimal marri and less than 20% prots cover	More Than 2km from Watering Point	Disease present	Final Score
36	2	0	0	0	0	0	0	0	1	-1	0	-1	-3	0	0	-2
9	1	0	0	0	0	0	0	0	1	-1	0	-1	-3	0	0	-3
10	2	0	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0
11	2	0	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0
12	2	0	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0
13	7	0	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0
14	2	0	0	0	0	0	0	0	0	1	-1	0	-1	-3	0	0
16	2	0	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0
18	2	0	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0
19	2	0	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0
20	7	0	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0
3	2	0	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0
7	1	0	0	0	0	0	0	0	0	1	-1	0	-1	-3	0	0
24	1	0	0	0	0	0	0	0	0	1	-1	0	-1	-3	0	0
36	1	0	0	0	0	0	0	0	0	1	-1	0	-1	-3	0	0
14	7	0	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0
29	7	0	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0
25	7	0	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0
33	7	0	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0
5	2	0	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0
6	2	0	0	0	0	0	0	0	0	1	-1	0	-1	-3	0	0
8	1	0	0	0	0	0	0	0	0	0	-1	0	-1	-3	-1	0
22	1	0	0	0	0	0	0	0	0	1	-1	0	-1	-3	0	0



Appendix K

Black Cockatoo Trees
Quadrat Raw Data

Object ID	Quadrat No.	Veg_Unit	No_Trees	Fire_Scarr	Tree_Species	DBH (CM)	Tree_Heig	Occupancy	Evidence of Use	Comments	Easting	Northing
1	1	AfXpHh	0	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	No trees	373550.6	6373562
2	2	AfHcEp	2	No	Eucalyptus gomphocephala (Tuart)	57	1800	<Null>	No	No hollows	373968	6369421
3		AfHcEp		No	Eucalyptus gomphocephala (Tuart)	53	2200	<Null>	No	No hollows	373985.5	6369438
4	3	AfHcEp	1	No	Eucalyptus gomphocephala (Tuart)	50	1800	<Null>	No	No hollows	373793.9	6369090
5	4	Eg	8	No	Eucalyptus gomphocephala (Tuart)	130	26	<Null>	No	1 hollow total - potentially suitable	373713.4	6369415
6		Eg		No	Eucalyptus gomphocephala (Tuart)	102	18	<Null>	No	1 hollow total - unsuitable	373702.2	6369413
7		Eg		No	Eucalyptus gomphocephala (Tuart)	120	1700	<Null>	No	No hollows	373672.7	6369417
8		Eg		No	Eucalyptus gomphocephala (Tuart)	160	2200	<Null>	No	No hollows	373663.7	6369415
9		Eg		No	Eucalyptus gomphocephala (Tuart)	62	2300	<Null>	No	No hollows	373694.7	6369392
10		Eg		No	Eucalyptus gomphocephala (Tuart)	91	1800	<Null>	No	No hollows	373698.6	6369426
11		Eg		No	Eucalyptus gomphocephala (Tuart)	74	25	No	No	2 hollows - 1 potentially suitable	373687.6	6369412
12		Eg		No	Eucalyptus gomphocephala (Tuart)	89	25	<Null>	No	3 hollows - 2 potentially suitable	373689.5	6369408
164	5	EgMsTd	5	No	Stag (old dead tree, unknown species)	50	1800	<Null>	No	No hollows	373848.4	6370282
165		EgMsTd		No	Stag (old dead tree, unknown species)	60	1800	<Null>	No	No hollows	373865.7	6370278
166		EgMsTd		No	Eucalyptus gomphocephala (Tuart)	78	2000	<Null>	No	Two main stems, second stem DBH 50+	373836.8	6370284
167		EgMsTd		No	Eucalyptus gomphocephala (Tuart)	105	1800	<Null>	No	No hollows	373848.4	6370270
168		EgMsTd		No	Eucalyptus gomphocephala (Tuart)	60	1400	<Null>	No	No hollows	373822.6	6370269
131	6	Eg	11	No	Eucalyptus gomphocephala (Tuart)	51	1300	<Null>	No	No hollows	372773.7	6371196
133		Eg		No	Eucalyptus gomphocephala (Tuart)	81	2200	<Null>	No	4 hollows - 1 potentially suitable	372748.3	6371204
134		Eg		No	Eucalyptus gomphocephala (Tuart)	110	2200	<Null>	Honeycomb inside	4 trunk hollows - 1 is potentially suitable but has honeycomb inside.	372745	6371197
136		Eg		No	Eucalyptus gomphocephala (Tuart)	72	1700	<Null>	No	No hollows	372791.4	6371216
137		Eg		No	Eucalyptus gomphocephala (Tuart)	64	1700	<Null>	No	No hollows	372775.9	6371242
139		Eg		No	Eucalyptus gomphocephala (Tuart)	54	1800	<Null>	No	1 spout hollow potentially suitable	372780.4	6371239
141		Eg		No	Eucalyptus gomphocephala (Tuart)	98	15	<Null>	No	2 potentially suitable hollows	372775.4	6371225
142		Eg		No	Eucalyptus gomphocephala (Tuart)	63	12	<Null>	No	2 potentially suitable hollows	372781.1	6371236
143		Eg		No	Eucalyptus gomphocephala (Tuart)	53	20	<Null>	No	No hollows	372767.7	6371213
144		Eg		No	Eucalyptus gomphocephala (Tuart)	102	25	<Null>	No	2 hollows - 1 potentially suitable	372769.5	6371229
145		Eg		No	Eucalyptus gomphocephala (Tuart)	67	20	<Null>	No	Dead tree - 1 small unsuitable hollow	372776.6	6371205
123	7	AfXpHh	6	No	Eucalyptus gomphocephala (Tuart)	95	2200	<Null>	No	No hollows	374106	6371550
146		AfXpHh		No	Eucalyptus gomphocephala (Tuart)	78	2000	<Null>	No	No hollows	374119.7	6371528
147		AfXpHh		No	Eucalyptus gomphocephala (Tuart)	219	2200	<Null>	No	No hollows	374119.9	6371535
148		AfXpHh		No	Eucalyptus gomphocephala (Tuart)	54	2200	<Null>	No	No hollows	374132.6	6371530
149		AfXpHh		No	Eucalyptus gomphocephala (Tuart)	80	2500	<Null>	No	No hollows	374106.5	6371540
150		AfXpHh		No	Eucalyptus gomphocephala (Tuart)	96	1900	<Null>	No	No hollows	374101.8	6371536
17	8	AfXpHh	7	Yes	Eucalyptus gomphocephala (Tuart)	95	1800	<Null>	No	No hollows	373786.9	6372118
18		AfXpHh		No	Eucalyptus gomphocephala (Tuart)	84	1900	<Null>	No	No hollows	373788.1	6372129
19		AfXpHh		Yes	Eucalyptus gomphocephala (Tuart)	81	1800	<Null>	No	No hollows	373794.4	6372136
20		AfXpHh		No	Eucalyptus gomphocephala (Tuart)	65	2200	<Null>	No	No hollows	373791.9	6372141
21		AfXpHh		No	Eucalyptus gomphocephala (Tuart)	80	2200	<Null>	No	No hollows	373815.6	6372111
22		AfXpHh		Yes	Eucalyptus gomphocephala (Tuart)	57	1800	<Null>	No	Two main trunks, one dead with 3 hollows	373797	6372120
23		AfXpHh		No	Eucalyptus gomphocephala (Tuart)	78	2000	<Null>	No	No hollows	373801.4	6372136
25	9	AfXpHh	6	No	Eucalyptus gomphocephala (Tuart)	74	2000	<Null>	No	No hollows	373728.2	6372306
26		AfXpHh		No	Eucalyptus gomphocephala (Tuart)	76	1800	<Null>	No	No hollows	373714.8	6372312
27		AfXpHh		Yes	Eucalyptus gomphocephala (Tuart)	86	2000	<Null>	No	No hollows	373722.5	6372319
28		AfXpHh		Yes	Eucalyptus gomphocephala (Tuart)	60	1700	<Null>	No	No hollows	373706.6	6372327
30		AfXpHh		Yes	Eucalyptus gomphocephala (Tuart)	150	1800	<Null>	No	No hollows	373720.7	6372335
31		AfXpHh		Yes	Eucalyptus gomphocephala (Tuart)	100	1600	<Null>	No	Main trunk broken and burnt, second stem DBH 50+, no hollows	373743.1	6372323
34	10	AfXpHh	6	No	Eucalyptus gomphocephala (Tuart)	53	1300	<Null>	No	No hollows	373185.5	6373366
35		AfXpHh		Yes	Eucalyptus gomphocephala (Tuart)	50	1100	<Null>	No	No hollows	373186.1	6373378
36		AfXpHh		Yes	Eucalyptus gomphocephala (Tuart)	73	1300	<Null>	No	No hollows	373182.5	6373395
37		AfXpHh		Yes	Eucalyptus gomphocephala (Tuart)	60	1200	<Null>	No	No hollows	373184.8	6373396
38		AfXpHh		Yes	Eucalyptus gomphocephala (Tuart)	63	1500	<Null>	No	2 hollows - none suitable	373176.4	6373377
39		AfXpHh		Yes	Eucalyptus gomphocephala (Tuart)	63	1600	<Null>	No	2 stems, second stem DBH 50+	373181.4	6373389
42		AfXpHh		No	Eucalyptus gomphocephala (Tuart)	50	1300	<Null>	No	2 hollows, 0 potentially suitable	373210.6	6373391
43	11	AfXpHh	5	Yes	Eucalyptus gomphocephala (Tuart)	106	1400	<Null>	No	No hollows - tree half dead	373571.1	6373425
44		AfXpHh		No	Eucalyptus gomphocephala (Tuart)	57	1500	<Null>	No	1 hollow - unsuitable	373571.1	6373409
45		AfXpHh		Yes	Eucalyptus gomphocephala (Tuart)	68	800	Bees	No	Dead, 4 hollows - none suitable	373556.4	6373422
46		AfXpHh		Yes	Eucalyptus gomphocephala (Tuart)	62	1100	<Null>	No	1 hollow unsuitable	373540.6	6373403
47		AfXpHh		Yes	Stag (old dead tree, unknown species)	53	1100	<Null>	No	No hollows	373540.5	6373400

51	12	AfHcEp	0	<Null>	<Null>	<Null>	<Null>	<Null>	No	No trees	372434.4	6373464
52	13	EgXpTd	9	No	Eucalyptus gomphocephala (Tuart)	73	1500	<Null>	No	No hollows	372505.5	6372519
53		EgXpTd		Yes	Eucalyptus gomphocephala (Tuart)	74	1600	<Null>	No	No hollows	372513.9	6372516
54		EgXpTd		Yes	Eucalyptus gomphocephala (Tuart)	75	2000	<Null>	No	2 hollows - 0 suitable due to small size	372517.8	6372522
55		EgXpTd		No	Eucalyptus gomphocephala (Tuart)	45	2100	<Null>	No	1 hollow - 0 suitable too small	372520.8	6372536
56		EgXpTd		No	Eucalyptus gomphocephala (Tuart)	105	<Null>	<Null>	No	5 hollows - 2 potentially suitable	372529	6372553
57		EgXpTd		No	Eucalyptus gomphocephala (Tuart)	90	1800	<Null>	No	3 hollows - 2 potentially suitable	372533	6372548
58		EgXpTd		No	Eucalyptus gomphocephala (Tuart)	72	1600	<Null>	No	No hollows	372526.3	6372568
59		EgXpTd		Yes	Eucalyptus gomphocephala (Tuart)	110	2200	<Null>	No	1 hollow, none suitable	372500.8	6372561
60		EgXpTd		No	Eucalyptus gomphocephala (Tuart)	89	1800	<Null>	No	No hollows	372511.4	6372575
173	14	Eg	7	No	Eucalyptus gomphocephala (Tuart)	91	2000	<Null>	No	No hollows	373649.4	6368833
175		Eg		No	Eucalyptus gomphocephala (Tuart)	78	2000	<Null>	No	No hollows	373653.6	6368829
176		Eg		No	Eucalyptus gomphocephala (Tuart)	76	2200	<Null>	No	No hollows	373662.4	6368799
177		Eg		Yes	Stag (old dead tree, unknown species)	61	15	<Null>	No	4 hollows - 3 potentially suitable	373607.5	6368830
178		Eg		No	Eucalyptus gomphocephala (Tuart)	89	1800	<Null>	Being used by owl	No hollows	373643.5	6368799
179		Eg		No	Eucalyptus gomphocephala (Tuart)	95	20	<Null>	No	No hollows	373616.7	6368828
180		Eg		Yes	Eucalyptus gomphocephala (Tuart)	50	15	<Null>	No	2 hollows - none potentially suitable	373626.2	6368827
62	15	AfXpHhHg	1	No	Eucalyptus gomphocephala (Tuart)	62	2500	<Null>	No	No hollows	374229.3	6368439
66	16	AfXpHhHg	3	No	Eucalyptus marginata (jarrah)	58	2000	<Null>	No	No hollows	374212.6	6368556
67		AfXpHhHg		No	Eucalyptus gomphocephala (Tuart)	50	2200	<Null>	No	No hollows	374214.8	6368570
69		AfXpHhHg		No	Eucalyptus marginata (jarrah)	53	1200	<Null>	No	No hollows	374264.1	6368550
70	17	AfXpHh	1	Yes	Eucalyptus gomphocephala (Tuart)	59	11	<Null>	No	No hollows	373554.4	6373673
71	18	AfHcEP	0	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	No trees	373697.9	6369159
72	19	AfHcEp	0	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	No trees	372226.7	6373200



Appendix L

Lake Clifton Wetlands Assessment Forms

Appendix L Lake Clifton Wetland Assessment Forms

1.0 UFI 3096

1.1 General Information

Assessor details	
Name	Floora de Wit and Lyn van Gorp
Date of site visit	27-28 June 2016
Company	AECOM Australia Pty Ltd
Weather during visit	Cloudy, light rains
Landowner	Main Roads Western Australia
Property details	
Location (lot/street)	
Latitude and longitude or Easting northing	
Wetland details	
Name	
UFI	3096
Hill et al. (1996) map sheet number and wetland ID number	
Consanguineous suite	Clifton
Area (ha) of wetland	54 ha
Area (ha) subject to this evaluation	54 ha
Is wetland assessed as portion of wetland with varying degrees of value?	No
Mapped management category	Conservation
Wetland type (see table below)	Sumpland

Water permanence	Host landform				
	Basin	Flat	Slope	Highland	Channel
Permanent inundation	Lake	-	-	-	River*
Seasonal inundation	Sumpland	Floodplain*	-	-	Creek*
Intermittent inundation	Playa*	Barlkarra*	-	-	Wadi*
Seasonal waterlogging	Dampland	Palusplain	Paluslope	Palusmont*	Trough*

*Wetland types not applicable to this evaluation methodology.

1.2 Wetland desktop evaluation

Land uses	
Current ownership of wetland	Main Roads Western Australia
Current land use	Vegetated
Past land use	Agriculture
Surrounding land use	RAMSAR wetland, native vegetation
Existing management	No known management
Fire history/regime	Unknown, no evidence of recent fire

International, national or regional significance	
Indicate whether the wetland is identified (permanent or interim) on one of the following international, national or state registers or listings.	
Conservation Significance	Y/N
Ramsar Convention on Wetlands (Ramsar 1971)	N
Directory of Important Wetlands in Australia (Environment Australia 2001)	N
Register of National Estate (Commonwealth of Australia 2007)	N
Conservation Reserves for Western Australia Systems 1, 2, 3, 5 (Department of Conservation and Environment, 1976)	n/a
Conservation Reserves for Western Australia, The Darling System – System 6 (Department of Conservation and Environment, 1983)	N
A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton – Walpole Region (Pen 1997)	N
The Environmental Significance of Wetlands in the Perth to Bunbury Region (Le Provost et al. 1987)	N
Bush Forever (Government of Western Australia 2000)	N
Swan Bioplan (Environmental Protection Authority 2010)	N
Environmental Protection (Swan Coastal Plain Lakes) Policy 1992	N
Environmental Protection (Western Swamp Tortoise Habitat) Policy Approval Order 2002	N
Conservation Estate (e.g. National Park, Nature Reserve, A Class Reserve)	N
Other (list):	Y ESA
Does the wetland retain the values for which it was originally registered or listed, describe: Yes, contains TEC.	

Fauna			
Note the presence (recorded or observed) or evidence of fauna in or surrounding the wetland which is listed by the Commonwealth (e.g. Environment Protection and Biodiversity Conservation Act 1999, CAMBA, RoKAMBA, JAMBA) or State (e.g. Threatened or Specially Protected Fauna under the Wildlife Conservation Act 1950) or Priority Fauna or Priority or Threatened Ecological Communities related to fauna which are listed by DPaW.			
Species / name of ecological community	Significance (e.g. EPBC Act, CAMBA)	Observations (e.g. population size, age, evidence, activities, habitat requirements)	Source of information (e.g. observatory, literature, DPaW, WA Museum)

Scientific value		
List any scientific values including geoheritage or geoconservation values (e.g. important sediments or geological features, fossils, pollen records, stromatolites, thrombolites, evidence of evolutionary processes, evidence of a change in climate, unique flora or fauna adaptations) that the wetland may contain.		
Scientific, geoheritage or geoconservation values	Significance and observations	Source of information (e.g. observatory, literature, DPaW, WA Museum)

Flora				
Use aerial photography and a site visit to determine and confirm the condition of the vegetation within and 50 metres surrounding the wetland. Using the scale outlined in Appendix B, display the locations of the vegetation conditions in the attached map and calculate their total area:				
Vegetation condition	Total area (%) within the wetland	Area (%) 50 metres surrounding the wetland		
Pristine				
Excellent	100%	100%		
Very Good				
Good				
Degraded				
Completely Degraded				
Using this information, is the wetland dominated by vegetation in a good or better condition:		Yes		
What vegetation complex (Heddlé et al. 1980) does the wetland belong to:		Yoongarillup complex		
Using the information sources outlined in Appendix B, what extent of the vegetation complex is remaining on the Swan Coastal Plain		38 %		
List any occurrences of Priority and Threatened Ecological Communities related to flora and wetland systems which are known to occur within and 5 kilometres surrounding the wetland. If they are located within or adjacent to the wetland display their boundary in the attached map:				
Name of ecological community	Significance (e.g. priority, threatened)	Observations (e.g. condition, area, habitat type)	Source of information (e.g. observatory, literature, DPaW)	
FCT25 Southern <i>Eucalyptus gomphocephala</i> and <i>Agonis flexuosa</i> woodland	Priority 3	Adjacent to wetland boundary	DPaW, ENV(2009)	
Stromatolite like freshwater microbialite community of coastal brackish lakes	Cth: Critically Endangered State: Critically Endangered	Wetland within buffer of this TEC	DPaW	
List any occurrences of Declared Rare flora or Priority flora known to occur within and 1 kilometre surrounding the wetland and display their location in the attached map:				
Species	Significance (e.g. Declared Rare, Priority 1)	Population measure (number, single record, abundance comment)	Observations (e.g. habitat type, flowering season)	Source of information (e.g., literature, DPaW, surveyed population, Herbarium record)
<i>Lasiopetalum membranaceum</i>	P3	Single record	None	DPaW database record from 1988 located 250 east of wetland boundary.
<i>Eucalyptus argutifolia</i>	Cth: Threatened State: Threatened	One population (no count data available)	None	DPaW database records, ENV (2009) and Weston (2003)

Representativeness	
Using the wetlands data outlined in section 4.3, Appendix D and available on DPaW's website record the corresponding area:	
	% area
What is the % area of wetlands with the same classification assigned a Conservation management category on the Swan Coastal Plain	37.0
What is the % area of wetlands in the same consanguineous suite assigned a Conservation management category	78.1
What is the % area of wetlands with the same classification in the same consanguineous suite assigned a conservation management category	24.7
Is the wetland rare? (e.g. only wetland in its consanguineous suite, best wetland example in its consanguineous suite or region, only Conservation management category wetland in the consanguineous suite or region, primary saline wetland within a consanguineous suite predominated by freshwater):	N

No.	Criteria	Y/N
1	The wetland is currently recognised as internationally or nationally significant for its natural values. Lists/registers include: <ul style="list-style-type: none"> - The Ramsar Convention on Wetlands - State government endorsed candidate sites for the Ramsar Convention on Wetlands - Directory of Important Wetlands in Australia - National Heritage List - Or equivalent. 	N N N N N
2	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is identified as significant for its natural values under one or more of the following: <ul style="list-style-type: none"> - <i>Conservation Reserves for Western Australia Systems 1, 2, 3, 5</i> - <i>Conservation Reserves for Western Australia, The Darling System – System 6</i> - <i>A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton – Waipole Region</i> - <i>The Environmental Significance of Wetlands in the Perth to Bunbury Region</i> - <i>Bush Forever, Swan Bioplan or equivalent.</i> 	N N N N N
3	The wetland supports a breeding, roosting, or refuge site or a critical feeding site for populations of fauna listed by the Australian Government (for example, <i>Environment Protection and Biodiversity Conservation Act 1999</i> , migratory bird agreements such as JAMBA, CAMBA and RoKAMBA) or the State (for example, Threatened and Specially Protected Fauna listed under the Wildlife Conservation Act 1950).	Y
4	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and supports one or more of the following: <ul style="list-style-type: none"> - An occurrence of a Threatened Ecological Community - A confirmed occurrence of a Priority 1 or Priority 2 Ecological Community - A confirmed occurrence of a Declared Rare (Threatened) flora species. 	N Y N
5	Equal to or greater than 90% of the wetland supports vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B.	Y
6	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is known to support internationally, nationally or state-wide scientific values including geoheritage and geoconservation.	N
7	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and meets one of the following: <ul style="list-style-type: none"> - ≤10% of wetlands of the same type are assigned Conservation management category within the Swan Coastal Plain (by area) - ≤10% of all wetlands in the same consanguineous suite are assigned Conservation management category (by area) - ≤10% of wetlands of the same type in its consanguineous suite are assigned Conservation management category (by area) - best representative of its type within its consanguineous suite domain. 	N N N N

1.3 Secondary Assessment Form

No.	General criteria	Criteria	Score
Geomorphology			
1	<i>Representativeness</i>	≤20% of wetlands of the same type are assigned Conservation on the Swan Coastal Plain by area.	H
2		≤20% of wetlands in the same consanguineous suite are assigned Conservation by area.	H
3		≤20% of wetlands of the same type in the same consanguineous suite are assigned Conservation by area.	H
4		The wetland is outstanding in some geomorphic aspect, for example size, origin, height relative to sea level, depth, age.	H
5	<i>Naturalness</i>	Alteration to the wetland's geomorphology by % area: < 25% altered 25-75% altered > 75% altered.	H I L
6	<i>Scarcity</i>	The wetland exhibits unusual geomorphology or unusual internal geomorphic features compared to other wetlands of the same type in the consanguineous suite.	H
7		The wetland is the best example of its type in its consanguineous suite.	H
Wetland processes			
8	<i>Representativeness</i>	The wetland is an important component of the natural hydrological cycle providing natural functions (e.g. flood protection and recharge/discharge). The wetland's vegetation, geomorphology, hydrology or sediments are modified; however, the wetland is still a component of the hydrological cycle providing natural and artificial functions (e.g. flood remediation, recharge/discharge and hydrological storage). The wetland's vegetation, geomorphology, hydrology or sediments are modified to the extent that the wetlands hydrological functions are artificial such as storage, or the wetland has been disconnected from the natural hydrological cycle and no longer provides natural attributes and functions.	H
9		The wetland supports a representative process (e.g. wetland process typical of the wetland's hydrological setting, sediment accretionary process typical of the wetland's geomorphic setting or hydrochemical process typical of the wetland's geological setting).	H
10	<i>Naturalness</i>	The wetland is not subject to altered wetland processes or, is subject to altered wetland processes and the wetland's natural attributes and functions are maintained. The wetland is subject to altered wetland processes and the wetland's natural attributes and functions have been changed; however, they have the potential to be rehabilitated. The wetland is subject to altered wetland processes to the extent that the wetland no longer supports natural attributes and functions.	H
11	<i>Scarcity</i>	The wetland exhibits unusual processes (e.g. hydrological, sedimentological, chemical, biological) compared to other wetlands of the same type in the consanguineous suite.	H

No.	General criteria	Criteria	Score
Linkages			
12	<i>Representativeness</i>	The wetland is a hydrological link in a larger or more complex and intact system.	H
13	<i>Naturalness</i>	The wetland is part of a continuous ecological linkage or wildlife corridor, or a regionally significant ecological linkage or wildlife corridor connecting bushland or wetland areas. The wetland is part of a fragmented ecological linkage or wildlife corridor. The wetland is disturbed and isolated, surrounded by either a built or highly disturbed environment with no nearby native vegetation or waterways to support an intact or fragmented ecological linkage or wildlife corridor.	H I L
14	<i>Scarcity</i>	The wetland has unusual hydrological, hydrochemical or ecological linkages with adjacent wetland or bushland.	I
Habitats			
15	<i>Representativeness</i>	The wetland is isolated from other undisturbed wetlands or bushland and as a result, maintains important ecological or genetic fauna or flora diversity within its consanguineous suite domain.	H
16		The wetland contains evidence of surface water that is vital to maintaining regionally significant populations of native aquatic or terrestrial flora or fauna.	H
17		The wetland provides a nursery for native fauna populations, or maintains fauna populations at a vulnerable stage of their life cycle.	H
18	<i>Naturalness</i>	The wetland supports habitats that are unaltered or the wetland has been altered and its natural habitats are maintained. The wetland supports habitats that are altered; however, the habitats are still identifiable and have the potential to be rehabilitated. The wetland is altered and as a result is no longer supporting natural habitats which can be rehabilitated.	H I L
19	<i>Scarcity</i>	The wetland supports habitats that are unusual compared to other wetlands of the same type on the Swan Coastal Plain.	H
Flora			
20	<i>Representativeness</i>	The wetland's current diversity of native flora is similar to what would be expected in an unaltered state. The wetland supports a reduced diversity of native flora due to human induced disturbances. The wetland supports a significantly reduced diversity of native flora species due to human induced disturbances.	H I L
21		The wetland is identified in a vegetation complex (Heddl et al. 1980) which is represented by: ≤30% of the pre-European extent 30-50% of the pre-European extent.	 H I
22	<i>Naturalness</i>	Using the vegetation condition scale outlined in Appendix B, the wetland's vegetation condition by area is: ≥ 75% Good, Very Good, Excellent or Pristine 25-75% Good, Very Good, Excellent or Pristine < 25% Good, Very Good, Excellent or Pristine.	 H I L

No.	General criteria	Criteria	Score
23		The wetland or ≥ 50% of the wetland boundary is surrounded by land dominated by remnant native vegetation.	H
		The wetland or 10-50% of the wetland boundary is surrounded by land dominated by remnant native vegetation.	I
		The wetland or < 10% of the wetland boundary is surrounded by land dominated by remnant native vegetation.	L
24	<i>Scarcity</i>	The wetland supports an occurrence of Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora, or an occurrence of 3 or more significant flora taxa.	H
25		The wetland is likely to support Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora; however, the occurrence cannot be located or its habitat has been altered and is no longer in a natural state.	I
26		The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	H
27		The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community.	I
Fauna			
28	<i>Representativeness</i>	The wetland is an ecological refuge for regionally significant fauna species or fauna assemblages.	H
		The wetland has the potential to be an ecological refuge but is disturbed and its attributes and functions require rehabilitation.	
29		The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regionally significant native fauna.	H
		The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regional or local fauna but only in association with other surrounding natural areas.	I
30	<i>Naturalness</i>	The wetland's current diversity of native fauna is similar to what would be expected in an unaltered state, or the wetland supports diverse fauna compared to other wetlands of the same type.	H
		The wetland supports a reduced diversity of fauna compared to other wetlands of the same type.	I
31		The wetland supports limited attributes and functions for fauna populations due to human induced disturbances.	L
32	<i>Scarcity</i>	The wetland is likely to support a breeding, roosting, refuge or feeding site for populations of fauna listed by the Commonwealth (e.g. <i>EPBC Act 1999</i> , JAMBA, CAMBA, RoKAMBA Agreements) or the State (e.g. Threatened or Specially Protected Fauna listed under the <i>Wildlife Conservation Act 1950</i>).	H
33		The wetland supports a breeding, roosting, refuge or feeding site for Priority 1, Priority 2, Priority 3 or Priority 4 fauna.	H
34		The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	H
35		The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community or a breeding, roosting, refuge or feeding site for significant fauna.	I
Cultural			
36	<i>Representativeness</i>	The wetland or its immediate surrounds is identified for its natural values on a national or State heritage list or the wetland supports other known regional heritage values.	H
37		The wetland or its immediate surrounds is identified for its natural values on a municipal heritage list or the wetland supports other known local heritage values.	I

No.	General criteria	Criteria	Score
38		The wetland or its immediate surrounds is identified on a national, State or local list or register for its Aboriginal cultural value (e.g. Department of Aboriginal Affairs register).	H
39		The wetland is important to the local community either nationally or state wide for its natural values.	H
40		The wetland is or has the potential to be a site for public or private based recreation.	I
41		The wetland is likely to support heritage, cultural or social values; however, the value cannot be confirmed or the value has been disturbed and are no longer as important or significant.	I
		The wetland did support heritage, cultural or social values; however, these have been significantly disturbed and are no longer important or the values have been removed.	L
Scientific and educational			
42	<i>Representativeness</i>	The wetland supports known important teaching or research characteristics and for this reason is an existing or potential education or research site. Note, the wetland must still support the relevant teaching or research characteristics.	H
		The wetland has the potential to be used as a study or research site.	I
43		The wetland supports known scientific, geoheritage or geoconservation values.	H
44		The wetland did support scientific or educational values; however, these have been significantly disturbed and are no longer as important or the values have been removed.	L

1.4 Results

Attributes/functions /values	Scores		
	High	Intermediate	Low
Geomorphology	1		
Wetland processes	3		
Linkages	2	1	
Habitats	2		
Flora	3	2	
Fauna	4	1	
Cultural		1	
Scientific and educational			
Total Score	15	5	
Defining attributes/ functions/values	Fauna		
Applicable management category	Conservation		

Appendix C: Murdoch University Research Proposal

Conservation management for the long-term survivorship of black cockatoos endemic to the south-west of Western Australia: the application of telemetry to determine spatial ecology on the Perth-Peel Coastal Plain, south-west forest region and key breeding sites in response to a changing environment

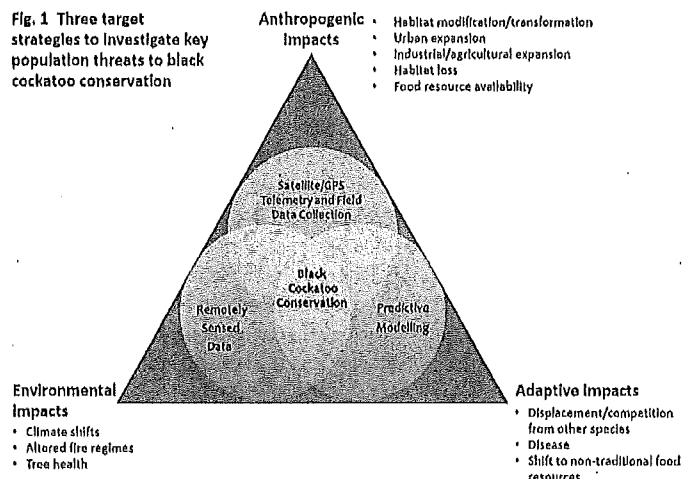
A/Professor Kristin Warren¹, Dr Jill Shephard¹, Dr Lian Yeap¹, Dr Bethany Jackson¹, Dr Rebecca Vaughan-Higgins¹, Rebecca Donaldson¹, Dr David Mitchell², Dr Geoff Barrett², Rick Dawson², Dr Peter Mawson², Dr Denis Saunders³, Professor Willem Bouten⁴

¹ Harry Butler Institute, Murdoch University, ² Department of Biodiversity, Conservation and Attractions, ³ CSIRO, ⁴ University of Amsterdam.

Summary

Western Australia's three endemic black cockatoo species, Carnaby's cockatoos (*Calyptorhynchus latirostris*), Baudin's cockatoos (*Calyptorhynchus baudinii*) and forest red-tailed black cockatoos (*Calyptorhynchus banksii naso*) are threatened and receive special protection as Matters of National Environmental Significance (MNES) under the Environment Protection and Biodiversity Conservation Act (1999)¹⁻⁷. Threats to species survivorship for these black cockatoos are well documented, and include habitat loss and modification, urban and industrial expansion, disease, displacement by competing species, and climate shifts¹⁻² (Figure 1). Despite significant research to date⁸⁻¹³, key information required to address the National Recovery Plan remains outstanding.

Fig. 1 Three target strategies to investigate key population threats to black cockatoo conservation



Background and Significance

Black cockatoos are iconic species in the Western Australian landscape. People hold strong cultural associations with them, and they are well placed to function as flagship species for habitat conservation. All three species occupy a large area of habitat in the south-west of Western Australia, including populations that inhabit the Perth-Peel Coastal Plain; with Carnaby's cockatoos typically migrating from inland breeding areas to coastal habitat during the non-breeding season, Baudin's cockatoos migrating from wintering sites in the Darling Ranges to southern breeding sites, and forest red-tailed black cockatoos moving between the Perth-Peel Coastal Plain and the Darling Ranges. All three species also have populations that inhabit the south-west forests in the southern part of their distribution range, which do not migrate to the Perth-Peel Coastal Plain.

Carnaby's cockatoos are listed as Endangered under Australian Federal law (*Environment Protection and Biodiversity Conservation Act 1999*) and internationally by the IUCN^{1,4}. At the state level they are listed as Endangered under the Western Australia *Biodiversity Conservation Act 2016*⁵. The species has undergone an estimated 50% decline over the last 5 decades¹, including an estimated average decline of 5% per annum across the Perth-Peel Coastal Plain over the last nine years¹³. Overall this has contributed to a suggested 30% range contraction¹, and significant loss of breeding populations^{1,13}.

Forest red-tailed black cockatoos have declined in range by 30% as a result of habitat loss and have suffered a marked decline in population numbers since the 1950s^{2,9,10}. The species is listed as Vulnerable under Australian Federal law (*Environment Protection and Biodiversity Conservation Act 1999*) and under the Western Australia *Biodiversity Conservation Act 2016*⁵. The forest red-tailed black cockatoo fits the IUCN Red List Criteria for Vulnerable due to a projected or suspected decline in the population of more than 30% within the next 10 years or three generations².

Baudin's cockatoos are listed as Endangered at the Federal Level (*Environment Protection and Biodiversity Conservation Act 1999*), and at the State Level (*Biodiversity Conservation Act 2016*)⁵. The population has been in decline over the last 50 years, however in the last eleven years there has been a dramatic decline (over 90%) in the numbers recorded at traditional autumn-winter roost sites in the northern Darling Range¹⁵. Additionally, in 2017 there were unexpectedly few records of large flocks of this species in the south-west¹⁵.

The Carnaby's Cockatoo Recovery Plan¹ lists six priority Actions that must be undertaken to meet the Plan's objectives; and the Forest Black Cockatoo Recovery Plan² lists 13 Actions. The Actions listed in both these Recovery Plans have remained largely out of reach, as they have required information about the species' ecology, movement patterns and habitat use/selection which can only be obtained by large-scale tracking of wild flocks. Our team has developed and tested an approach enabling us to track wild flocks using satellite and GPS tags at both local population and landscape scales; allowing us to collect a suite of hitherto unknown ecological information. Accordingly, this proposed project will address and inform all six priority Actions from the Carnaby's Cockatoo Recovery Plan, and seven of the priority Actions in the Forest Black Cockatoo Recovery Plan.

Threatening processes for Western Australia's black cockatoos are exacerbated by the rapidly increasing urban and industrial development in the Perth-Peel region and the south-west of Western Australia³. Perth's human population is projected to nearly double to 3.5 million by 2050³, emphasising the need to understand flock movements and habitat use, and identify critical feeding and breeding sites; which still remain largely unknown despite early attempts using direct observation^{8-13,16-19}. There is an apparent mismatch between legislative intent and management action as insufficient knowledge exists about basic behavioural ecology across spatial scales, and which habitats are integral to long-term retention of black cockatoos.

Our tracking research, which identifies habitat use and flock movements through the landscape, can assist with identifying key habitats and areas for conservation/revegetation. Our research team is in a strong position to work alongside government to identify areas of habitat that are high-use, and to inform decisions regarding which areas are most appropriate to conserve and manage to halt black cockatoo population declines.

Our research team at Murdoch University has developed a novel tracking methodology for black cockatoos using GPS and satellite telemetry²⁰⁻²¹. Together this will enable researchers to obtain movement, behavioural and ecological data at both the extent and spatial scale (local population and landscape scales) required to inform conservation and land management planning.

Three industry partners have proposed funding for this project in relation to their offset packages – Main Roads Western Australia, the Public Transport Authority (PTA) of Western Australia and Talison Lithium.

Main Roads WA are responsible for the building and provision of road infrastructure and operations in relation to improvement in road efficiency, as well as maintenance of the State's major government roads, bridges and road verges. *It is proposed that Main Roads WA would provide funding for Year 1 of this research project.*

The Government of Western Australia has embarked on the delivery of METRONET, considered to be Perth's most ambitious public transport program, which aims to address sustainability issues in the city through the optimisation of existing rail capacity and building new rail systems. The rail extensions currently underway, and those that are proposed, will impact on remnant vegetation that our current tracking work indicates is important black cockatoo habitat. Various rail projects will affect all three black cockatoo species as follows: Thornlie-Cockburn Link - Carnaby's cockatoo, forest red-tailed black cockatoo; Yanchep Rail Extension Part 1 - Carnaby's cockatoo, forest red-tailed black cockatoo; Yanchep Rail Extension Part 2 - Carnaby's cockatoo, forest red-tailed black cockatoo; Morley-Ellenbrook Line - Carnaby's cockatoo, forest-red-tailed cockatoo; Byford Rail Extension - Carnaby's cockatoo, forest-red tailed cockatoo, Baudin's cockatoo; Midland Line Rail Extension and new Midland Station - Carnaby's cockatoo, forest-red tailed cockatoos; and, Karnup Station - Carnaby's cockatoo, forest red-tailed black cockatoo. *The funding component from PTA in Year 2-5 is linked to proposed rail extension projects for the Thornlie Cockburn Link, Yanchep Rail Extension Part 2 and Morley-Ellenbrook Line.*

Talison Lithium Australia Pty Ltd has been operating the Greenbushes Lithium mine, in the Greenbushes region in south-west WA, for over 30 years. Talison Lithium is proposing to expand its operations at this mine site to increase the production of spodumene ore and lithium mineral concentrate. *The funding component from Talison Lithium in Year 2-5 is linked to the proposed expansion of the Greenbushes Lithium mine.*

These industry partners have indicated that they are committed to sustainable development; they aim to minimise and manage potential environmental impacts and work with the Federal Department of Environment and Energy in relation to environmental approval and offset requirements.

Development and biodiversity conservation are not mutually exclusive. Perth is undergoing rapid and extensive development, and could be a strong model for how development and conservation can be managed synergistically. A large part of what makes Perth special is its unique and endemic biodiversity, which we are fortunate to have in our urban areas; including endangered and iconic black cockatoos. As Perth develops, it will be important to implement effective efforts to ensure the conservation management of our threatened species. For black cockatoos, this will mean identifying and protecting important habitat on the Perth-Peel Coastal Plain, alongside creation of replacement habitat, to ensure no net habitat loss across their distribution range.

Proposed Research

This project aims to utilise innovative tracking methodologies to undertake a movement ecology study of Western Australia's three threatened black cockatoo species, to determine habitat use and threatening processes in modified landscapes. We will track the three species of black cockatoos on the Perth-Peel Coastal Plain and in the south-west forest region of Greenbushes; and additionally – given the importance of the Perth-Peel Coastal Plain for Carnaby's cockatoos during the non-breeding season – we will track Carnaby's cockatoos at key breeding sites to better understand migratory movement dynamics of this species across its distribution range. We will also undertake health research on Carnaby's cockatoos to better understand the potential role of disease as a threatening process for this species. Several potential pathogens associated with avian disease have been found in wild Carnaby's cockatoo nestlings in south-western Australia, including: (1) psittacine beak and feather disease (a listed Key Threatening Process for endangered parrots, Commonwealth EPBC Act 1999); (2) polyoma virus; and, (3) *Chlamydia* sp. The clinical significance of these diseases for species survival remains unknown²². The Murdoch team has also been involved in the investigation of Carnaby's cockatoo Hindlimb Paralysis Syndrome (CHiPs) in adult Carnaby's cockatoos, likely associated with toxicity events involving birds exposed to agricultural chemicals at breeding sites. Each year a number of Carnaby's cockatoos that have migrated back to the Perth-Peel Coastal Plain following the breeding season, are observed with clinical symptoms suggestive of delayed organophosphate neuropathy. This disease is also suspected to have caused two mass mortality events at a key Wheatbelt breeding site (2009, 2012), resulting in a population crash at this site of > 90% of breeding birds, and functional extirpation of this important breeding population²³.

This research will use remote sensing to produce predictive modelling of black cockatoo population movements and habitat use, in association with existing and emerging threats across key range areas. The project offers a novel approach: it combines (a) satellite/GPS derived movement data from our innovative tracking system; (b) other remotely sensed landscape data (e.g. vegetation, water); and (c) existing fire and climate models, to identify crucial habitat characteristics and regions most resilient to impacts of threatening processes (fire, climate shifts, habitat modification, tree health, disease, urban expansion). The data and information they generate will allow collaborators to develop policies and take action to manage land changes, and build resilience into modified landscapes to address black cockatoo declines.

Objectives of the Study

In this study we adopt a multidisciplinary approach (Fig. 1) to meet the following five objectives: 1) Characterise black cockatoo movement and habitat use across the Perth-Peel Coastal Plain and in the south-west forest region of Greenbushes for all three black cockatoo species; 2) Study known Carnaby's cockatoo breeding sites, focussing on characterising habitat suitability, food resource availability and selection, nestling health, specific threatening processes and fledgling dispersal routes; 3) Identify new breeding sites in inland or southern areas for all three species based on migratory movement of birds to breeding grounds; 4) Apply new ecotoxicology methods to investigate CHiPs toxicity cases, particularly in the agricultural zone; and 5) predictively model survivorship scenarios for all three species of black cockatoo using movement, habitat use and threats.

Methods and Analytical Framework to meet Objectives

Obj 1 and Obj 3 – Flock Movements and Habitat Use across the PPCP; south-west forest region of Greenbushes; New Breeding Sites (Carnaby's cockatoo, Baudin's cockatoo and forest red-tailed black cockatoo)

- Double mounted Satellite and GPS tracking – 16 black cockatoos tracked on the Perth-Peel Coastal Plain per annum for four years - 8 Carnaby's cockatoos (4 individuals released into two different resident flocks), 4 Baudin's cockatoos and 4 forest red-tailed black cockatoos released into resident wild flocks on the Perth-Peel Coastal Plain and in south-west forest region of Greenbushes* – use of Switching State-Space Models²⁴, First-Passage Time Analysis²⁵ and GIS to model movement behaviour, habitat selection and foraging strategies. *The number of releases of black cockatoos equates to a total of 10 releases on the Perth-Peel Coastal Plain i.e. 6 for Carnaby's cockatoos, 2 for forest red-tailed black cockatoos, 2 for Baudin's cockatoos) and 6 releases in the south-west forest region of Greenbushes i.e. 2 for Carnaby's cockatoos, 2 for forest red-tailed black cockatoos, 2 for Baudin's cockatoos; fewer Baudin's cockatoos present for rehabilitation and whilst it is likely there will be birds from this species undergoing rehabilitation that will enable a number of release groups, in the event that there are insufficient Baudin's cockatoos to have four release groups over the duration of the project, additional Carnaby's cockatoos or forest red-tailed black cockatoos will be released instead based on discussion with the industry partners and DBCA.

Obj 2 – Known Breeding Sites and Dispersal Routes (Carnaby's cockatoo)

- GPS tracking and Satellite tracking – 9 breeding sites across the distribution range – 3 sites per annum for three years, with each site monitored in the subsequent year through field observations by research staff. Numbers of birds tracked: 4 adult breeding birds per site per year (i.e. 12 birds per year), each double mounted (UVA-BITS and Telonics tags). This will include sites currently monitored by DBCA and Birdlife Australia (e.g. Coomallo Creek, Borden, Lake King, Stennetts Lake), and new sites (e.g. Kojonup and 4 additional sites identified by the tracking work) – Use of Switching State-Space Models, Calculation of Utilisation Distributions and associated Home Range estimators to identify and quantify high use habitat for feeding and watering; Examination of ecological linkages across identified habitat parameters using spatially explicit models (e.g. GLMs, GAMs, Maxent, Random Forests) to assess linkages between bird movement and specific habitat features (including travel

distances to foraging and watering sites). These data will also be used in comparative studies between sites/regions and to inform predictive modelling.

- Energetics – combined analysis using GPS accelerometer derived activity budgets and caloric benefit of identified food species determined by Bomb Calorimetry.
- Nestling health - 20 nestlings per site - 60 nestlings per year. Screening for: i) psittacine beak and feather disease (key threatening process), ii) polyoma virus, iii) *Chlamydia* sp. (present in nestlings in south-western Australia).
- Ground surveys – Identification of new nest hollows, assessment of hollow condition, inventory of current and potential future threats at each site.

Obj 3 – Identify new breeding sites – see Obj 1 above

Obj 4 – CHIPs toxicity (Carnaby's cockatoo)

- Application of new ecotoxicology methods to investigate CHIPs toxicity – catastrophic mass mortality events in 2009 and 2012 led to functional extirpation of a key breeding site in the Wheatbelt²³. Separation Science (e.g. GC-MS) targeting agricultural pesticides undertaken. Samples will include environmental samples, eggshells and cadavers (in the event of further mortality events; CHIPs clinical cases).

Obj 5 – Predictive modelling of perturbation scenarios (Carnaby's cockatoo, forest red-tailed black cockatoo and Baudin's cockatoo)

- Realised movement, habitat use, food and water resources will be modelled in a predictive framework (e.g. using Ensemble Species Distribution Modelling²⁶ against various perturbation scenarios including: habitat loss, habitat modification due to climate shifts, fire impacts, and forecast land-use transformation through urban and industrial expansion to identify landscape critical for supporting species survivorship in the long-term [modelled in 10yr increments for 50-100yrs]). Existing fire and climate models exist, Ensemble modelling allows the prioritisation of habitat according to competing ecological hypotheses and is an excellent tool for guiding conservation management under large-scale disturbance scenarios.

Projected Conservation Management Outcomes

This project will deliver major new flock movement and habitat use information and conservation outcomes. Since 2015, our research team has successfully deployed 84 tags and generated over 140,000 GPS location fixes, 33,000 km of track movement and over 2.8M accelerometer records. The methodology is proven, and facilitates black cockatoo flock movement characterisation at spatial and temporal scales previously unattainable. The proposed research builds on this existing success, with a clear focus on conservation and management of all three black cockatoo species on the Perth-Peel Coastal Plain and the south-west forest region of Greenbushes, as well as at key Carnaby's cockatoo breeding sites across the species distribution range.

We envisage the following direct conservation management outcomes:

1. Identification and prioritisation of key habitat resources, including food, water and vegetation corridors, to maximise the retention of critical conservation value habitat for the long-term retention of Carnaby's cockatoos, Baudin's cockatoos and forest red-tailed black cockatoos across their distribution range.
2. Characterisation of appropriate roosting habitat for all three species of black cockatoo, particularly on the Perth-Peel Coastal Plain – this is important as it is not necessarily synonymous with appropriate feeding or nesting habitat.
3. Characterisation of optimal provisioning distances based on energetics work to inform future offset purchases.
4. Identification of new breeding sites (and nest hollow identification) for all three species of black cockatoo, facilitating additional long-term monitoring and protection of stronghold populations, and informing the purchase of off-set land.
5. Additional knowledge about key threatening processes (disease, displacement spp., pesticide exposure etc) on Perth-Peel Coastal Plain, in the south-west forest region and at breeding sites.
6. Additional knowledge about critical habitat resources and the overall health of breeding populations at key Carnaby's cockatoo breeding sites, which is required to ensure appropriate long-term conservation management of these sites.
7. Correlation of realised species movement ecology with existing PVA models.
8. Facilitation of consultation with local government to maximise future urban and peri-urban design to retain birds on the Perth-Peel Coastal Plain and maximise conservation management.
9. Continued liaison with stakeholder groups which consult with private landowners and industry, to manage properties and to maximise landscape and habitat integrity suitable to sustain black cockatoo populations over the long-term.

This project has been developed in collaboration with DBCA to meet the requirements of the EPBC Act Referral Guidelines for the three black cockatoo species⁴, as well as priority Actions and recommendations from the national Carnaby's Cockatoo Recovery Plan¹; Forest Black Cockatoo Recovery Plan²; Matters of National Environmental Significance (MNES) Significant Impact Guidelines⁴⁻⁷; and the Consideration of MNES by the WA land use planning system Discussion Paper⁶.

In addition, this project will meet the following recommendations from the MNES Paper:

- Will address the Government of Western Australia's MNES Discussion Paper recommendations⁴⁻⁷ to identify key areas within a region to sustain threatened populations, including collecting sufficient spatial information to inform assessments

Appendix D: DBCA’s guide how to design and place artificial hollows

Artificial hollows for Carnaby's cockatoo



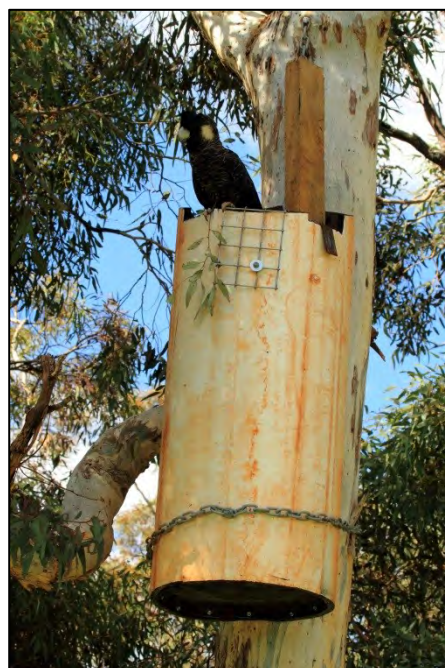
How to design and place artificial hollows for Carnaby's cockatoo

Artificial hollows can be used to help conserve the threatened Carnaby's cockatoo by enabling the cockatoos to breed in areas where natural hollows are limited.

A wide variety of artificial hollow designs have been used with mixed success. Evidence suggests that, while the hollow must meet some basic requirements, other factors such as proximity to existing breeding areas may be more important in determining the success of artificial hollows. Before using this information sheet to construct or install an artificial hollow, you should refer to the criteria listed in the separate information sheet; *When to use artificial hollows for Carnaby's cockatoo*.

This information sheet contains broad guidelines for the design and placement of artificial hollows for Carnaby's cockatoo.

Below are three examples of successful artificial hollows used by Carnaby's cockatoo for nesting. Artificial hollows made from a natural log with cut side entrance (left), white industrial pipe with top entrance (centre) and natural log with natural side entrance (right).



Photos by Christine Groom (left and right) and Rick Dawson (centre)

Walls

The walls of the artificial hollow need to be constructed from a material that is;

- Durable enough to withstand exposure to elements for an extended period of time (i.e. 20+ years).
- Able to simulate the thermal properties of a natural tree hollow.
- Not less than 380 mm in internal diameter.
- Preferably 1.2 m deep overall and 1m deep to top of substrate/nesting material.

Successful artificial hollows have been constructed from sections of salvaged natural hollow, black and white industrial pipe. When using non-natural materials care must be taken to ensure there are no toxic residues and that the materials are safe to ingest.

Base

The base of the artificial hollow must be;

- Able to support the adult and nestling(s).
- Durable enough to last the life of the nest.
- Free draining.
- At least 380 mm in diameter.
- Covered with 200 mm of sterile, dry, free draining material such as charcoal, hardwood woodchips or wood debris.

Do not use:

- Saw dust or fibre products that will retain moisture.

Example materials that could be used for artificial hollow bases include heavy duty stainless steel, galvanised or treated metal (e.g. Zinalume ®), thick hardwood timber slab or marine ply (not chipboard or MDF). The base material must be cut to size to fit internally with sharp or rough edges ground away or curled inwards and fixed securely to the walls.



Carnaby's cockatoo eggs in an artificial hollow.
Photo by Rick Dawson

Entrance

The entrance of the artificial hollow must;

- Have a diameter of at least 270 mm).
- Preferably be top entry which will minimise use by non-target species.

Top entry hollows are unattractive to nest competitors such as feral bees, galahs and corellas. Side entry hollows have been successful in areas where feral bees are not a problem and where galahs and corellas are deterred.

Ladder

For artificial hollows made of non-natural materials, or of processed boards, it is necessary to provide a ladder to enable the birds to climb in and out of the hollow easily.

The ladder must be;

- Securely mounted to the inside of the hollow.
- Made from an open heavy wire mesh such as WeldMesh™ with mesh size of 30 - 50 mm, or heavy chain.

Do not use:

- A material that the birds can chew.
- Galvanized because the birds may grip or chew the ladder and ingest harmful compounds.

If using mesh for the ladder, the width will depend on the curvature of the nest walls. A minimum width of about 60 - 100 mm is recommended.

Sacrificial chewing posts

For artificial hollows made of non-natural materials, or of processed boards, it is necessary to provide sacrificial chewing posts. The birds chew material to prepare a dry base on which to lay their egg(s).

The sacrificial chewing posts must:

- Be made of untreated hardwood such as jarrah, marri or wandoo
- Be thick enough to satisfy the birds' needs between maintenance visits.
- Extend beyond the top of the hollow as an aid to see whether the nest is being used.
- Be placed on the inside of the hollow.
- Be attached in such a way that they are easy to replace e.g. hook over the top of hollow or can slide in/out of a pair of U bolts fitted to the side of the hollow.

It is recommended that at least two posts are provided. Posts 70 x 50 mm have been used, but require replacing at least every second breeding season when the nest is active. Birds do vary in their chewing habits and therefore the frequency at which the chewing posts require replacement will also vary.



Bottom of an artificial hollow showing ladder that is fixed to the wall and a chewed sacrificial post which is 200 mm from the floor.

Photo by Rick Dawson

Mountings

The artificial hollows must be mounted such that:

- The fixings used will last the duration of the nest e.g. galvanized bracket or chain fixed with galvanized coach screws.
- It is secured by more than one anchor for security and stability.
- It is positioned vertically or near vertically.

Placement

Sites should be chosen within current breeding areas and where they can be monitored, but preferably not conspicuous to the general public. It is important that artificial hollows are placed where they will be accessible for future monitoring and maintenance. For more detail refer to the separate information sheet; *When to use artificial hollows for Carnaby's cockatoo*.

The height at which artificial hollows should be placed is variable. The average height of natural hollows in dominant tree species in the area is a good guide. Natural hollows used by Carnaby's cockatoos have been recorded as low as 2 m above the ground. If located on private property the hollows can be placed lower to the ground so they are accessible by ladder or a rope and pulley system can be used. Where public access is possible artificial hollows should be placed at least 7 m high (i.e. higher than most ladders) and on the side of the tree away from public view to reduce the chance of interference or poaching.

Carnaby's cockatoo show no preference for aspect of natural hollows, however, it may still be beneficial to place artificial hollows facing away from prevailing weather and where they receive the most shade and protection.

Artificial hollows to be placed in trees require:

- Accessibility of the tree for a vehicle, elevated work platform or cherry picker.
- A section of trunk 2-3 m long suitable for attaching the hollow

If necessary, artificial hollows may be placed on poles, but this may result in excessive exposure to sun during very hot weather. When erected on poles there should be"

- A hinge at the bottom of the pole that can be secured when the pole is in the upright position.
- Access for a vehicle to assist raising the pole.

Safety

Care needs to be taken when placing artificial hollows to ensure safety is considered at all times. Artificial hollows are heavy and require lifting and manoeuvring into position up to 7 m above the ground.

Maintenance and monitoring

Once artificial hollows have been placed they require monitoring and maintenance to ensure they continue to be useful for nesting by Carnaby's cockatoo. It is important to monitor artificial hollows to determine use by Carnaby's cockatoo, other native species as well as pest species. By undertaking monitoring the success of the design and placement of artificial hollows can be determined and areas for improvement identified for future placement of artificial hollows.

Monitoring can also assess whether any maintenance is required. Without regular maintenance artificial hollows are unlikely to achieve their objective (that is, they will fail to provide nesting opportunities for threatened cockatoos). Therefore it is important to continue a regime of regular maintenance while the artificial hollow is required. It may be several (to many) decades until a natural replacement hollow is available.

For further advice on monitoring and maintenance of artificial hollows please refer to the separate information sheet; *How to monitor and maintain artificial hollows for Carnaby's cockatoo*.



Carnaby's cockatoo female prospecting an artificial hollow.
Photo by Rick Dawson



Example fixing for artificial hollow
Photo by Christine Groom

Acknowledgements

This information sheet is a joint initiative of Birdlife Australia, the Western Australian Museum and the Department of Parks and Wildlife. Many individuals have contributed to its preparation. Special acknowledgement is made for the contributions of Ron Johnstone from the WA Museum, Alan Elliott from the Serpentine-Jarrahdale Land care Centre and Denis Saunders. This updated version was compiled by Rick Dawson Department of Parks and Wildlife).

Other information sheets in the series: Artificial hollows for Carnaby's cockatoo

- *How to design and place artificial hollows for Carnaby's cockatoo*
- *How to monitor and maintain artificial hollows for Carnaby's cockatoo*

Information sheets available on the *Saving Carnaby's cockatoo* webpage:

<http://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-animals/208-saving-carnaby-s-cockatoo>

Appendix E: Preliminary offset calculations

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Corymbia-Xanthorrhoea TEC
EPBC Act status	Endangered
Annual probability of extinction <small>Based on IUCN category definitions</small>	1.2%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator						
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
<i>Ecological communities</i>						
Area of community	Yes		Area	3.94	Hectares	Woodman (2020) 29.4% in 'Very Good' condition, 7.4% in 'Good' condition, 48.7% in 'Degraded' condition, and 0.57% in 'Completely Degraded' condition.
			Quality	4	Scale 0-10	
			Total quantum of impact	1.58	Adjusted hectares	
<i>Threatened species habitat</i>						
Area of habitat	No		Area			
			Quality			
			Total quantum of impact	0.00		
<i>Threatened species</i>						
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact	Units	Information source	
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Birth rate e.g. Change in nest success	No					
Mortality rate e.g. Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator																				
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source
<i>Ecological Communities</i>																				
Area of community	Yes	1.58	Adjusted hectares	Land acquisition	Risk-related time horizon (max. 20 years)	20	Start area (hectares)	26.2	Risk of loss (%) without offset	4%	Risk of loss (%) with offset	0%	Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source
						Future area without offset (adjusted hectares)		25.1	Future area with offset (adjusted hectares)	26.2										
						Time until ecological benefit		20	Start quality (scale of 0-10)	5	Future quality without offset (scale of 0-10)	4								
<i>Threatened species habitat</i>																				
Area of habitat	No				Time over which loss is averted (max. 20 years)		Start area (hectares)		Risk of loss (%) without offset		Risk of loss (%) with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source
						Future area without offset (adjusted hectares)		0.0	Future area with offset (adjusted hectares)	0.0										
						Time until ecological benefit			Start quality (scale of 0-10)		Future quality without offset (scale of 0-10)									
<i>Threatened species</i>																				
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start value	Future value without offset	Future value with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source				
Number of features e.g. Nest hollows, habitat trees	No																			
Condition of habitat Change in habitat condition, but no change in extent	No																			
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g. Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Summary							
Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost (\$)		
					Direct offset (\$)	Other compensatory measures (\$)	Total (\$)
Birth rate	0				\$0.00		\$0.00
Mortality rate	0				\$0.00		\$0.00
Number of individuals	0				\$0.00		\$0.00
Number of features	0				\$0.00		\$0.00
Condition of habitat	0				\$0.00		\$0.00
Area of habitat	0				\$0.00		\$0.00
Area of community	1.576	1.59	100.59%	Yes	\$0.00	N/A	\$0.00
					\$0.00	\$0.00	\$0.00

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Tetraria australiensis
EPBC Act status	Endangered
Annual probability of extinction <small>Based on IUCN category definitions</small>	1.2%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator						
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact	Units	Information source	
<i>Ecological communities</i>						
Area of community	Yes		Area	Hectares		
			Quality	Scale 0-10		
			Total quantum of impact	0.00	Adjusted hectares	
<i>Threatened species habitat</i>						
Area of habitat	Yes		Area	Hectares		
			Quality	Scale 0-10		
			Total quantum of impact	0.00	Adjusted hectares	
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact	Units	Information source	
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
<i>Threatened species</i>						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g. Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	Yes	Removal of individuals	165	Count		

Offset calculator																			
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start area and quality	Future area and quality without offset	Future area and quality with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source			
<i>Ecological Communities</i>																			
Area of community	Yes	Adjusted hectares			Risk-related time horizon (max. 20 years)	Start area (hectares)	Risk of loss (%) without offset	Risk of loss (%) with offset	0.00		0.00	0.00	0.00	#DIV/0!	#DIV/0!				
					Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0											
					Time until ecological benefit	Start quality (scale of 0-10)	Future quality without offset (scale of 0-10)	Future quality with offset (scale of 0-10)	0.00		0.00	0.00							
<i>Threatened species habitat</i>																			
Area of habitat	No				Time over which loss is averted (max. 20 years)	Start area (hectares)	Risk of loss (%) without offset	Risk of loss (%) with offset	0.0		0.0								
					Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0											
					Time until ecological benefit	Start quality (scale of 0-10)	Future quality without offset (scale of 0-10)	Future quality with offset (scale of 0-10)											
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start value	Future value without offset	Future value with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source			
Number of features e.g. Nest hollows, habitat trees	No																		
Condition of habitat Change in habitat condition, but no change in extent	No																		
<i>Threatened species</i>																			
Birth rate e.g. Change in nest success	No																		
Mortality rate e.g. Change in number of road kills per year	No																		
Number of individuals e.g. Individual plants/animals	Yes	165	Count	Land acquisition	1	350	0	350	350	50%	175.00	172.92	104.80%	Yes					

Summary							
Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost (\$)		
					Direct offset (\$)	Other compensatory measures (\$)	Total (\$)
Birth rate	0				\$0.00		\$0.00
Mortality rate	0				\$0.00		\$0.00
Number of individuals	165	172.92	104.80%	Yes	\$0.00	N/A	\$0.00
Number of features	0				\$0.00		\$0.00
Condition of habitat	0				\$0.00		\$0.00
Area of habitat	0				\$0.00		\$0.00
Area of community	0	0.00	#DIV/0!	#DIV/0!	\$0.00	#DIV/0!	#DIV/0!
					\$0.00	#DIV/0!	#DIV/0!

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Tetraria australiensis
EPBC Act status	Endangered
Annual probability of extinction <small>Based on IUCN category definitions</small>	1.2%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator						
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
<i>Ecological communities</i>						
Area of community	Yes		Area	3.44	Hectares	
			Quality	5	Scale 0-10	
			Total quantum of impact	1.72	Adjusted hectares	
<i>Threatened species habitat</i>						
Area of habitat	No		Area			
			Quality			
			Total quantum of impact	0.00		
<i>Threatened species</i>						
Protected matter attributes						
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
<i>Threatened species</i>						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g. Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	Yes	Removal of individuals	165		Count	

Offset calculator																				
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source
<i>Ecological Communities</i>																				
Area of community	Yes	1.72	Adjusted hectares	Land acquisition	Risk-related time horizon (max. 20 years)	20	Start area (hectares)	27.2	Risk of loss (%) without offset	4%	Risk of loss (%) with offset	0%	Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source
						Future area without offset (adjusted hectares)		26.0	Future area with offset (adjusted hectares)	27.2										
						Time until ecological benefit		20	Start quality (scale of 0-10)	6	Future quality without offset (scale of 0-10)	5								
<i>Threatened species habitat</i>																				
Area of habitat	No				Time over which loss is averted (max. 20 years)		Start area (hectares)		Risk of loss (%) without offset		Risk of loss (%) with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source
						Future area without offset (adjusted hectares)		0.0	Future area with offset (adjusted hectares)	0.0										
						Time until ecological benefit			Start quality (scale of 0-10)		Future quality without offset (scale of 0-10)									
<i>Threatened species</i>																				
Protected matter attributes																				
Number of features e.g. Nest hollows, habitat trees	No																			
Condition of habitat Change in habitat condition, but no change in extent	No																			
<i>Threatened species</i>																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g. Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	Yes	165	Count	Land acquisition	1		350	0		350	350	50%	175.00	172.92	104.80%	Yes				

Summary							
Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost (\$)		
					Direct offset (\$)	Other compensatory measures (\$)	Total (\$)
Birth rate	0				\$0.00		\$0.00
Mortality rate	0				\$0.00		\$0.00
Number of individuals	165	172.92	104.80%	Yes	\$0.00	N/A	\$0.00
Number of features	0				\$0.00		\$0.00
Condition of habitat	0				\$0.00		\$0.00
Area of habitat	0				\$0.00		\$0.00
Area of community	1.72	1.73	100.52%	Yes	\$0.00	N/A	\$0.00
					\$0.00	\$0.00	\$0.00

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Carnaby's Cockatoo, Baudin's
EPBC Act status	Endangered
Annual probability of extinction <small>Based on IUCN category definitions</small>	1.2%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator						
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
<i>Ecological communities</i>						
Area of community	No		Area			
			Quality			
			Total quantum of impact	0.00		
<i>Threatened species habitat</i>						
Area of habitat	Yes	Foraging habitat	Area	20.9	Hectares	Stratigen-JBS&G (2011) Black cockatoo habitat quality assessment
			Quality	6	Scale 0-10	
			Total quantum of impact	12.54	Adjusted hectares	
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact	Units	Information source	
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
<i>Threatened species</i>						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g. Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator																				
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start area and quality	Future area and quality without offset	Future area and quality with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source				
<i>Ecological Communities</i>																				
Area of community	No				Risk-related time horizon (max. 20 years)	Start area (hectares)	Risk of loss (%) without offset	Risk of loss (%) with offset												
					Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0												
					Time until ecological benefit	Start quality (scale of 0-10)	Future quality without offset (scale of 0-10)	Future quality with offset (scale of 0-10)												
<i>Threatened species habitat</i>																				
Area of habitat	Yes	12.54	Adjusted hectares	Land acquisition	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	14.2	Risk of loss (%) without offset	5%	Risk of loss (%) with offset	0%	0.67	90%	0.61	0.48	1.23	9.85%	No	
					Future area without offset (adjusted hectares)	13.5	Future area with offset (adjusted hectares)	14.2	0.67	90%	0.61	0.48	1.23	9.85%	No					
					Time until ecological benefit	20	Start quality (scale of 0-10)	8	Future quality without offset (scale of 0-10)	7	Future quality with offset (scale of 0-10)	8	1.00	80%	0.80	0.63				
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start value	Future value without offset	Future value with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source				
Number of features e.g. Nest hollows, habitat trees	Yes		Count						0		0.00	0.00	#DIV/0!	#DIV/0!						
Condition of habitat Change in habitat condition, but no change in extent	No																			
<i>Threatened species</i>																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g. Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Summary							
Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost (\$)		
					Direct offset (\$)	Other compensatory measures (\$)	Total (\$)
Birth rate	0				\$0.00		\$0.00
Mortality rate	0				\$0.00		\$0.00
Number of individuals	0				\$0.00		\$0.00
Number of features	0	0.00	#DIV/0!	#DIV/0!	\$0.00	#DIV/0!	#DIV/0!
Condition of habitat	0				\$0.00		\$0.00
Area of habitat	12.54	1.23	9.85%	No	\$0.00	#DIV/0!	#DIV/0!
Area of community	0				\$0.00		\$0.00
					\$0.00	#DIV/0!	#DIV/0!

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012
This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Carnaby's Cockatoo, Baudin's
EPBC Act status	Endangered
Annual probability of extinction <small>Based on IUCN category definitions</small>	1.2%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator						
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
<i>Ecological communities</i>						
Area of community	No		Area			
			Quality			
			Total quantum of impact	0.00		
<i>Threatened species habitat</i>						
Area of habitat	Yes	Foraging habitat	Area	20.9	Hectares	Stratgen-JBS&G (2021) Black cockatoo habitat quality assessment
			Quality	6	Scale 0-10	
			Total quantum of impact	12.54	Adjusted hectares	
<i>Threatened species</i>						
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Birth rate e.g. Change in nest success	No					
Mortality rate e.g. Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator																				
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source	
<i>Ecological Communities</i>																				
Area of community	No					Risk-related time horizon (max. 20 years)	Start area (hectares)	Risk of loss (%) without offset	0.0	Risk of loss (%) with offset	0.0									
						Future area without offset (adjusted hectares)		Future area with offset (adjusted hectares)												
						Time until ecological benefit	Start quality (scale of 0-10)	Future quality without offset (scale of 0-10)	7	Future quality with offset (scale of 0-10)	8									
<i>Threatened species habitat</i>																				
Area of habitat	Yes	12.54	Adjusted hectares	Land acquisition	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	23.13	Risk of loss (%) without offset	8%	Risk of loss (%) with offset	0%	1.88	90%	1.69	1.33	2.41	19.19%	No	
						Future area without offset (adjusted hectares)	21.2	Future area with offset (adjusted hectares)	23.1	1.00	80%	0.80	0.63							
						Time until ecological benefit	20	Start quality (scale of 0-10)	8	Future quality without offset (scale of 0-10)	7	Future quality with offset (scale of 0-10)	8							
<i>Threatened species</i>																				
Number of features e.g. Nest hollows, habitat trees	Yes		Count									0		0.00	0.00	#DIV/0!	#DIV/0!			
Condition of habitat Change in habitat condition, but no change in extent	No																			
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g. Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Summary							
Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost (\$)		
					Direct offset (\$)	Other compensatory measures (\$)	Total (\$)
Birth rate	0				\$0.00		\$0.00
Mortality rate	0				\$0.00		\$0.00
Number of individuals	0				\$0.00		\$0.00
Number of features	0	0.00	#DIV/0!	#DIV/0!	\$0.00	#DIV/0!	#DIV/0!
Condition of habitat	0				\$0.00		\$0.00
Area of habitat	12.54	2.41	19.19%	No	\$0.00	#DIV/0!	#DIV/0!
Area of community	0				\$0.00		\$0.00
					\$0.00	#DIV/0!	#DIV/0!

Offsets Assessment Guide

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2 October 2012
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Matter of National Environmental Significance	
Name	Carnaby's Cockatoo, Baudin's
EPBC Act status	Endangered
Annual probability of extinction Based on IUCN category definitions	1.2%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator						
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
<i>Ecological communities</i>						
Area of community	No		Area			
			Quality			
			Total quantum of impact	0.00		
<i>Threatened species habitat</i>						
Area of habitat	Yes	Foraging habitat	Area	20.9	Hectares	Stratgen-JBS&G (2011) Black cockatoo habitat quality assessment
			Quality	6	Scale 0-10	
			Total quantum of impact	12.54	Adjusted hectares	
<i>Threatened species</i>						
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Birth rate e.g. Change in nest success	No					
Mortality rate e.g. Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator																						
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source			
<i>Ecological Communities</i>																						
Area of community	No					Risk-related time horizon (max. 20 years)	Start area (hectares)	Risk of loss (%) without offset	0.0	Risk of loss (%) with offset	0.0											
						Future area without offset (adjusted hectares)		Future area with offset (adjusted hectares)														
						Time until ecological benefit	Start quality (scale of 0-10)	Future quality without offset (scale of 0-10)	7	Future quality with offset (scale of 0-10)	8											
<i>Threatened species habitat</i>																						
Area of habitat	Yes	12.54	Adjusted hectares	Land acquisition	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	71	Risk of loss (%) without offset	8%	Risk of loss (%) with offset	0%	5.80	90%	5.22	4.11	6.37	50.81%	No			
						Future area without offset (adjusted hectares)	65.2	Future area with offset (adjusted hectares)	71.0													
						Time until ecological benefit	20	Start quality (scale of 0-10)	8	Future quality without offset (scale of 0-10)	7	Future quality with offset (scale of 0-10)	8	1.00	60%	0.60	0.47					
<i>Threatened species</i>																						
Number of features e.g. Nest hollows, habitat trees	Yes		Count									0		0.00	0.00	#DIV/0!	#DIV/0!					
Condition of habitat Change in habitat condition, but no change in extent	No																					
Birth rate e.g. Change in nest success	No																					
Mortality rate e.g. Change in number of road kills per year	No																					
Number of individuals e.g. Individual plants/animals	No																					

Summary							
Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost (\$)		
					Direct offset (\$)	Other compensatory measures (\$)	Total (\$)
Birth rate	0				\$0.00		\$0.00
Mortality rate	0				\$0.00		\$0.00
Number of individuals	0				\$0.00		\$0.00
Number of features	0	0.00	#DIV/0!	#DIV/0!	\$0.00	#DIV/0!	#DIV/0!
Condition of habitat	0				\$0.00		\$0.00
Area of habitat	12.54	6.37	50.81%	No	\$0.00	#DIV/0!	#DIV/0!
Area of community	0				\$0.00		\$0.00
					\$0.00	#DIV/0!	#DIV/0!

Offsets Assessment Guide

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2 October 2012

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Matter of National Environmental Significance	
Name	Carnaby's Cockatoo, Baudin's
EPBC Act status	Endangered
Annual probability of extinction Based on IUCN category definitions	1.2%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator						
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
<i>Ecological communities</i>						
Area of community	No		Area			
			Quality			
			Total quantum of impact	0.00		
<i>Threatened species habitat</i>						
Area of habitat	Yes	Foraging habitat	Area	20.9	Hectares	Stratgen-JBS&G (2011) Black cockatoo habitat quality assessment
			Quality	6	Scale 0-10	
			Total quantum of impact	12.54	Adjusted hectares	
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact	Units	Information source	
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
<i>Threatened species</i>						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g. Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator																			
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start area and quality	Future area and quality without offset	Future area and quality with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source			
<i>Ecological Communities</i>																			
Area of community	No				Risk-related time horizon (max. 20 years)	Start area (hectares)	Risk of loss (%) without offset	Risk of loss (%) with offset											
					Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0											
					Time until ecological benefit	Start quality (scale of 0-10)	Future quality without offset (scale of 0-10)	Future quality with offset (scale of 0-10)											
<i>Threatened species habitat</i>																			
Area of habitat	Yes	12.54	Adjusted hectares	Land acquisition	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	26.2	Risk of loss (%) without offset	4%	Risk of loss (%) with offset	0%	1.13	90%	1.02	0.80	1.59	12.64%	No
					Future area without offset (adjusted hectares)	25.1	Future area with offset (adjusted hectares)	26.2											
					Time until ecological benefit	20	Start quality (scale of 0-10)	5	Future quality without offset (scale of 0-10)	4	Future quality with offset (scale of 0-10)	5	1.00	60%	0.60	0.47			
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start value	Future value without offset	Future value with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source			
Number of features e.g. Nest hollows, habitat trees	Yes		Count						0		0.00	0.00	#DIV/0!	#DIV/0!					
Condition of habitat Change in habitat condition, but no change in extent	No																		
<i>Threatened species</i>																			
Birth rate e.g. Change in nest success	No																		
Mortality rate e.g. Change in number of road kills per year	No																		
Number of individuals e.g. Individual plants/animals	No																		

Summary							
Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost (\$)		
					Direct offset (\$)	Other compensatory measures (\$)	Total (\$)
Birth rate	0				\$0.00		\$0.00
Mortality rate	0				\$0.00		\$0.00
Number of individuals	0				\$0.00		\$0.00
Number of features	0	0.00	#DIV/0!	#DIV/0!	\$0.00	#DIV/0!	#DIV/0!
Condition of habitat	0				\$0.00		\$0.00
Area of habitat	12.54	1.59	12.64%	No	\$0.00	#DIV/0!	#DIV/0!
Area of community	0				\$0.00		\$0.00
					\$0.00	#DIV/0!	#DIV/0!

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Carnaby's Cockatoo, Baudin's
EPBC Act status	Endangered
Annual probability of extinction Based on IUCN category definitions	1.2%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator						
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
<i>Ecological communities</i>						
Area of community	No		Area			
			Quality			
			Total quantum of impact	0.00		
<i>Threatened species habitat</i>						
Area of habitat	Yes	Foraging habitat	Area	20.9	Hectares	Stratigen-JBS&G (2011) Black cockatoo habitat quality assessment
			Quality	6	Scale 0-10	
			Total quantum of impact	12.54	Adjusted hectares	
<i>Threatened species</i>						
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Birth rate e.g. Change in nest success	No					
Mortality rate e.g. Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator																				
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start area and quality	Future area and quality without offset	Future area and quality with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source				
<i>Ecological Communities</i>																				
Area of community	No				Risk-related time horizon (max. 20 years)	Start area (hectares)	Risk of loss (%) without offset	Risk of loss (%) with offset												
					Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0												
					Time until ecological benefit	Start quality (scale of 0-10)	Future quality without offset (scale of 0-10)	Future quality with offset (scale of 0-10)												
<i>Threatened species habitat</i>																				
Area of habitat	Yes	12.54	Adjusted hectares	Land acquisition	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	1.13	Risk of loss (%) without offset	4%	Risk of loss (%) with offset	0%	0.05	90%	0.04	0.03	0.07	0.57%	No	
					Future area without offset (adjusted hectares)	1.1	Future area with offset (adjusted hectares)	1.1	0.05	90%	0.04	0.03								
					Time until ecological benefit	20	Start quality (scale of 0-10)	5	Future quality without offset (scale of 0-10)	5	Future quality with offset (scale of 0-10)	6	1.00	60%	0.60	0.47				
<i>Threatened species</i>																				
Number of features e.g. Nest hollows, habitat trees	Yes		Count						0		0.00	0.00	#DIV/0!	#DIV/0!						
Condition of habitat Change in habitat condition, but no change in extent	No																			
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g. Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Summary							
Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost (\$)		
					Direct offset (\$)	Other compensatory measures (\$)	Total (\$)
Birth rate	0				\$0.00		\$0.00
Mortality rate	0				\$0.00		\$0.00
Number of individuals	0				\$0.00		\$0.00
Number of features	0	0.00	#DIV/0!	#DIV/0!	\$0.00	#DIV/0!	#DIV/0!
Condition of habitat	0				\$0.00		\$0.00
Area of habitat	12.54	0.07	0.57%	No	\$0.00	#DIV/0!	#DIV/0!
Area of community	0				\$0.00		\$0.00
					\$0.00	#DIV/0!	#DIV/0!

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	FRTBC
EPBC Act status	Vulnerable
Annual probability of extinction <small>Based on IUCN category definitions</small>	0.2%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator						
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
<i>Ecological communities</i>						
Area of community	No		Area			
			Quality			
			Total quantum of impact	0.00		
<i>Threatened species habitat</i>						
Area of habitat	Yes	Foraging habitat	Area	20.9	Hectares	Stratgen-JBS&G (2011) Black cockatoo habitat quality assessment
			Quality	6	Scale 0-10	
			Total quantum of impact	12.54	Adjusted hectares	
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact	Units	Information source	
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
<i>Threatened species</i>						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g. Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator																				
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start area and quality	Future area and quality without offset	Future area and quality with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source				
<i>Ecological Communities</i>																				
Area of community	No				Risk-related time horizon (max. 20 years)	Start area (hectares)	Risk of loss (%) without offset	Risk of loss (%) with offset												
					Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0												
					Time until ecological benefit	Start quality (scale of 0-10)	Future quality without offset (scale of 0-10)	Future quality with offset (scale of 0-10)												
<i>Threatened species habitat</i>																				
Area of habitat	Yes	12.54	Adjusted hectares	Land acquisition	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	14.2	Risk of loss (%) without offset	5%	Risk of loss (%) with offset	0%	0.67	90%	0.61	0.58	1.39	11.08%	No	
					Future area without offset (adjusted hectares)	13.5	Future area with offset (adjusted hectares)	14.2	0.67	90%	0.61	0.58	1.39	11.08%	No					
					Time until ecological benefit	20	Start quality (scale of 0-10)	6	Future quality without offset (scale of 0-10)	5	Future quality with offset (scale of 0-10)	6	1.00	80%	0.80	0.77				
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start value	Future value without offset	Future value with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source				
Number of features e.g. Nest hollows, habitat trees	Yes		Count						0		0.00	0.00	#DIV/0!	#DIV/0!						
Condition of habitat Change in habitat condition, but no change in extent	No																			
<i>Threatened species</i>																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g. Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Summary							
Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost (\$)		
					Direct offset (\$)	Other compensatory measures (\$)	Total (\$)
Birth rate	0				\$0.00		\$0.00
Mortality rate	0				\$0.00		\$0.00
Number of individuals	0				\$0.00		\$0.00
Number of features	0	0.00	#DIV/0!	#DIV/0!	\$0.00	#DIV/0!	#DIV/0!
Condition of habitat	0				\$0.00		\$0.00
Area of habitat	12.54	1.39	11.08%	No	\$0.00	#DIV/0!	#DIV/0!
Area of community	0				\$0.00		\$0.00
					\$0.00	#DIV/0!	#DIV/0!

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	FRTBC
EPBC Act status	Vulnerable
Annual probability of extinction <small>Based on IUCN category definitions</small>	0.2%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator						
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
<i>Ecological communities</i>						
Area of community	No		Area			
			Quality			
			Total quantum of impact	0.00		
<i>Threatened species habitat</i>						
Area of habitat	Yes	Foraging habitat	Area	20.9	Hectares	Stratgen-JBS&G (2021) Black cockatoo habitat quality assessment
			Quality	6	Scale 0-10	
			Total quantum of impact	12.54	Adjusted hectares	
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Number of features <small>e.g. Nest hollows, habitat trees</small>	No					
Condition of habitat <small>Change in habitat condition, but no change in extent</small>	No					
<i>Threatened species</i>						
Birth rate <small>e.g. Change in nest success</small>	No					
Mortality rate <small>e.g. Change in number of road kills per year</small>	No					
Number of individuals <small>e.g. Individual plants/animals</small>	No					

Offset calculator																						
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start area and quality	Future area and quality without offset	Future area and quality with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source						
<i>Ecological Communities</i>																						
Area of community	No				Risk-related time horizon (max. 20 years)	Start area (hectares)	Risk of loss (%) without offset	Risk of loss (%) with offset														
					Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0														
					Time until ecological benefit	Start quality (scale of 0-10)	Future quality without offset (scale of 0-10)	Future quality with offset (scale of 0-10)														
<i>Threatened species habitat</i>																						
Area of habitat	Yes	12.54	Adjusted hectares	Land acquisition	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	23.13	Risk of loss (%) without offset	8%	Risk of loss (%) with offset	0%	Raw gain	1.88	Confidence in result (%)	90%	Adjusted gain	1.69	Net present value	1.63		
					Future area without offset (adjusted hectares)	21.2	Future area with offset (adjusted hectares)	23.1														
					Time until ecological benefit	20	Start quality (scale of 0-10)	8	Future quality without offset (scale of 0-10)	7	Future quality with offset (scale of 0-10)	8	Raw gain	1.00	Confidence in result (%)	80%	Adjusted gain	0.80	Net present value	0.77		
<i>Threatened species</i>																						
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start value	Future value without offset	Future value with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source						
Number of features <small>e.g. Nest hollows, habitat trees</small>	Yes		Count						0		0.00	0.00	#DIV/0!	#DIV/0!								
Condition of habitat <small>Change in habitat condition, but no change in extent</small>	No																					
<i>Threatened species</i>																						
Birth rate <small>e.g. Change in nest success</small>	No																					
Mortality rate <small>e.g. Change in number of road kills per year</small>	No																					
Number of individuals <small>e.g. Individual plants/animals</small>	No																					

Summary							
Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost (\$)		
					Direct offset (\$)	Other compensatory measures (\$)	Total (\$)
Birth rate	0				\$0.00		\$0.00
Mortality rate	0				\$0.00		\$0.00
Number of individuals	0				\$0.00		\$0.00
Number of features	0	0.00	#DIV/0!	#DIV/0!	\$0.00	#DIV/0!	#DIV/0!
Condition of habitat	0				\$0.00		\$0.00
Area of habitat	12.54	2.94	23.41%	No	\$0.00	#DIV/0!	#DIV/0!
Area of community	0				\$0.00		\$0.00
					\$0.00	#DIV/0!	#DIV/0!

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	FRTBC
EPBC Act status	Vulnerable
Annual probability of extinction <small>Based on IUCN category definitions</small>	0.2%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator						
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
<i>Ecological communities</i>						
Area of community	No		Area			
			Quality			
			Total quantum of impact	0.00		
<i>Threatened species habitat</i>						
Area of habitat	Yes	Foraging habitat	Area	20.9	Hectares	Stratgen-JBS&G (2021) Black cockatoo habitat quality assessment
			Quality	6	Scale 0-10	
			Total quantum of impact	12.54	Adjusted hectares	
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact	Units	Information source	
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
<i>Threatened species</i>						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g. Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator																			
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source
<i>Ecological Communities</i>																			
Area of community	No					Risk-related time horizon (max. 20 years)	Start area (hectares)	Risk of loss (%) without offset	0.0	Risk of loss (%) with offset	0.0								
						Future area without offset (adjusted hectares)		Future area with offset (adjusted hectares)											
						Time until ecological benefit	Start quality (scale of 0-10)	Future quality without offset (scale of 0-10)	7	Future quality with offset (scale of 0-10)	8								
<i>Threatened species habitat</i>																			
Area of habitat	Yes	12.54	Adjusted hectares	Land acquisition	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	71	Risk of loss (%) without offset	8%	Risk of loss (%) with offset	0%	5.80	90%	5.22	5.02	7.77	61.97%	No
						Future area without offset (adjusted hectares)	65.2	Future area with offset (adjusted hectares)	71.0	1.00	60%	0.60	0.58						
						Time until ecological benefit	20	Start quality (scale of 0-10)	8	Future quality without offset (scale of 0-10)	7	Future quality with offset (scale of 0-10)	8						
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start value	Future value without offset	Future value with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source			
Number of features e.g. Nest hollows, habitat trees	Yes		Count						0		0.00	0.00	#DIV/0!	#DIV/0!					
Condition of habitat Change in habitat condition, but no change in extent	No																		
<i>Threatened species</i>																			
Birth rate e.g. Change in nest success	No																		
Mortality rate e.g. Change in number of road kills per year	No																		
Number of individuals e.g. Individual plants/animals	No																		

Summary							
Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost (\$)		
					Direct offset (\$)	Other compensatory measures (\$)	Total (\$)
Birth rate	0				\$0.00		\$0.00
Mortality rate	0				\$0.00		\$0.00
Number of individuals	0				\$0.00		\$0.00
Number of features	0	0.00	#DIV/0!	#DIV/0!	\$0.00	#DIV/0!	#DIV/0!
Condition of habitat	0				\$0.00		\$0.00
Area of habitat	12.54	7.77	61.97%	No	\$0.00	#DIV/0!	#DIV/0!
Area of community	0				\$0.00		\$0.00
					\$0.00	#DIV/0!	#DIV/0!

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

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Matter of National Environmental Significance	
Name	FRTBC
EPBC Act status	Vulnerable
Annual probability of extinction <small>Based on IUCN category definitions</small>	0.2%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator						
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
<i>Ecological communities</i>						
Area of community	No		Area			
			Quality			
			Total quantum of impact	0.00		
<i>Threatened species habitat</i>						
Area of habitat	Yes	Foraging habitat	Area	20.9	Hectares	Stratgen-JBS&G (2011) Black cockatoo habitat quality assessment
			Quality	6	Scale 0-10	
			Total quantum of impact	12.54	Adjusted hectares	
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact	Units	Information source	
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
<i>Threatened species</i>						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g. Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator																				
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start area and quality	Future area and quality without offset	Future area and quality with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source				
<i>Ecological Communities</i>																				
Area of community	No				Risk-related time horizon (max. 20 years)	Start area (hectares)	Risk of loss (%) without offset	Risk of loss (%) with offset												
					Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0												
					Time until ecological benefit	Start quality (scale of 0-10)	Future quality without offset (scale of 0-10)	Future quality with offset (scale of 0-10)												
<i>Threatened species habitat</i>																				
Area of habitat	Yes	12.54	Adjusted hectares	Land acquisition	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	26.2	Risk of loss (%) without offset	4%	Risk of loss (%) with offset	0%	1.13	90%	1.02	0.98	1.93	15.42%	No	
					Future area without offset (adjusted hectares)	25.1	Future area with offset (adjusted hectares)	26.2	1.00	60%	0.60	0.58								
					Time until ecological benefit	20	Start quality (scale of 0-10)	5	Future quality without offset (scale of 0-10)	4	Future quality with offset (scale of 0-10)	5								
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start value	Future value without offset	Future value with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source				
Number of features e.g. Nest hollows, habitat trees	Yes		Count						0		0.00	0.00	#DIV/0!	#DIV/0!						
Condition of habitat Change in habitat condition, but no change in extent	No																			
<i>Threatened species</i>																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g. Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Summary							
Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost (\$)		
					Direct offset (\$)	Other compensatory measures (\$)	Total (\$)
Birth rate	0				\$0.00		\$0.00
Mortality rate	0				\$0.00		\$0.00
Number of individuals	0				\$0.00		\$0.00
Number of features	0	0.00	#DIV/0!	#DIV/0!	\$0.00	#DIV/0!	#DIV/0!
Condition of habitat	0				\$0.00		\$0.00
Area of habitat	12.54	1.93	15.42%	No	\$0.00	#DIV/0!	#DIV/0!
Area of community	0				\$0.00		\$0.00
					\$0.00	#DIV/0!	#DIV/0!

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	FRTBC
EPBC Act status	Vulnerable
Annual probability of extinction <small>Based on IUCN category definitions</small>	0.2%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator						
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
<i>Ecological communities</i>						
Area of community	No		Area			
			Quality			
			Total quantum of impact	0.00		
<i>Threatened species habitat</i>						
Area of habitat	Yes	Foraging habitat	Area	20.9	Hectares	Stratgen-JBS&G (2011) Black cockatoo habitat quality assessment
			Quality	6	Scale 0-10	
			Total quantum of impact	12.54	Adjusted hectares	
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact	Units	Information source	
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
<i>Threatened species</i>						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g. Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator																				
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start area and quality	Future area and quality without offset	Future area and quality with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source				
<i>Ecological Communities</i>																				
Area of community	No				Risk-related time horizon (max. 20 years)	Start area (hectares)	Risk of loss (%) without offset	Risk of loss (%) with offset												
					Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0												
					Time until ecological benefit	Start quality (scale of 0-10)	Future quality without offset (scale of 0-10)	Future quality with offset (scale of 0-10)												
<i>Threatened species habitat</i>																				
Area of habitat	Yes	12.54	Adjusted hectares	Land acquisition	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	1.13	Risk of loss (%) without offset	4%	Risk of loss (%) with offset	0%	0.05	90%	0.04	0.04	0.09	0.70%	No	
					Future area without offset (adjusted hectares)	1.1	Future area with offset (adjusted hectares)	1.1												
					Time until ecological benefit	20	Start quality (scale of 0-10)	5	Future quality without offset (scale of 0-10)	5	Future quality with offset (scale of 0-10)	6	1.00	60%	0.60	0.58				
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start value	Future value without offset	Future value with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source				
Number of features e.g. Nest hollows, habitat trees	Yes		Count						0		0.00	0.00	#DIV/0!	#DIV/0!						
Condition of habitat Change in habitat condition, but no change in extent	No																			
<i>Threatened species</i>																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g. Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Summary							
Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost (\$)		
					Direct offset (\$)	Other compensatory measures (\$)	Total (\$)
Birth rate	0				\$0.00		\$0.00
Mortality rate	0				\$0.00		\$0.00
Number of individuals	0				\$0.00		\$0.00
Number of features	0	0.00	#DIV/0!	#DIV/0!	\$0.00	#DIV/0!	#DIV/0!
Condition of habitat	0				\$0.00		\$0.00
Area of habitat	12.54	0.09	0.70%	No	\$0.00	#DIV/0!	#DIV/0!
Area of community	0				\$0.00		\$0.00
					\$0.00	#DIV/0!	#DIV/0!

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Baudin's Cockatoo
EPBC Act status	Endangered
Annual probability of extinction <small>Based on IUCN category definitions</small>	1.2%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator						
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
<i>Ecological communities</i>						
Area of community	No		Area			
			Quality			
			Total quantum of impact	0.00		
<i>Threatened species habitat</i>						
Area of habitat	Yes	Foraging habitat	Area	20.9	Hectares	Stratigen-JBS&G (2011) Black cockatoo habitat quality assessment
			Quality	6	Scale 0-10	
			Total quantum of impact	12.54	Adjusted hectares	
<i>Threatened species</i>						
Birth rate <small>e.g. Change in nest success</small>	No					
Mortality rate <small>e.g. Change in number of road kills per year</small>	No					
Number of individuals <small>e.g. Individual plants/animals</small>	No					

Offset calculator																													
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source									
<i>Ecological Communities</i>																													
Area of community	No					Risk-related time horizon (max. 20 years)	Start area (hectares)	Risk of loss (%) without offset	Future area without offset (adjusted hectares)	0.0	Risk of loss (%) with offset	Future area with offset (adjusted hectares)	0.0																
						Time until ecological benefit		Start quality (scale of 0-10)		Future quality without offset (scale of 0-10)	Future quality with offset (scale of 0-10)																		
<i>Threatened species habitat</i>																													
Area of habitat	Yes	12.54	Adjusted hectares	Land acquisition	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	14.2	Risk of loss (%) without offset	5%	Risk of loss (%) with offset	0%	Raw gain	0.67	Confidence in result (%)	90%	Adjusted gain	0.61	Net present value	0.48	% of impact offset	1.14	9.09%	Minimum (90%) direct offset requirement met?	No	Cost (\$ total)		Information source	
						Time until ecological benefit		20		Start quality (scale of 0-10)		6		Future quality without offset (scale of 0-10)		5		Future quality with offset (scale of 0-10)		6									
<i>Threatened species</i>																													
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start value	Future value without offset	Future value with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source													
Number of features <small>e.g. Nest hollows, habitat trees</small>	Yes		Count						0		0.00	0.00	#DIV/0!	#DIV/0!															
Condition of habitat <small>Change in habitat condition, but no change in extent</small>	No																												
Birth rate <small>e.g. Change in nest success</small>	No																												
Mortality rate <small>e.g. Change in number of road kills per year</small>	No																												
Number of individuals <small>e.g. Individual plants/animals</small>	No																												

Summary							
Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost (\$)		
					Direct offset (\$)	Other compensatory measures (\$)	Total (\$)
Birth rate	0				\$0.00		\$0.00
Mortality rate	0				\$0.00		\$0.00
Number of individuals	0				\$0.00		\$0.00
Number of features	0	0.00	#DIV/0!	#DIV/0!	\$0.00	#DIV/0!	#DIV/0!
Condition of habitat	0				\$0.00		\$0.00
Area of habitat	12.54	1.14	9.09%	No	\$0.00	#DIV/0!	#DIV/0!
Area of community	0				\$0.00		\$0.00
					\$0.00	#DIV/0!	#DIV/0!

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Baudin's Cockatoo
EPBC Act status	Endangered
Annual probability of extinction Based on IUCN category definitions	1.2%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator						
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
<i>Ecological communities</i>						
Area of community	No		Area			
			Quality			
			Total quantum of impact	0.00		
<i>Threatened species habitat</i>						
Area of habitat	Yes	Foraging habitat	Area	20.9	Hectares	Stratigen-JBS&G (2021) Black cockatoo habitat quality assessment
			Quality	6	Scale 0-10	
			Total quantum of impact	12.54	Adjusted hectares	
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact	Units	Information source	
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
<i>Threatened species</i>						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g. Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator																													
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start area and quality	Future area and quality without offset	Future area and quality with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source													
<i>Ecological Communities</i>																													
Area of community	No				Risk-related time horizon (max. 20 years)	Start area (hectares)	Risk of loss (%) without offset	Risk of loss (%) with offset																					
					Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0																					
					Time until ecological benefit	Start quality (scale of 0-10)	Future quality without offset (scale of 0-10)	Future quality with offset (scale of 0-10)																					
<i>Threatened species habitat</i>																													
Area of habitat	Yes	12.54	Adjusted hectares	Land acquisition	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	23.13	Risk of loss (%) without offset	8%	Risk of loss (%) with offset	0%	Raw gain	1.88	Confidence in result (%)	90%	Adjusted gain	1.69	Net present value	1.33	% of impact offset	19.19%	Minimum (90%) direct offset requirement met?	No	Cost (\$ total)		Information source		
					Future area without offset (adjusted hectares)	21.2	Future area with offset (adjusted hectares)	23.1																					
					Time until ecological benefit	20	Start quality (scale of 0-10)	8	Future quality without offset (scale of 0-10)	7	Future quality with offset (scale of 0-10)	8	Raw gain	1.00	Confidence in result (%)	80%	Adjusted gain	0.80	Net present value	0.63									
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start value	Future value without offset	Future value with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source													
Number of features e.g. Nest hollows, habitat trees	Yes		Count						0		0.00	0.00	#DIV/0!	#DIV/0!															
Condition of habitat Change in habitat condition, but no change in extent	No																												
<i>Threatened species</i>																													
Birth rate e.g. Change in nest success	No																												
Mortality rate e.g. Change in number of road kills per year	No																												
Number of individuals e.g. Individual plants/animals	No																												

Summary							
Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost (\$)		
					Direct offset (\$)	Other compensatory measures (\$)	Total (\$)
Birth rate	0				\$0.00		\$0.00
Mortality rate	0				\$0.00		\$0.00
Number of individuals	0				\$0.00		\$0.00
Number of features	0	0.00	#DIV/0!	#DIV/0!	\$0.00	#DIV/0!	#DIV/0!
Condition of habitat	0				\$0.00		\$0.00
Area of habitat	12.54	2.41	19.19%	No	\$0.00	#DIV/0!	#DIV/0!
Area of community	0				\$0.00		\$0.00
					\$0.00	#DIV/0!	#DIV/0!

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

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Matter of National Environmental Significance	
Name	Baudin's Cockatoo
EPBC Act status	Endangered
Annual probability of extinction Based on IUCN category definitions	1.2%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator						
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
<i>Ecological communities</i>						
Area of community	No		Area			
			Quality			
			Total quantum of impact	0.00		
<i>Threatened species habitat</i>						
Area of habitat	Yes	Foraging habitat	Area	20.9	Hectares	Stratigen-JBS&G (2021) Black cockatoo habitat quality assessment
			Quality	6	Scale 0-10	
			Total quantum of impact	12.54	Adjusted hectares	
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact	Units	Information source	
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
<i>Threatened species</i>						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g. Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator																				
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start area and quality	Future area and quality without offset	Future area and quality with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source				
<i>Ecological Communities</i>																				
Area of community	No				Risk-related time horizon (max. 20 years)	Start area (hectares)	Risk of loss (%) without offset	Risk of loss (%) with offset												
					Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0												
					Time until ecological benefit	Start quality (scale of 0-10)	Future quality without offset (scale of 0-10)	Future quality with offset (scale of 0-10)												
<i>Threatened species habitat</i>																				
Area of habitat	Yes	12.54	Adjusted hectares	Land acquisition	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	71	Risk of loss (%) without offset	8%	Risk of loss (%) with offset	0%	5.80	90%	5.22	4.11	6.37	50.81%	No	
					Future area without offset (adjusted hectares)	65.2	Future area with offset (adjusted hectares)	71.0	1.00	60%	0.60	0.47								
					Time until ecological benefit	20	Start quality (scale of 0-10)	8	Future quality without offset (scale of 0-10)	7	Future quality with offset (scale of 0-10)	8								
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start value	Future value without offset	Future value with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source				
Number of features e.g. Nest hollows, habitat trees	Yes		Count						0		0.00	0.00	#DIV/0!	#DIV/0!						
Condition of habitat Change in habitat condition, but no change in extent	No																			
<i>Threatened species</i>																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g. Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Summary							
Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost (\$)		
					Direct offset (\$)	Other compensatory measures (\$)	Total (\$)
Birth rate	0				\$0.00		\$0.00
Mortality rate	0				\$0.00		\$0.00
Number of individuals	0				\$0.00		\$0.00
Number of features	0	0.00	#DIV/0!	#DIV/0!	\$0.00	#DIV/0!	#DIV/0!
Condition of habitat	0				\$0.00		\$0.00
Area of habitat	12.54	6.37	50.81%	No	\$0.00	#DIV/0!	#DIV/0!
Area of community	0				\$0.00		\$0.00
					\$0.00	#DIV/0!	#DIV/0!

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Baudin's Cockatoo
EPBC Act status	Endangered
Annual probability of extinction <small>Based on IUCN category definitions</small>	1.2%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator						
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
<i>Ecological communities</i>						
Area of community	No		Area			
			Quality			
			Total quantum of impact	0.00		
<i>Threatened species habitat</i>						
Area of habitat	Yes	Foraging habitat	Area	20.9	Hectares	Stratigen-JBS&G (2011) Black cockatoo habitat quality assessment
			Quality	6	Scale 0-10	
			Total quantum of impact	12.54	Adjusted hectares	
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Number of features <small>e.g. Nest hollows, habitat trees</small>	No					
Condition of habitat <small>Change in habitat condition, but no change in extent</small>	No					
<i>Threatened species</i>						
Birth rate <small>e.g. Change in nest success</small>	No					
Mortality rate <small>e.g. Change in number of road kills per year</small>	No					
Number of individuals <small>e.g. Individual plants/animals</small>	No					

Offset calculator																				
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start area and quality	Future area and quality without offset	Future area and quality with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source				
<i>Ecological Communities</i>																				
Area of community	No				Risk-related time horizon (max. 20 years)	Start area (hectares)	Risk of loss (%) without offset	Risk of loss (%) with offset												
					Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0												
					Time until ecological benefit	Start quality (scale of 0-10)	Future quality without offset (scale of 0-10)	Future quality with offset (scale of 0-10)												
<i>Threatened species habitat</i>																				
Area of habitat	Yes	12.54	Adjusted hectares	Land acquisition	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	26.2	Risk of loss (%) without offset	4%	Risk of loss (%) with offset	0%	1.13	90%	1.02	0.80	1.59	12.64%	No	
					Future area without offset (adjusted hectares)	25.1	Future area with offset (adjusted hectares)	26.2	1.00	60%	0.60	0.47								
					Time until ecological benefit	20	Start quality (scale of 0-10)	5	Future quality without offset (scale of 0-10)	4	Future quality with offset (scale of 0-10)	5								
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start value	Future value without offset	Future value with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source				
Number of features <small>e.g. Nest hollows, habitat trees</small>	Yes		Count						0		0.00	0.00	#DIV/0!	#DIV/0!						
Condition of habitat <small>Change in habitat condition, but no change in extent</small>	No																			
<i>Threatened species</i>																				
Birth rate <small>e.g. Change in nest success</small>	No																			
Mortality rate <small>e.g. Change in number of road kills per year</small>	No																			
Number of individuals <small>e.g. Individual plants/animals</small>	No																			

Summary							
Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost (\$)		
					Direct offset (\$)	Other compensatory measures (\$)	Total (\$)
Birth rate	0				\$0.00		\$0.00
Mortality rate	0				\$0.00		\$0.00
Number of individuals	0				\$0.00		\$0.00
Number of features	0	0.00	#DIV/0!	#DIV/0!	\$0.00	#DIV/0!	#DIV/0!
Condition of habitat	0				\$0.00		\$0.00
Area of habitat	12.54	1.59	12.64%	No	\$0.00	#DIV/0!	#DIV/0!
Area of community	0				\$0.00		\$0.00
					\$0.00	#DIV/0!	#DIV/0!

Offsets Assessment Guide

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Matter of National Environmental Significance	
Name	Baudin's Cockatoo
EPBC Act status	Endangered
Annual probability of extinction <small>Based on IUCN category definitions</small>	1.2%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator						
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
<i>Ecological communities</i>						
Area of community	No		Area			
			Quality			
			Total quantum of impact	0.00		
<i>Threatened species habitat</i>						
Area of habitat	Yes	Foraging habitat	Area	20.9	Hectares	Stratigen-JBS&G (2011) Black cockatoo habitat quality assessment
			Quality	6	Scale 0-10	
			Total quantum of impact	12.54	Adjusted hectares	
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact	Units	Information source	
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
<i>Threatened species</i>						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g. Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator																				
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start area and quality	Future area and quality without offset	Future area and quality with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source				
<i>Ecological Communities</i>																				
Area of community	No				Risk-related time horizon (max. 20 years)	Start area (hectares)	Risk of loss (%) without offset	Risk of loss (%) with offset												
					Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0												
					Time until ecological benefit	Start quality (scale of 0-10)	Future quality without offset (scale of 0-10)	Future quality with offset (scale of 0-10)												
<i>Threatened species habitat</i>																				
Area of habitat	Yes	12.54	Adjusted hectares	Land acquisition	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	1.13	Risk of loss (%) without offset	4%	Risk of loss (%) with offset	0%	0.05	90%	0.04	0.03	0.07	0.57%	No	
					Future area without offset (adjusted hectares)	1.1	Future area with offset (adjusted hectares)	1.1	0.05	90%	0.04	0.03								
					Time until ecological benefit	20	Start quality (scale of 0-10)	5	Future quality without offset (scale of 0-10)	5	Future quality with offset (scale of 0-10)	6	1.00	60%	0.60	0.47				
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start value	Future value without offset	Future value with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source				
Number of features e.g. Nest hollows, habitat trees	Yes		Count						0		0.00	0.00	#DIV/0!	#DIV/0!						
Condition of habitat Change in habitat condition, but no change in extent	No																			
<i>Threatened species</i>																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g. Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Summary							
Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost (\$)		
					Direct offset (\$)	Other compensatory measures (\$)	Total (\$)
Birth rate	0				\$0.00		\$0.00
Mortality rate	0				\$0.00		\$0.00
Number of individuals	0				\$0.00		\$0.00
Number of features	0	0.00	#DIV/0!	#DIV/0!	\$0.00	#DIV/0!	#DIV/0!
Condition of habitat	0				\$0.00		\$0.00
Area of habitat	12.54	0.07	0.57%	No	\$0.00	#DIV/0!	#DIV/0!
Area of community	0				\$0.00		\$0.00
					\$0.00	#DIV/0!	#DIV/0!