Public Transport Authority

Byford Rail Extension

Offset Strategy, August 2021

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Document Information

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Prepared by	BL
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Prepared for	EPA Services Department of Agriculture, Water and the Environment (DAWE)
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Version Control

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REV_A	March 2021	DRAFT	BL	JS	PM
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Distribution List

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Executive Summary

The Public Transport Authority of Western Australia (PTA) is proposing to develop the Byford Rail Extension Proposal (The Proposal) as part of the Western Australian Government's METRONET vision. The Proposal extends the existing electrified passenger rail network 8 km from Armadale Station, 26 km southeast of Perth, to the proposed new Byford Station.

The assessment of the Proposal has concluded that, after avoidance and mitigation, significant residual impacts from the Proposal remain and will require an offset. The significant residual impacts are:

- 2.26 ha of impacts on threatened ecological community (TEC) *Corymbia calophylla - Kingia australis* woodlands on heavy soils (community identifier SCP3a), listed as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and assessed as Critically Endangered by the WA Threatened Ecological Communities Advisory Committee.
- 0.48 ha of impacts on threatened ecological community (TEC) *Corymbia calophylla - Xanthorrhoea preissii* woodlands and shrublands (community identifier SCP3c), listed as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and assessed as Critically Endangered by the WA Threatened Ecological Communities Advisory Committee.
- 19.3 ha of impacts (8.65 ha of Moderate quality and 10.67 ha of Low quality) on Carnaby's cockatoo *Calyptorhynchus latirostris* foraging habitat, listed as Endangered under the EPBC Act and the *Biodiversity Conservation Act 2016* (BC Act).
- 61.1 ha of impacts (8.65 ha of Moderate to High quality and 52.49 ha of Low) on forest red-tailed black cockatoo *Calyptorhynchus banksia* foraging habitat, listed as Vulnerable under the EPBC Act and the BC Act.
- 8.65 ha of impacts (of Moderate to High quality) on Baudin's cockatoo *Calyptorhynchus baudinii* foraging habitat, listed as Endangered under the EPBC Act and the BC Act.
- Impacts on 139 black cockatoo potential breeding trees.
- 2.6 ha of impacts on Conservation Category Wetlands (CCW) (assessed as high conservation value).
- 1.5 ha of impacts on native vegetation within Bush Forever areas.
- 0.68 ha of Guildford Complex.

The PTA will counterbalance the significant residual impacts to the threatened ecological communities through on-ground management at Lambert Lane Nature Reserve (SCP3a), Brickwood Reserve (SCP3a) and Roman Road Nature Reserve (SCP3c). The reserves are under increasing pressure from threats associated with the urban environment in which they are located including weed infestations, dieback, vandalism, rubbish dumping, pest fauna and uncontrolled access for recreational and other uses. Threatened ecological communities within these Reserves receive limited on-ground management.

The PTA will also provide a financial contribution towards one or more research activities that advance practical knowledge about the restoration and enhancement of degraded areas within the SCP3a ecological community.

Management actions conducted under the offset will prevent further degradation and/or maintain or improve the condition of existing occurrences of SCP3a and SCP3c threatened ecological communities. Management actions include revegetation of Degraded areas of specific floristic

community types within larger occurrences or on small sites to provide a buffer to the existing ecological communities.

The PTA have a high level of confidence that on-ground management can prevent further degradation, maintain and/or improve the existing condition and will provide the best environmental outcome for the ecological community, ensuring the larger patches persist in the long-term.

The PTA will counterbalance the impacts to black cockatoo habitat and Guildford Complex at the Lowlands Nature Reserve, the PTA's advanced offset site.

The PTA will counterbalance impacts to Conservation Category Wetlands and Bush Forever at Lambert Lane Nature Reserve, Brickwood Reserve and Roman Road Nature Reserve.

Lambert Lane and Roman Road Nature Reserves are Department of Biodiversity, Conservation and Attractions (DBCA) conservation sites. The Shire of Serpentine Jarrahdale manages Brickwood Reserve.

This Offset Strategy addresses how the proposed offsets meet Western Australian and Commonwealth offset principles, recovery plans, conservation advice and technical guidance for the relevant environmental matters.

The PTA have assessed the offsets proposed to counterbalance the significant residual impacts of the Proposal against the EPA's objective for each factor and consider that with the avoidance and mitigation measures undertaken and the proposed offsets, the EPA's objectives for each environmental factor are met. A summary of the proposed offsets is in Table ES 1.

Table ES 1: Summary of proposed offsets

Environmental Value	Significant residual impact	Proposed offset(s)	Quantum of offset extent
SCP3a	2.26 ha	Lambert Lane Nature Reserve (3.3 ha) and Brickwood Reserve (6.5 ha) - on-ground management including revegetation Research Project.	9.8 ha
SCP3c	0.48 ha	Roman Road Nature Reserve - on-ground management including revegetation	3 ha
Carnaby's cockatoo foraging habitat	19.3 ha consisting of 8.65 ha of Moderate quality and 10.67 ha of Low quality	Lowlands Nature Reserve – on-ground management	78.8 ha
Forest red-tailed black cockatoo foraging habitat	61.1 ha consisting of 8.65 ha of Moderate to High quality and 52.49 ha of Low quality		232.5 ha
Baudin's cockatoo foraging habitat	8.65 ha of Moderate to High quality		70.6 ha
Black cockatoo potential breeding trees	139 trees		417 trees
Conservation Category Wetlands	2.6 ha	Lambert Lane Nature Reserve and Brickwood Reserve - on-ground management including revegetation	7.8 ha

Environmental Value	Significant residual impact	Proposed offset(s)	Quantum of offset extent
Bush Forever	1.5 ha	Lambert Lane Nature Reserve - on-ground management including revegetation	3.0 ha
Guildford Complex	0.68 ha	Lowlands Nature Reserve – on-ground management	1.36 ha

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1. Introduction

1.1. Project overview

The Western Australian Government has developed a vision to implement and build METRONET, which will aid in transforming Perth's public transport network (METRONET 2021). The long-term vision to 2050 is for a public transport network to support a population of 3.5 million people.

The Public Transport Authority of Western Australia (PTA) is proposing to develop the Byford Rail Extension Proposal (The Proposal) as part of the Western Australian Government's METRONET vision. The Byford Rail Extension project (BRE) extends the existing electrified passenger rail network 8 km from Armadale Station, 26 km southeast of Perth, to the proposed new Byford Station.

The northern section of the Proposal is within the City of Armadale. The southern section is within the Shire of Serpentine Jarrahdale. The Proposal is an integral component of Perth's long-term public transport network, providing essential transportation services to the expanding south eastern suburbs and delivering improved sustainability outcomes envisioned by the Western Australian Government's Perth and Peel@3.5million plan (DPLH & WAPC 2018).

The Proposal includes a Development Envelope containing all potential construction and operational activities (Figure 1). Within the Development Envelope, a smaller indicative Footprint (the Footprint) is the predicted disturbance area for permanent infrastructure, temporary construction such as laydown areas, construction access, permanent access, and the operating railway.

The PTA assessed the Proposal's direct impacts by environmental factor (see Flora and Vegetation, Terrestrial Fauna, Inland Waters, Social Surroundings, Other Environmental Factors and Matters of National Environmental Significance (MNES) Chapters in the Environmental Review Document) by analysing environmental values and assessing impacts occurring within the Footprint (PTA 2021).

1.2. EPA objective

To identify and quantify the significant residual impacts and proposed offsets, including completing the offset template and the residual impact significance model.

1.3. Policy and guidance

The PTA has used the following legislation, policy and guidelines to propose appropriate offsets that counterbalance the significant residual impacts of the Proposal.

1.3.1. State

- *Biodiversity Conservation Act 2016* (BC Act)
- *Environmental Protection Act 1986* (EP Act)
- Western Australian Environmental Offsets Policy (GoWA 2011)
- Western Australian Environmental Offsets Guidelines (GoWA 2014)
- Western Australian Environmental Offsets Template (EPA 2014)
- State Planning Policy 2.8 (SPP 2.8) (WAPC 2010)

1.3.2. Commonwealth

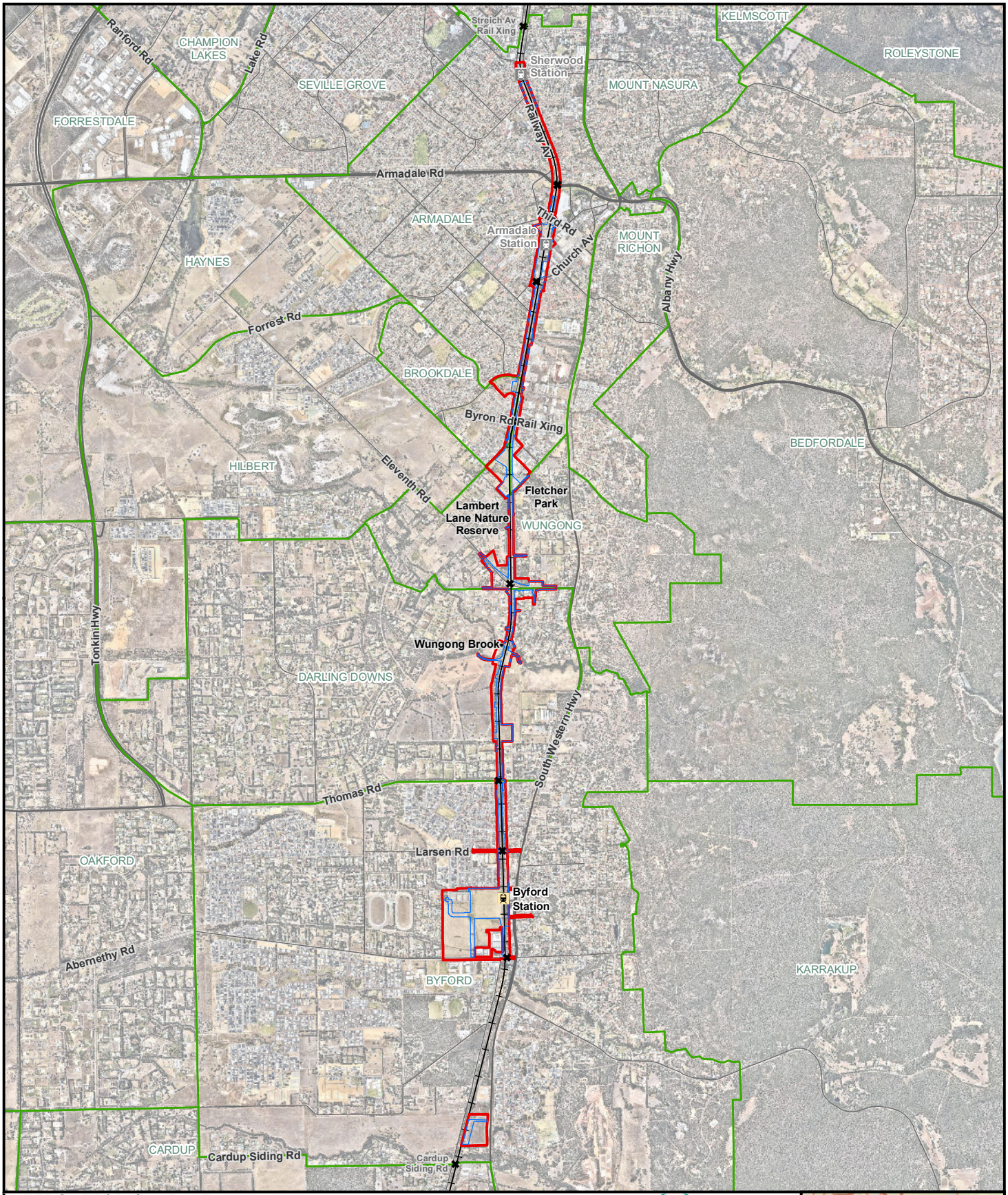
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- EPBC Act Environmental Offsets Policy (DSEWPaC 2012a)
- Offsets Assessment Guide (DSEWPaC 2012b)
- How to use the Offsets assessment guide (DSEWPaC 2012c)

1.3.3. Conservation advice and recovery plans

- Approved Conservation Advice for *Corymbia calophylla - Kingia australis* woodlands on heavy soils of the Swan Coastal Plain (DotEE 2017a)
- *Corymbia calophylla - Kingia australis* woodlands on heavy soil (Swan Coastal Plain Community type 3a - Gibson et al. 1994), Interim Recovery Plan 2011-2016 (DEC 2011)
- *Corymbia calophylla - Kingia australis* woodlands on heavy soil (Swan Coastal Plain Community type 3a - Gibson et al. 1994), Interim Recovery Plan 2000-2003. Interim Recovery Plan No. 59 (Blyth & English 2000a)
- Approved Conservation Advice for *Corymbia calophylla - Xanthorrhoea preissii* woodlands and shrublands of the Swan Coastal Plain (DotEE 2017b)
- *Corymbia calophylla - Xanthorrhoea preissii* woodlands and shrublands (Swan Coastal Plain Community type 3c - Gibson et al. 1994) Interim Recovery Plan 2000-2003 (Blyth & English 2000b)
- Carnaby's cockatoo (*Calyptorhynchus latirostris*) Recovery Plan. Department of Parks and Wildlife, Perth, Western Australia (DPaW 2013)
- Carnaby's Cockatoo in Environmental Impact Assessment in the Perth and Peel Region, Environmental Protection Authority, Western Australia (EPA 2019)
- Approved Conservation Advice for *Calyptorhynchus banksii naso* (Forest Red-tailed Black Cockatoo) (DEWHA 2009)
- Conservation Advice *Calyptorhynchus baudinii* Baudin's cockatoo (TSSC 2018)
- Forest Black Cockatoo (Baudin's Cockatoo *Calyptorhynchus baudinii* and Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso*) Recovery Plan. Department of Environment and Conservation, Perth (DEC 2008)
- Revised draft referral guideline for three threatened black cockatoo species: Carnaby's Cockatoo, Baudin's Cockatoo and the Forest Red-tailed Black Cockatoo (DotEE 2017c)
- EPBC Act referral guidelines for three threatened black cockatoo species (DSEWPAC 2012d)

1.4. Purpose and scope

The purpose and scope of this Offset Strategy is to demonstrate that the PTA can counterbalance the Proposal's significant residual environmental impact to MNES and significant State environmental values.



METRONET | Byford Rail Extension

Figure 1 | **The Proposal**

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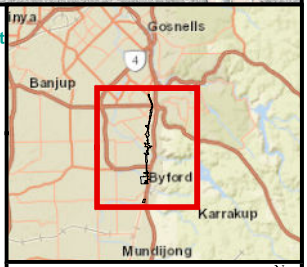
Legend

- Footprint
- Development Envelope
- Indicative Railway Alignment
- Proposed Railway Station
- Existing Railway Station
- Rail Crossing
- Locality Boundary



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2. Significant residual impacts

2.1. Significant residual environmental impacts

The EPA (GoWA 2014) define significant residual impacts as follows:

> *In general, significant residual impacts include those that affect rare and endangered plants and animals (such as declared rare flora and threatened species that are protected by statute), areas within the formal conservation reserve system, important environmental systems and species that are protected under international agreements (such as Ramsar listed wetlands) and areas that are already defined as being critically impacted in a cumulative context. Impacts may also be significant if, for example, they could cause plants or animals to become rare or endangered, or they affect vegetation which provides important ecological functions.*

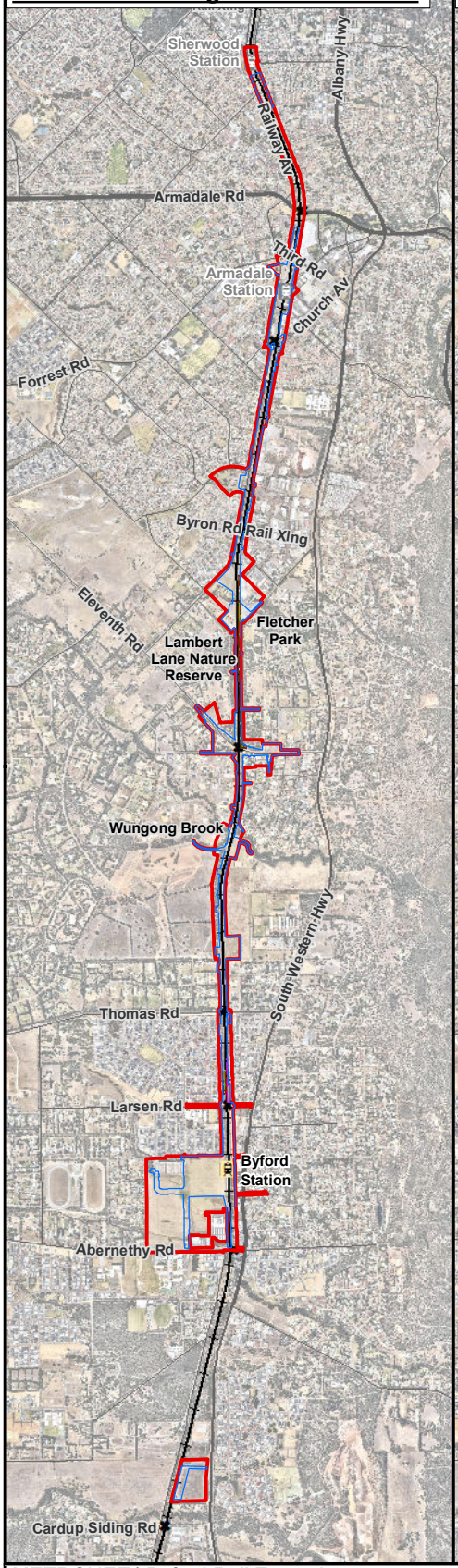
The Byford Rail Extension Environmental Review Document (ERD) (PTA 2021) assessed the significant residual impacts of the Proposal. The PTA revised the significant residual impacts following the public environmental review period. The environmental impacts on significant environmental factors following consideration and application of avoidance, minimisation and mitigation measures are to the following values:

- Threatened ecological community (TEC) *Corymbia calophylla - Kingia australis* woodlands on heavy soils (SCP3a), listed as Endangered under the EPBC Act and assessed as Critically Endangered by the WA Threatened Ecological Communities Advisory Committee.
- Threatened ecological community *Corymbia calophylla - Xanthorrhoea preissii* woodlands and shrublands (SCP3c), listed as Endangered under the EPBC Act and assessed as Critically Endangered by the WA Threatened Ecological Communities Advisory Committee.
- Carnaby's cockatoo *Calyptorhynchus latirostris*, listed as Endangered under the EPBC Act and the BC Act.
- Forest red-tailed black cockatoo *Calyptorhynchus banksii*, listed as Vulnerable under the EPBC Act and the BC Act.
- Baudin's cockatoo *Calyptorhynchus baudinii*, listed as Endangered under the EPBC Act and the BC Act.
- Conservation Category Wetlands – wetlands which support a high level of attributes and functions and are the highest priority for management (DBCA 2012).
- Bush Forever – identifies regionally significant bushland for protection in the Perth Metropolitan area (GoWA 2002a).

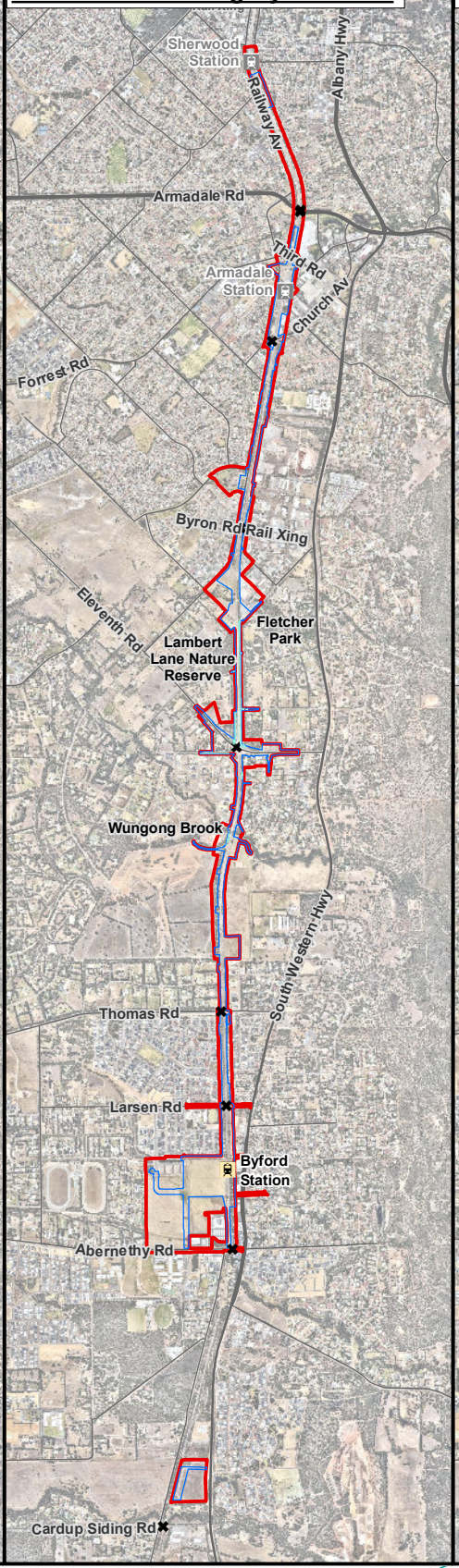
The PTA have prepared a Residual Impact Significance Model (RISM), as per Figure 3 in the WA Environmental Offsets Guidelines. The RISM is in Appendix A.

The extent, location and condition of significant residual impacts within the proposal Footprint are in Figures 2 through 4.

Threatend Ecological Communities



Conservation Category Wetlands



Bush Forever/ Guildford Complex

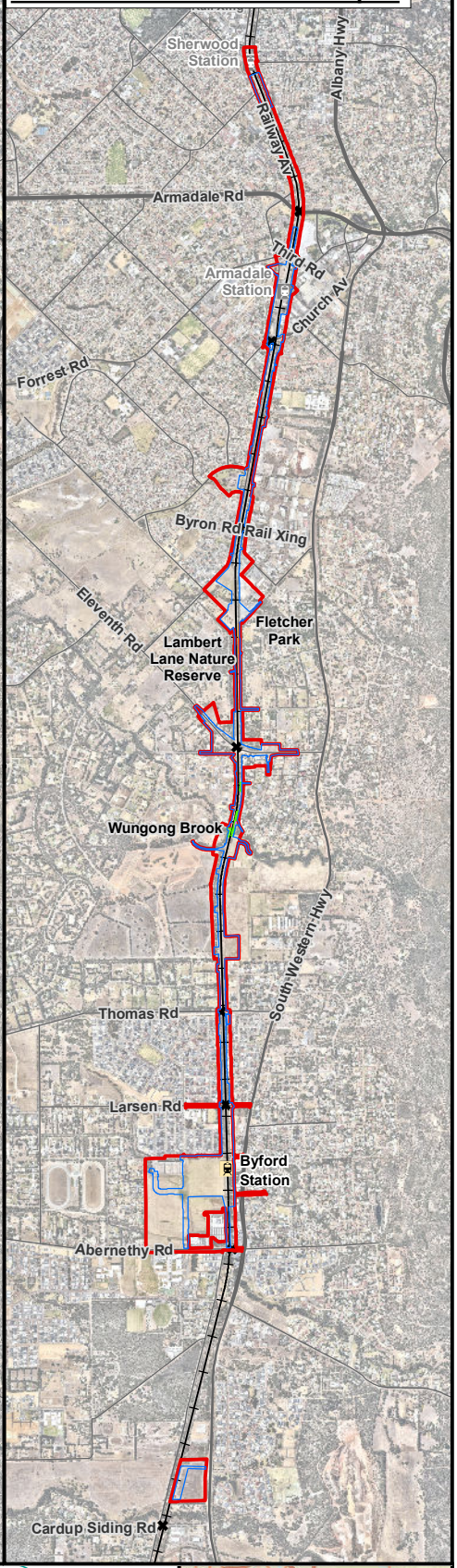


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Figure 2 | **Significant Residual Impacts - Threatend Ecological Communities (TEC), Consevation Category Wetlands (CCW), Bush Forever and Guildford Complex**

Public Transport Authority

Legend

- Footprint
- Development Envelope
- Indicative Railway Alignment
- Proposed Railway Station
- Existing Railway Station
- Rail Crossing

PEC/TEC (GHD, 2021)

- SCP3a
- SCP3c

EPBC and WA TEC *Corymbia calophylla - Kingia australis* woodlands on heavy soils(FCT3a) and *Xanthorrhoea preissii woodlands and shrublands* (FCT3c) (Condition)

- Excellent
- Very Good
- Good
- Degraded

- Conservation Category Wetlands (CCW)
- Guildford Complex

Guildford Complex (Condition)

- Degraded

Bush Forever (Condition)

- Excellent
- Good
- Degraded
- Completely Degraded

A
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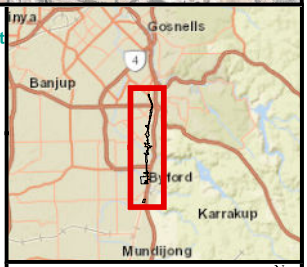

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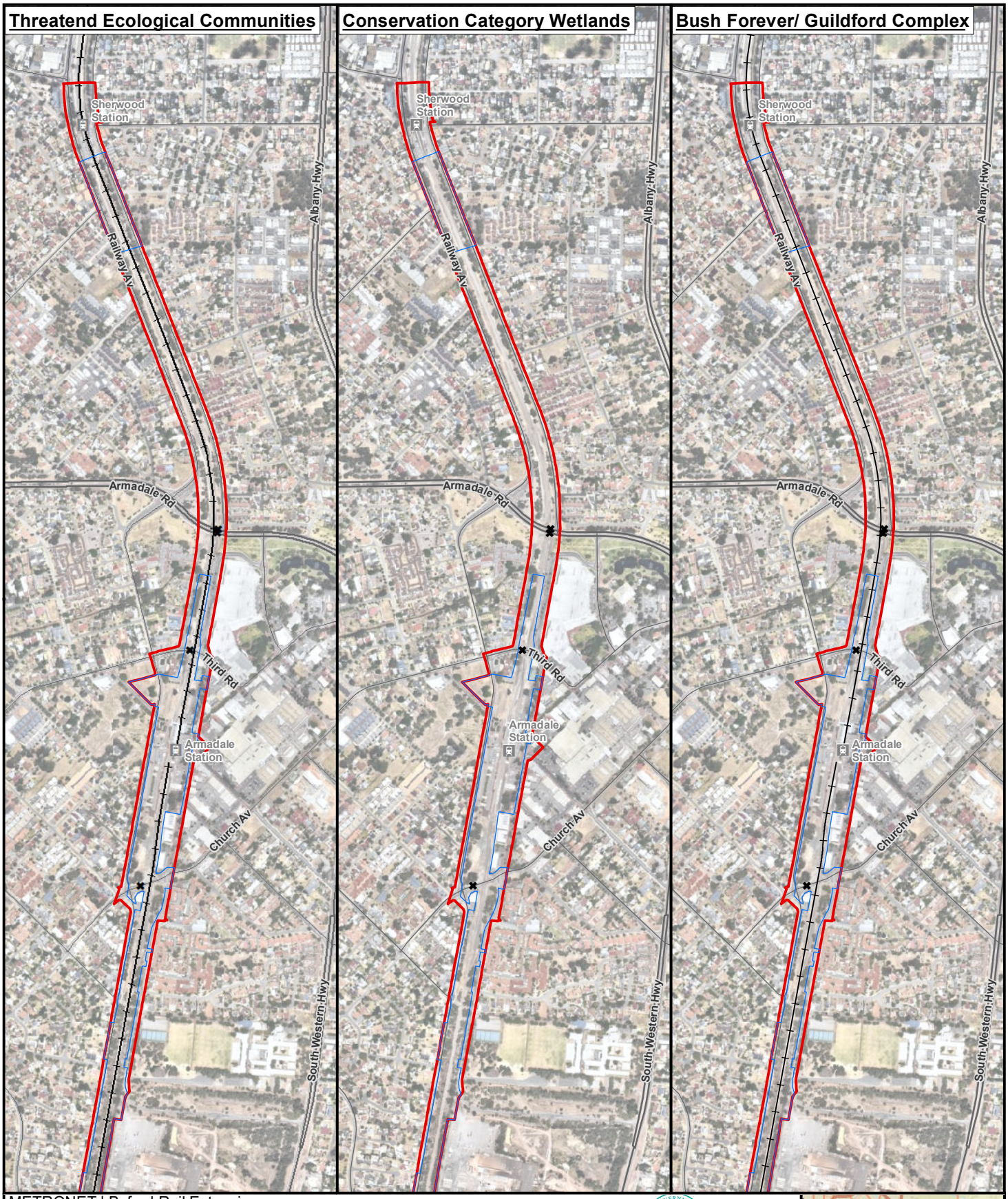


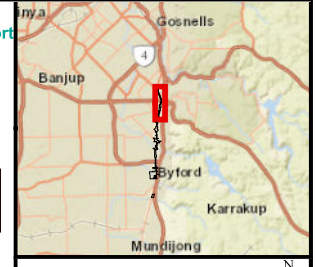
METRONET | Byford Rail Extension

Figure 2A | **Significant Residual Impacts - Threatend Ecological Communities (TEC), Consevation Category Wetlands (CCW), Bush Forever and Guildford Complex**

Public Transport Authority

Legend

- Footprint
- Development Envelope
- Indicative Railway Alignment
- Existing Railway Station
- Rail Crossing



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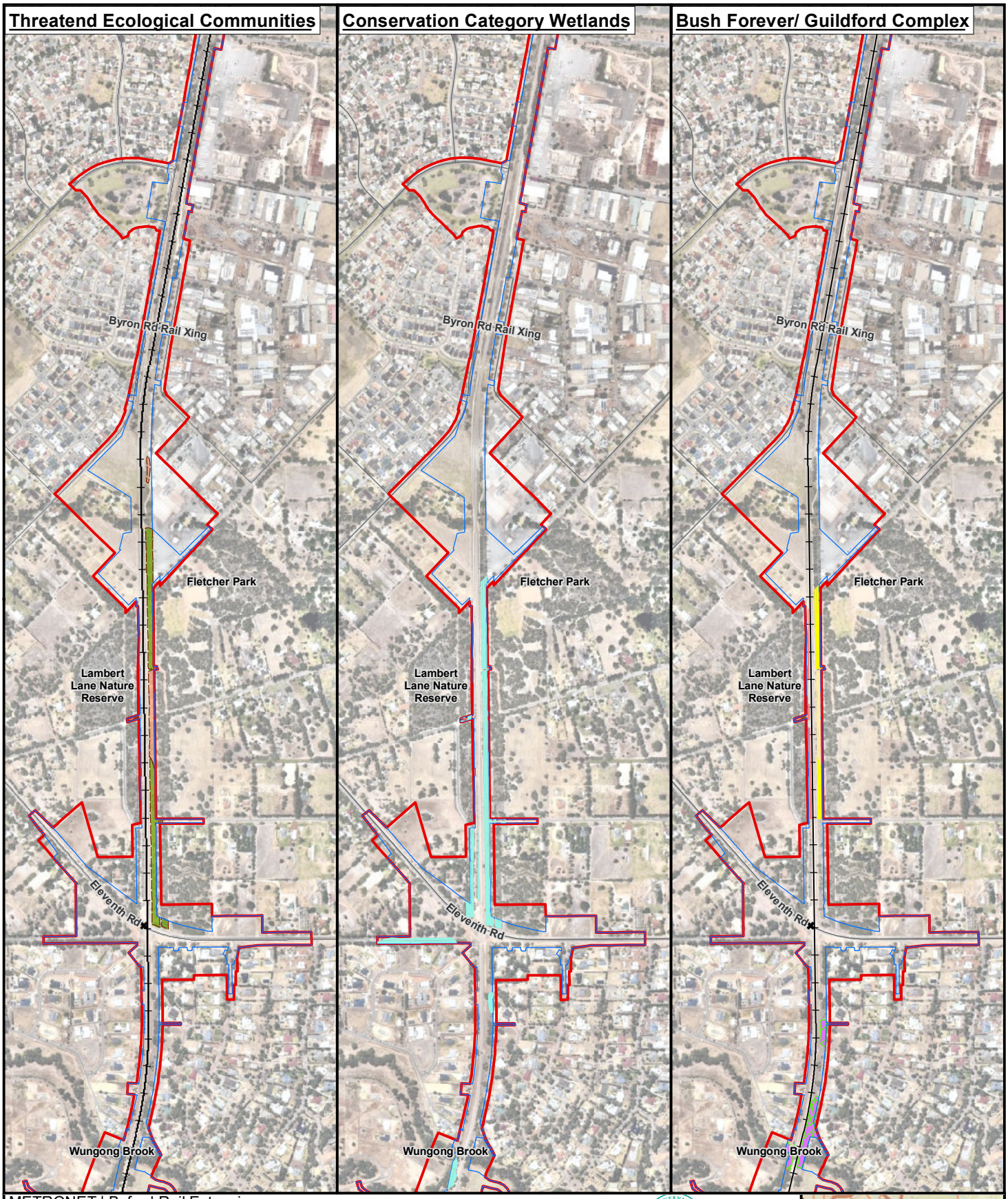

METRONET | Byford Rail Extension

Figure 2B | **Significant Residual Impacts - Threatend Ecological Communities (TEC), Consevation Category Wetlands (CCW), Bush Forever and Guildford Complex**

Public Transport Authority

Legend

- Footprint
- Development Envelope
- Indicative Railway Alignment
- Rail Crossing

PEC/TEC (GHD, 2021)

- SCP3a

EPBC and WA TEC *Corymbia calophylla - Kingia australis* woodlands on heavy soils(FCT3a) and *Xanthorrhoea preissii woodlands and shrublands* (FCT3c) (Condition)

- Excellent
- Very Good
- Good
- Degraded

- Conservation Category Wetlands (CCW)
- Guildford Complex

Guildford Complex (Condition)

- Degraded

Bush Forever (Condition)

- Excellent
- Good
- Degraded
- Completely Degraded

A
B
C
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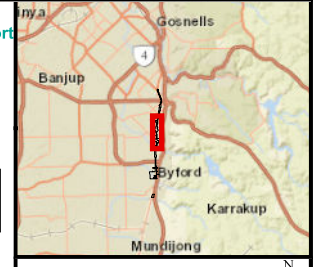

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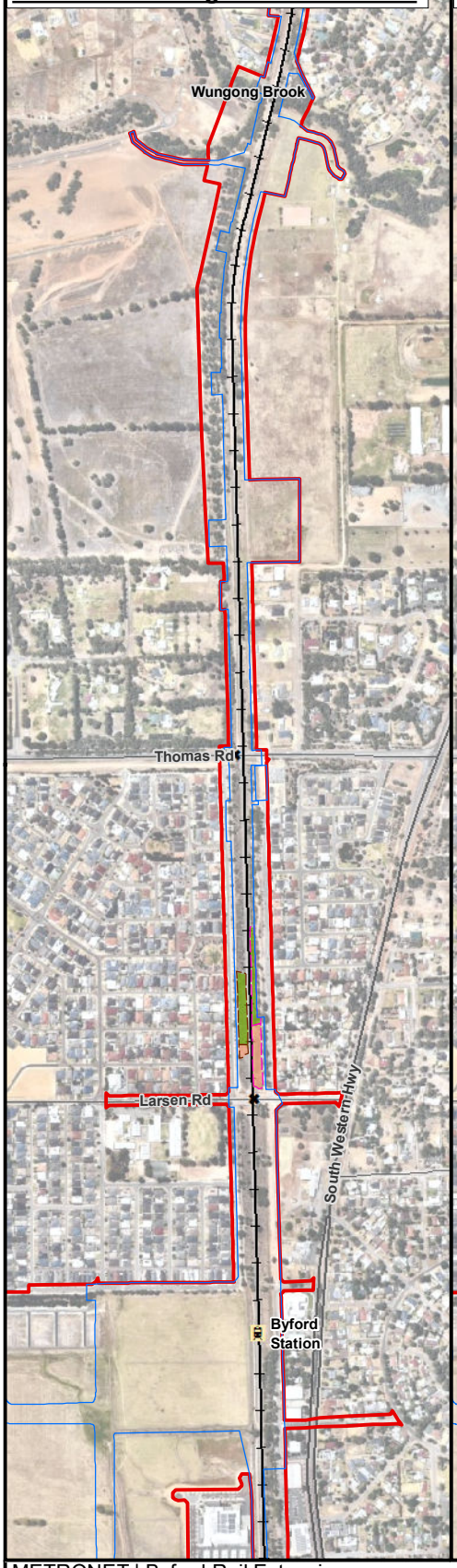
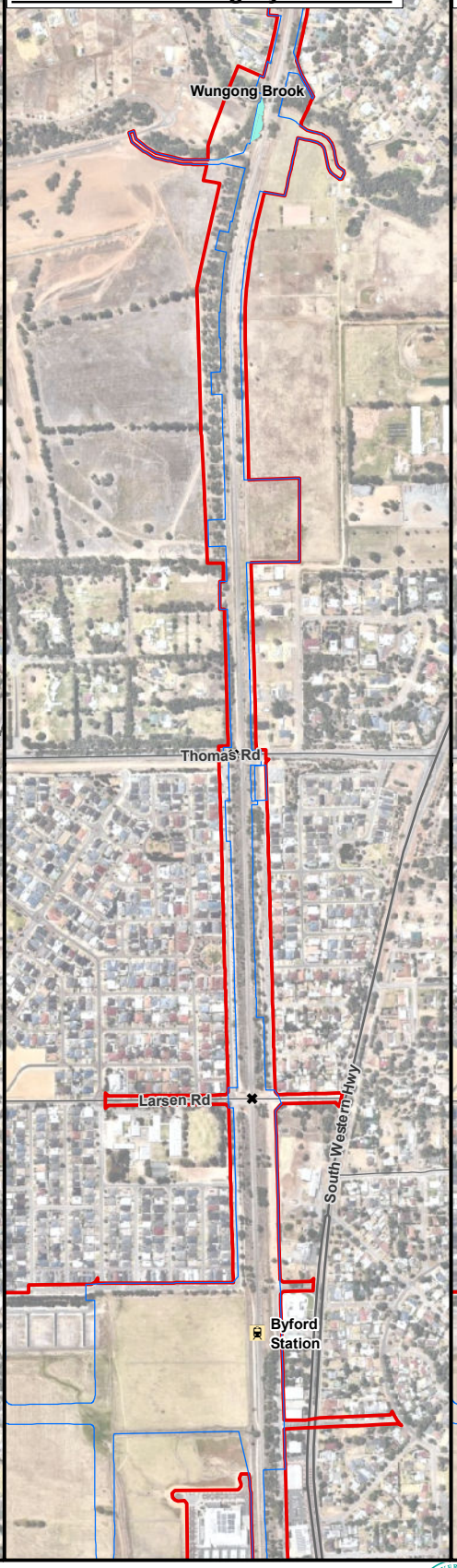
Threatend Ecological Communities



Conservation Category Wetlands



Bush Forever/ Guildford Complex

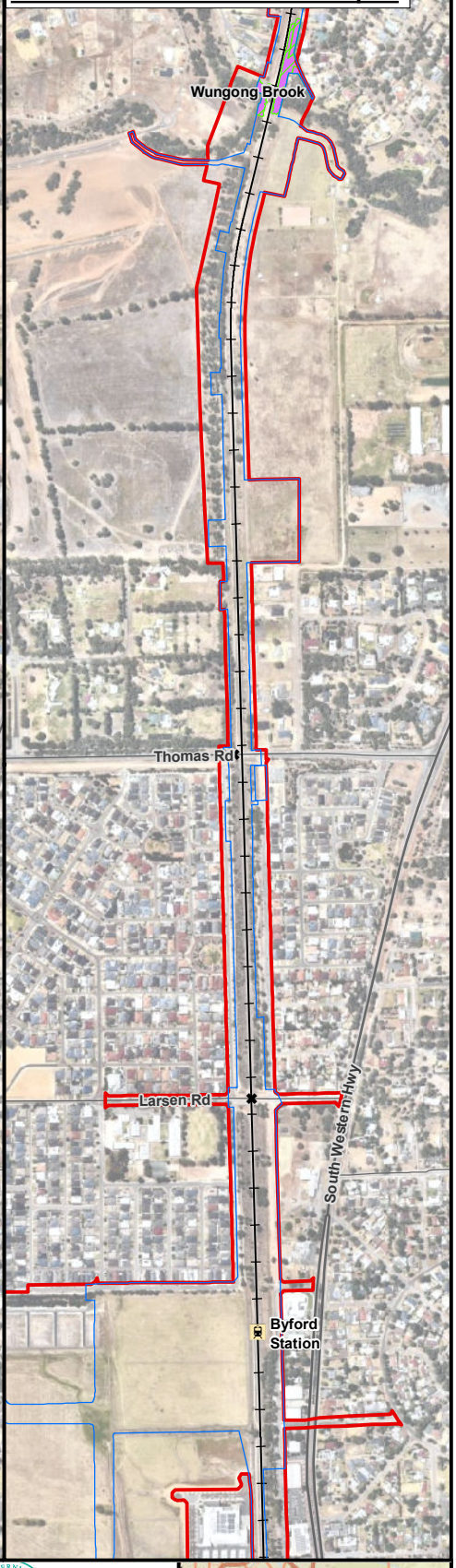


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Figure 2C | **Significant Residual Impacts - Threatend Ecological Communities (TEC), Consevation Category Wetlands (CCW), Bush Forever and Guildford Complex**

Public Transport Authority

Legend

- Footprint
- Development Envelope
- Indicative Railway Alignment
- Proposed Railway Station
- Rail Crossing

PEC/TEC (GHD, 2021)

- SCP3a
- SCP3c

EPBC and WA TEC *Corymbia calophylla - Kingia australis* woodlands on heavy soils(FCT3a) and *Xanthorrhoea preissii woodlands and shrublands* (FCT3c) (Condition)

- Good
- Degraded

- Conservation Category Wetlands (CCW)
- Guildford Complex

Guildford Complex (Condition)

- Degraded

Bush Forever (Condition)

- Degraded
- Completely Degraded

A
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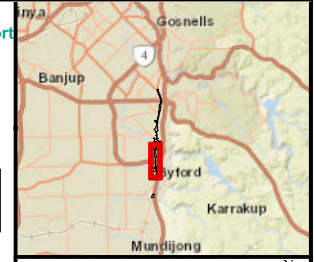

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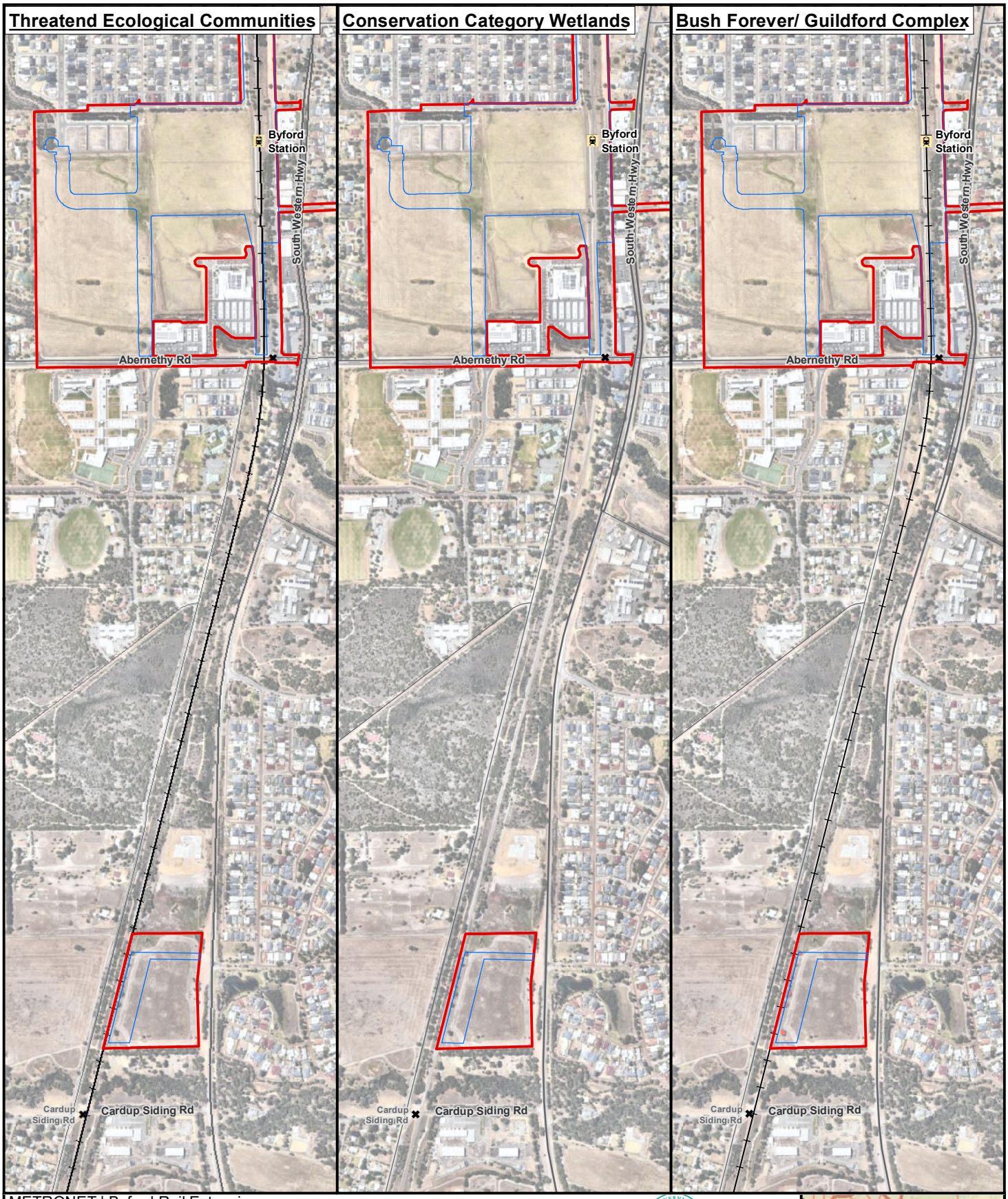

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Figure 2D | **Significant Residual Impacts - Threatend Ecological Communities (TEC), Consevation Category Wetlands (CCW), Bush Forever and Guildford Complex**

Public Transport Authority

Legend

- Footprint
- Development Envelope
- Indicative Railway Alignment
- Proposed Railway Station
- Rail Crossing

Bush Forever (Condition)

- Completely Degraded

A
B
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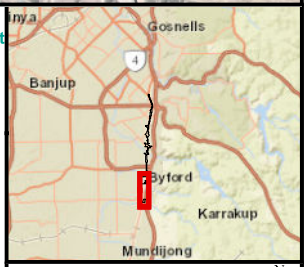
D



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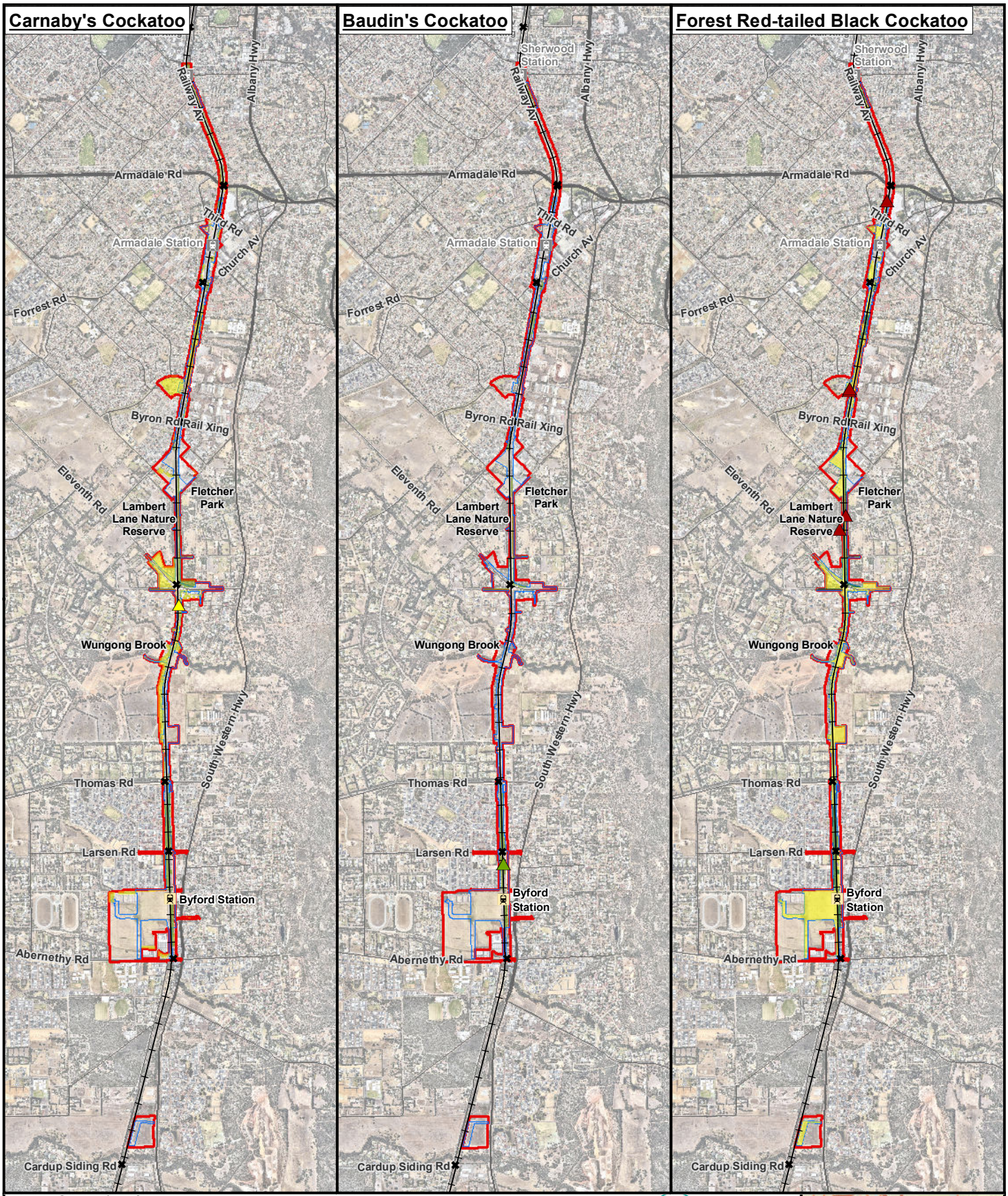

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Figure 3 | **Significant Residual Impacts - Black Cockatoo Foraging Habitat**

Public Transport Authority

Legend

- Footprint
- Development Envelope
- Indicative Railway Alignment
- Proposed Railway Station
- Existing Railway Station
- Rail Crossing

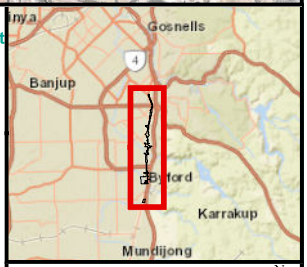
Fauna Sightings (2020)

- *Calyptorhynchus banksii naso* (Forest Red-tailed Black Cockatoo)
- *Calyptorhynchus baudinii* (Baudin's Cockatoo)
- *Calyptorhynchus latirostris* (Carnaby's Cockatoo)

Foraging Value (GHD, 2020)

- Moderate to High
- Moderate
- Low

A
B
C
D



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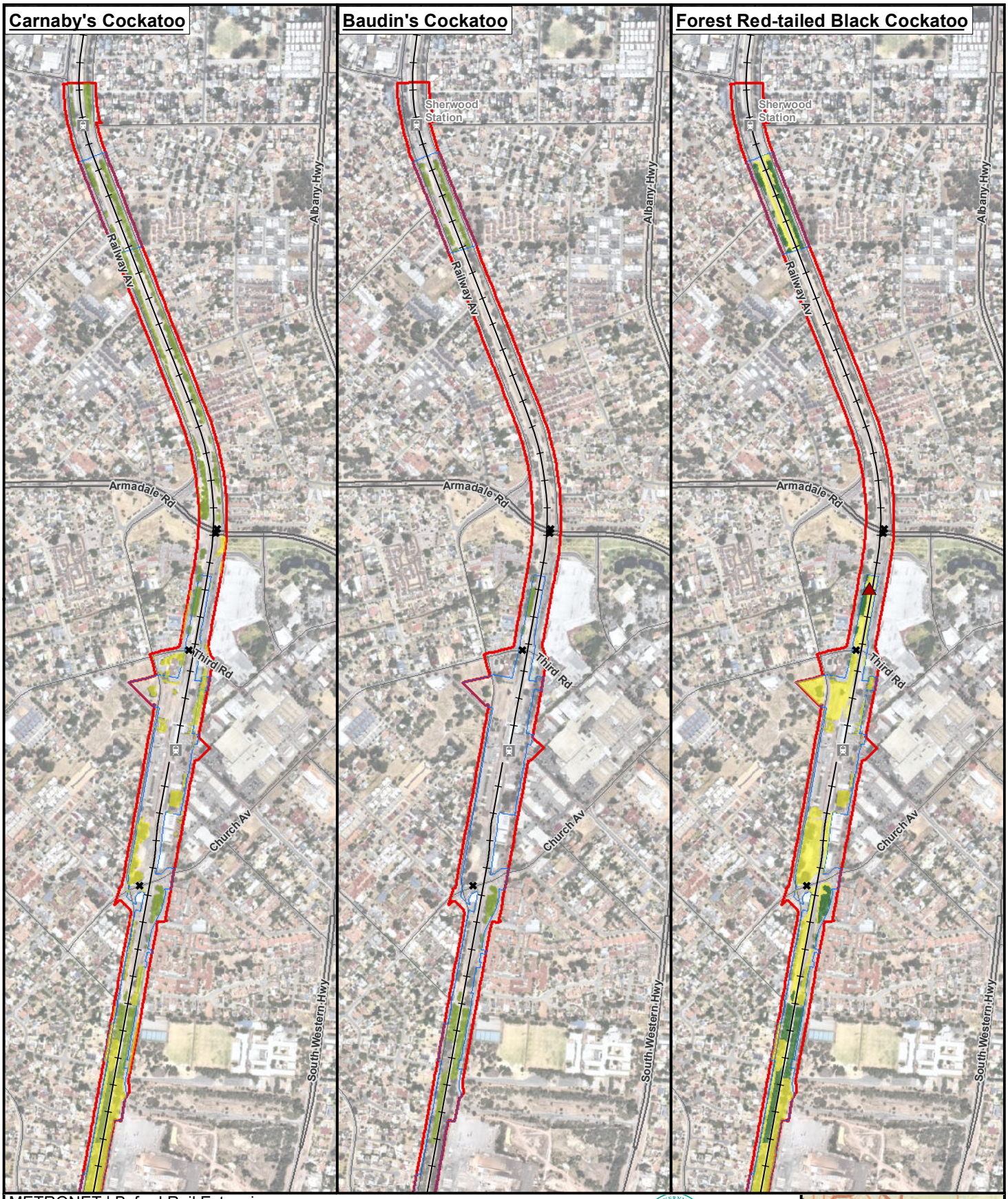

METRONET | Byford Rail Extension

Figure 3A | **Significant Residual Impacts - Black Cockatoo Foraging Habitat**

Public Transport Authority

Legend

- Footprint
- Development Envelope
- Indicative Railway Alignment
- Existing Railway Station
- Rail Crossing

Fauna Sightings (2020)

- *Calyptorhynchus banksii naso* (Forest Red-tailed Black Cockatoo)
- *Calyptorhynchus baudinii* (Baudin's Cockatoo)
- *Calyptorhynchus latirostris* (Carnaby's Cockatoo)

Foraging Value (GHD, 2020)

- Moderate to High
- Moderate
- Low

A
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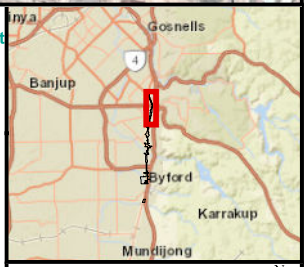
D



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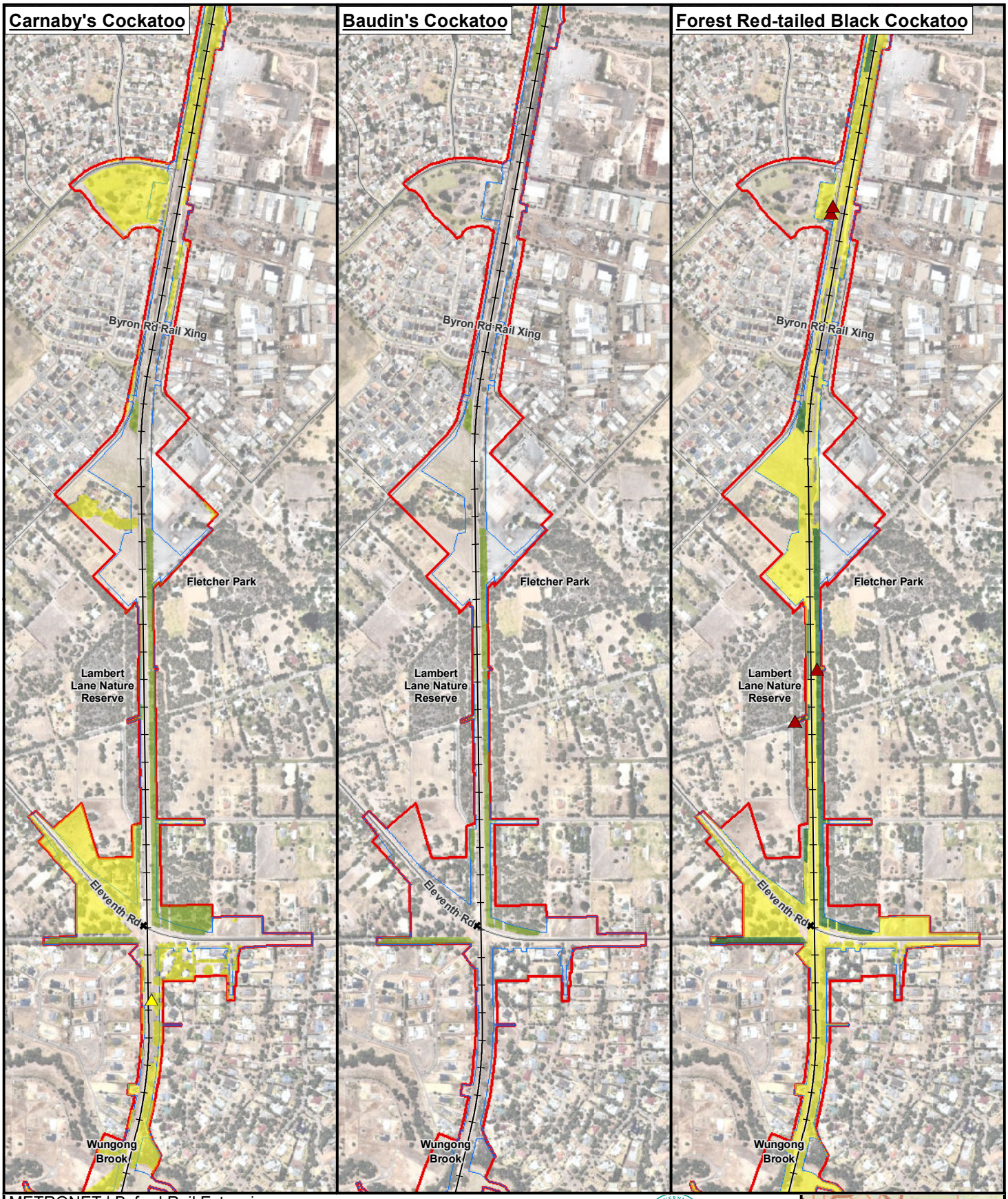


METRONET | Byford Rail Extension

Figure 3B | **Significant Residual Impacts - Black Cockatoo Foraging Habitat**

Public Transport Authority

Legend

- Footprint
- Development Envelope
- Indicative Railway Alignment
- Rail Crossing

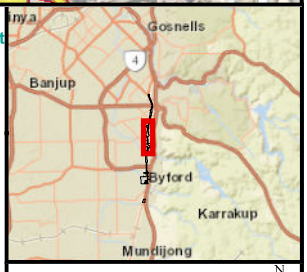
Fauna Sightings (2020)

- *Calyptorhynchus banksii naso* (Forest Red-tailed Black Cockatoo)
- *Calyptorhynchus baudinii* (Baudin's Cockatoo)
- *Calyptorhynchus latirostris* (Carnaby's Cockatoo)

Foraging Value (GHD, 2020)

- Moderate to High
- Moderate
- Low

A B C D



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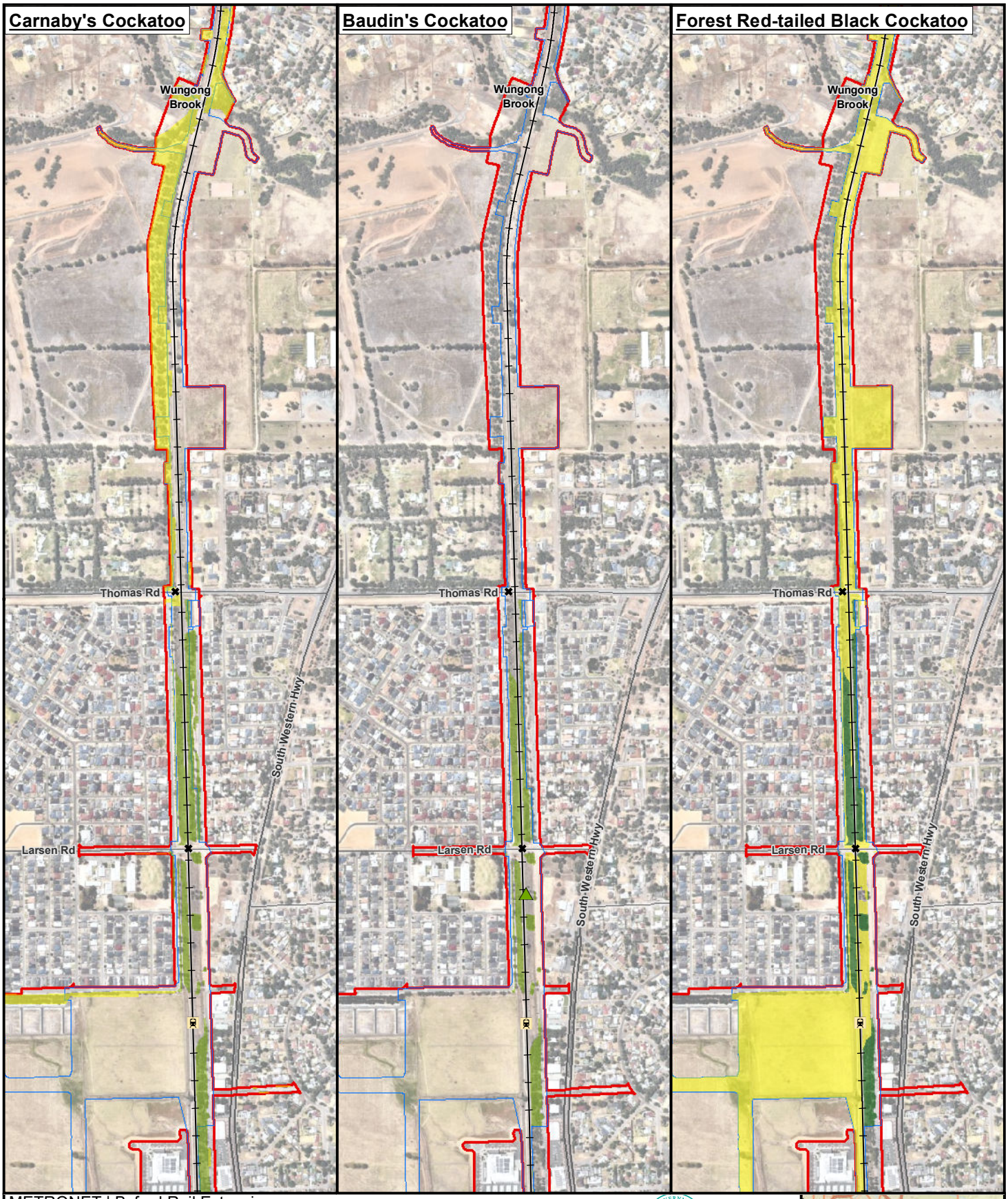

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Figure 3C | **Significant Residual Impacts - Black Cockatoo Foraging Habitat**

Public Transport Authority

Legend

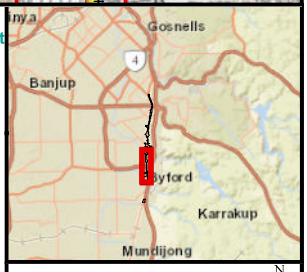
- Footprint
- Development Envelope
- Indicative Railway Alignment
- Proposed Railway Station
- Rail Crossing

Fauna Sightings (2020)

- *Calyptorhynchus banksii naso* (Forest Red-tailed Black Cockatoo)
- *Calyptorhynchus baudinii* (Baudin's Cockatoo)
- *Calyptorhynchus latirostris* (Carnaby's Cockatoo)

Foraging Value (GHD, 2020)

- Moderate to High
- Moderate
- Low



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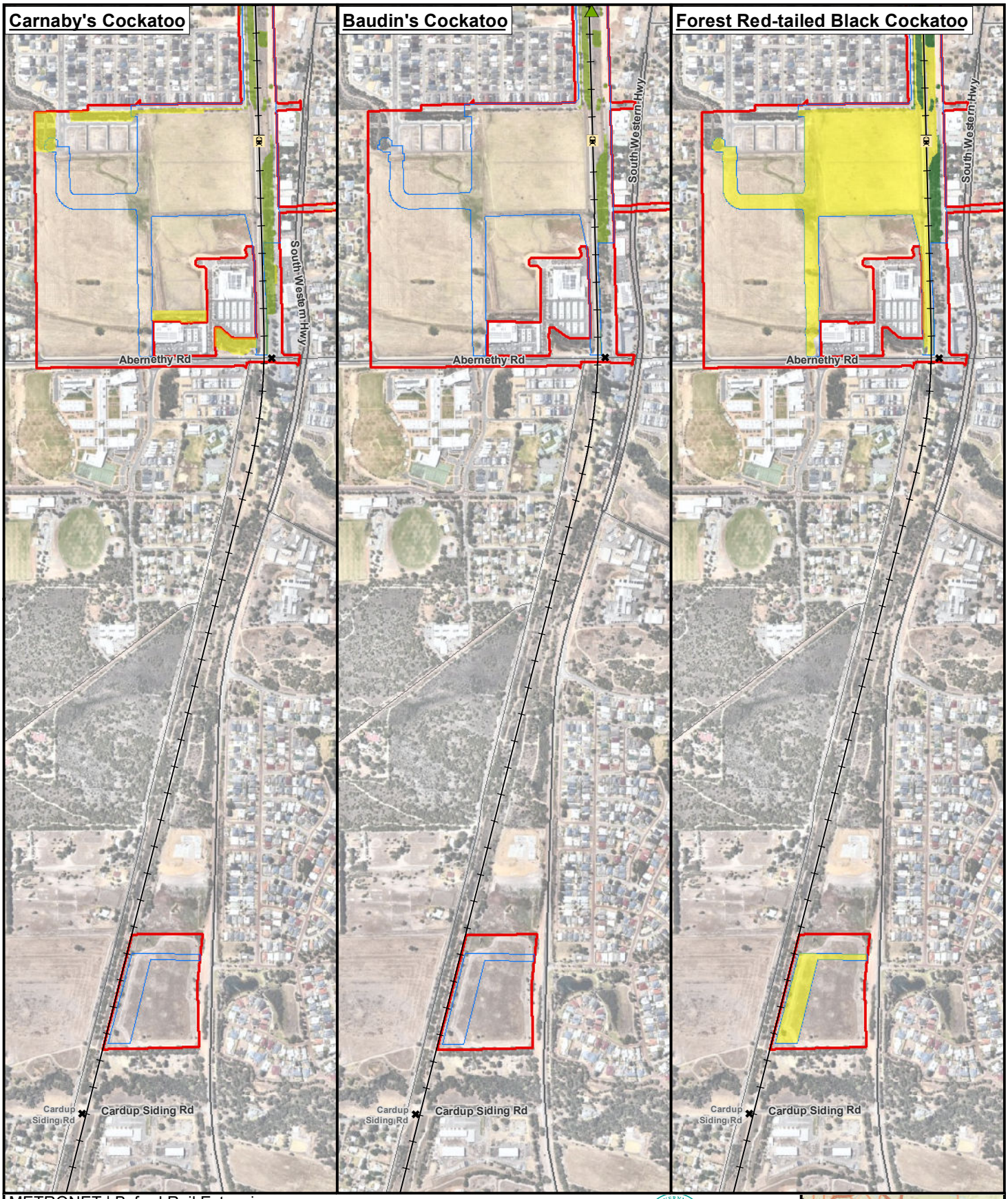

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Figure 3D | **Significant Residual Impacts - Black Cockatoo Foraging Habitat**

Public Transport Authority

Legend

- Footprint
- Development Envelope
- Indicative Railway Alignment
- Proposed Railway Station
- Rail Crossing

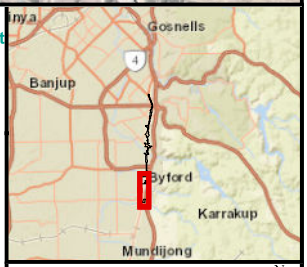
Fauna Sightings (2020)

- *Calyptorhynchus banksii naso* (Forest Red-tailed Black Cockatoo)
- *Calyptorhynchus baudinii* (Baudin's Cockatoo)
- *Calyptorhynchus latirostris* (Carnaby's Cockatoo)

Foraging Value (GHD, 2020)

- Moderate to High
- Moderate
- Low

A
B
C
D



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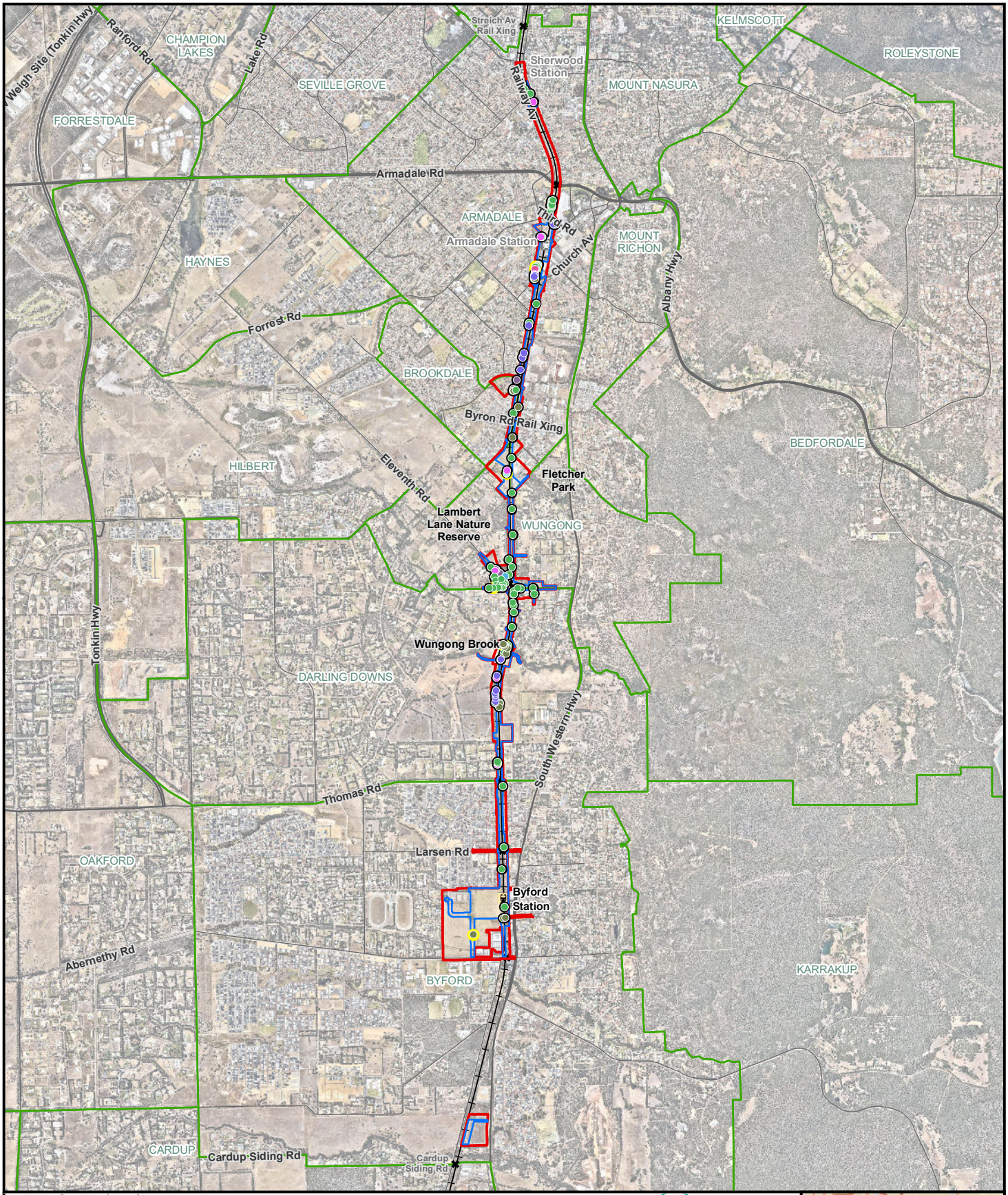

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Figure 4 | **Significant Residual Impacts - Black Cockatoo Potential Breeding Trees**

Public Transport Authority

Legend

- Footprint
- Development Envelope
- Indicative Railway Alignment
- Proposed Railway Station
- Existing Railway Station
- Rail Crossing

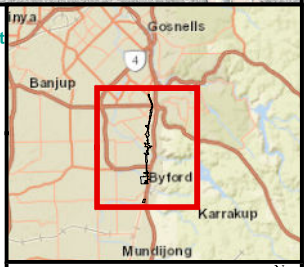
Hollow Present (GHD, 2020)

- Yes
- No

Trees (GHD, 2020)

- Corymbia calophylla
- Corymbia citriodora
- Eucalyptus globulus
- Eucalyptus marginata
- Eucalyptus rudis
- Eucalyptus sp.
- Eucalyptus wandoo
- Introduced

A
B
C
D



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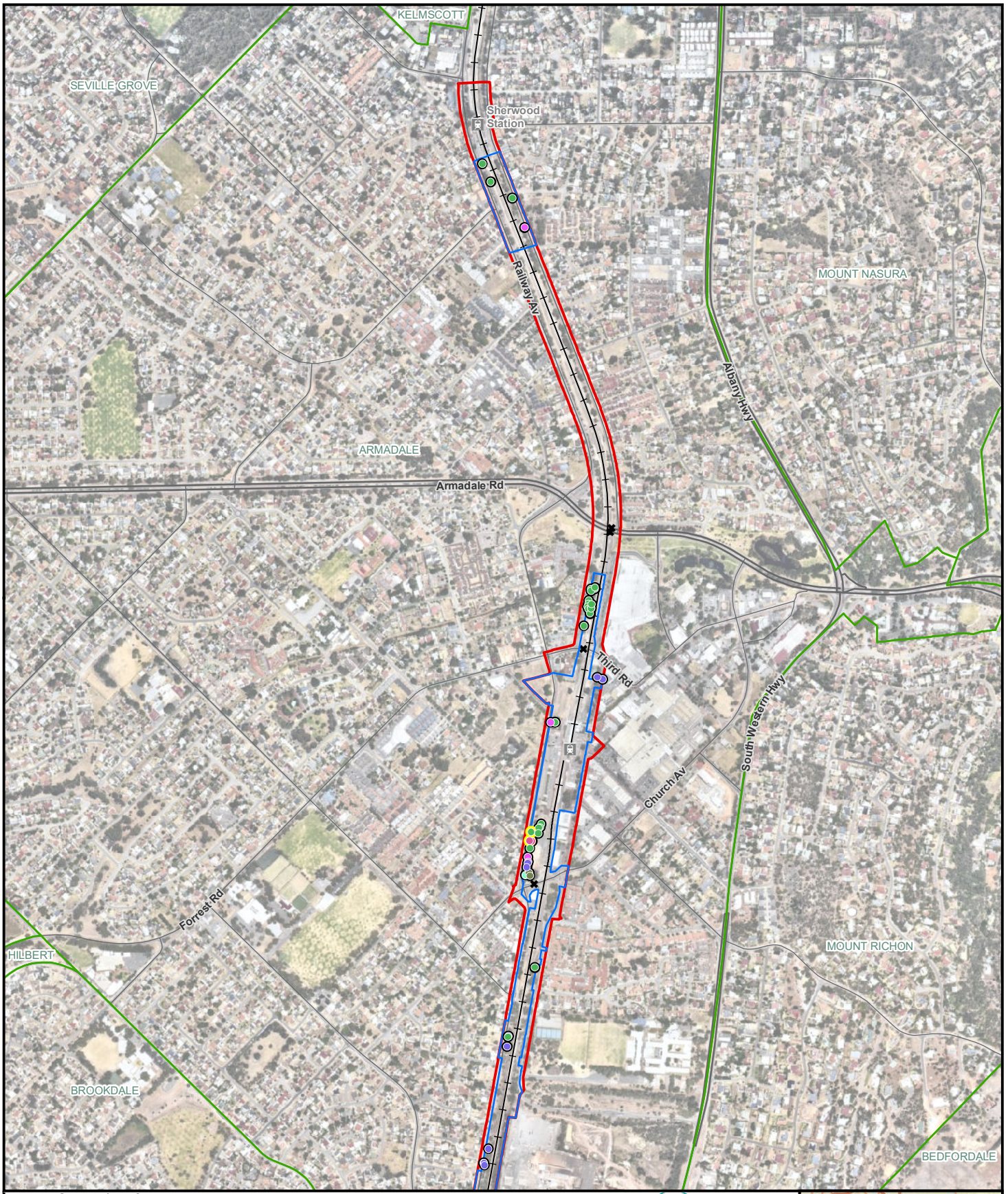

METRONET | Byford Rail Extension

Figure 4A | **Significant Residual Impacts - Black Cockatoo Potential Breeding Trees**

Public Transport Authority

Legend

- Footprint
- Development Envelope
- Indicative Railway Alignment
- Existing Railway Station
- Rail Crossing

Hollow Present (GHD, 2020)

- Yes
- No

Trees (GHD, 2020)

- Corymbia calophylla
- Corymbia citriodora
- Eucalyptus marginata
- Eucalyptus rudis
- Eucalyptus sp.
- Eucalyptus wandoo

A
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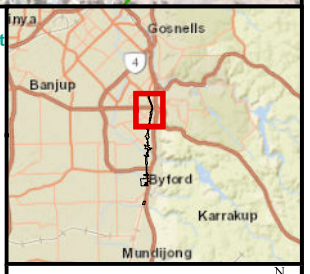

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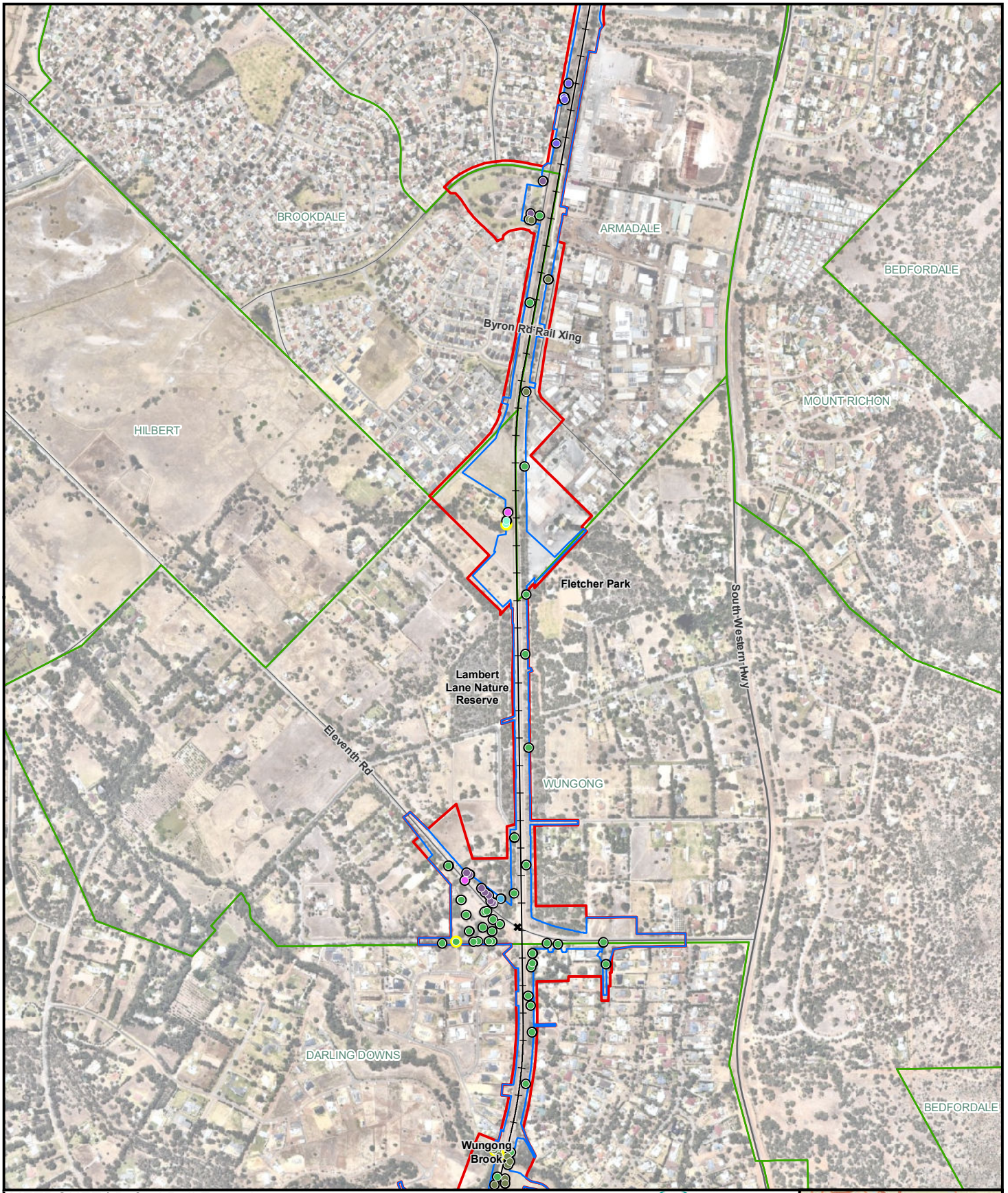


METRONET | Byford Rail Extension

Figure 4B | **Significant Residual Impacts - Black Cockatoo Potential Breeding Trees**

Public Transport Authority

Legend

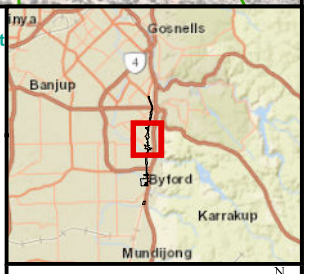
- Footprint
- Development Envelope
- Indicative Railway Alignment
- Rail Crossing

Hollow Present (GHD, 2020)

- Yes
- No

Trees (GHD, 2020)

- Corymbia calophylla
- Corymbia citriodora
- Eucalyptus globulus
- Eucalyptus rudis
- Eucalyptus sp.
- Eucalyptus wandoo
- Introduced



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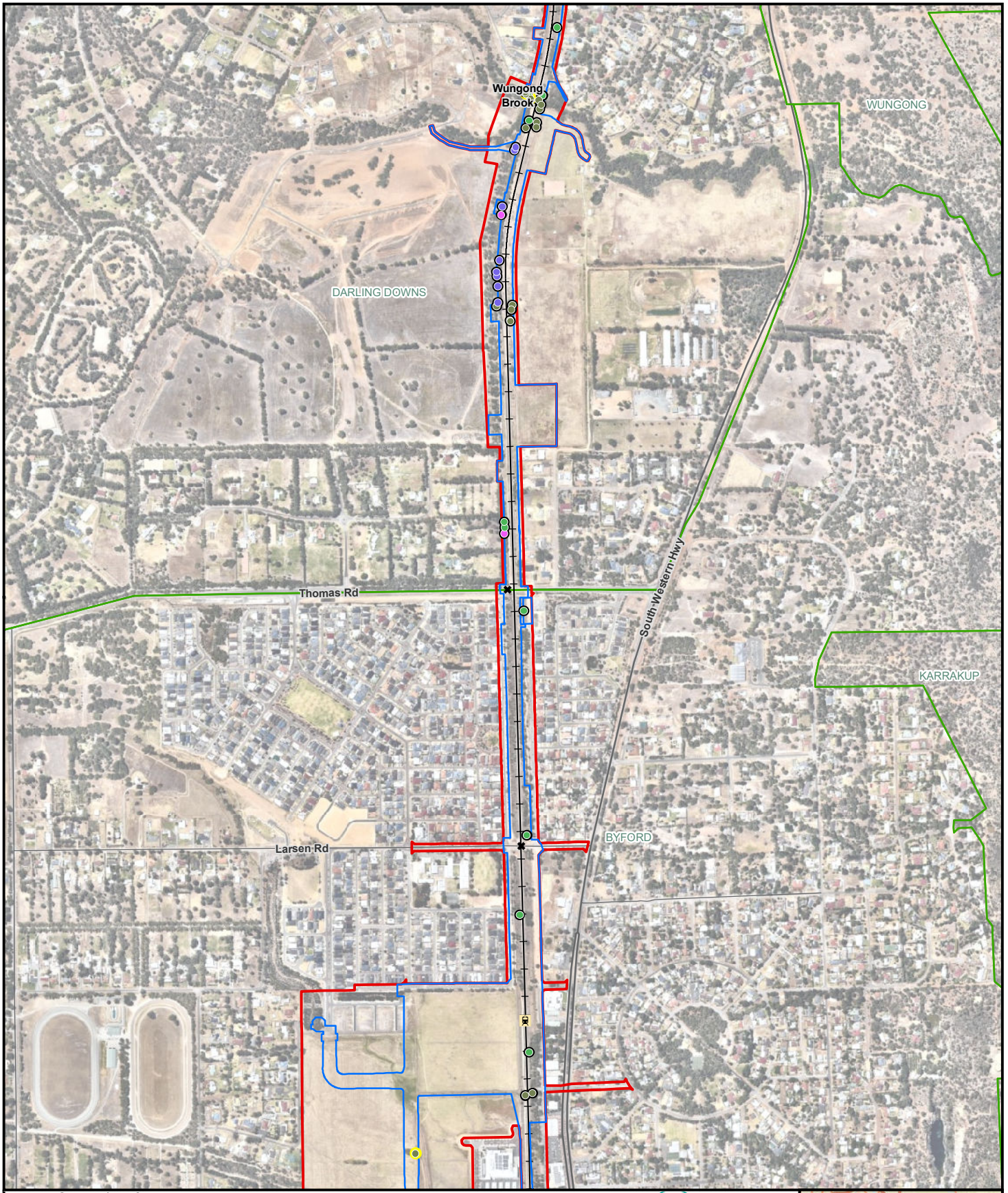


METRONET | Byford Rail Extension

Figure 4C | **Significant Residual Impacts - Black Cockatoo Potential Breeding Trees**

Public Transport Authority

Legend

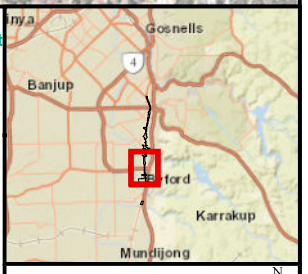
- Footprint
- Development Envelope
- Indicative Railway Alignment
- Proposed Railway Station
- Rail Crossing

Hollow Present (GHD, 2020)

- Yes
- No

Trees (GHD, 2020)

- Corymbia calophylla
- Corymbia citriodora
- Eucalyptus rudis
- Eucalyptus sp.



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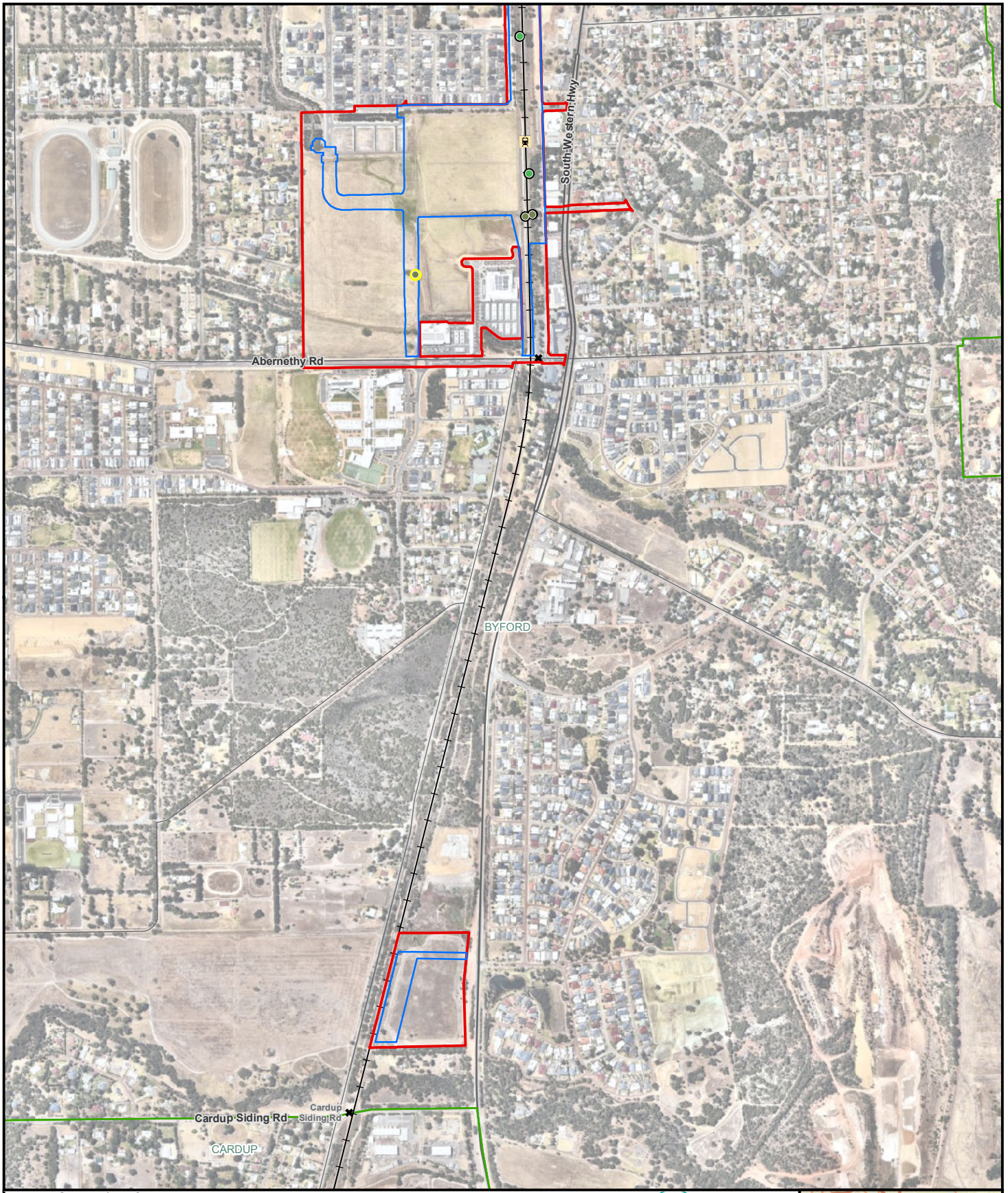


METRONET | Byford Rail Extension

Figure 4D | **Significant Residual Impacts - Black Cockatoo Potential Breeding Trees**

Public Transport Authority

Legend

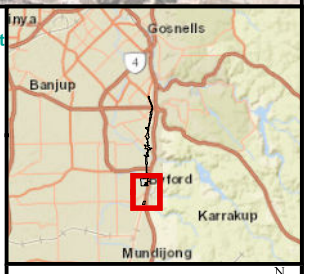
- Footprint
- Development Envelope
- Indicative Railway Alignment
- Proposed Railway Station
- Rail Crossing

Hollow Present (GHD, 2020)

- Yes
- No

Trees (GHD, 2020)

- Corymbia calophylla
- Eucalyptus rudis



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Base Data: Nearmap 2019, Landgate 2019, Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

3. Threatened Ecological Communities

3.1. Significant residual impact

3.1.1. *Corymbia calophylla - Kingia australis* woodlands on heavy soils (SCP3a)

SCP3a is a woodland community located on heavy soils of the eastern side of the Swan Coastal Plain (SCP). Typical and common native taxa in SCP3a include *Corymbia calophylla*; the shrubs Banksia *nivea*, *Philotheca spicata*, *Kingia australis* and *Xanthorrhoea preissii*; herbs, rushes and sedges, *Cyathochaeta avenacea*, *Dampiera linearis*, *Haemodorum laxum*, *Desmocladus fasciculatus*, *Mesomelaena tetragona* and *Tetraria octandra*. The introduced grass *Briza maxima* is also common in the community (DEC 2011). SCP3a is located between Ruabon (near Capel) and Guildford and is restricted to the Swan Coastal Plan Interim Biogeographic Regionalisation for Australia (IBRA) region (DEC 2011).

The Proposal will result in a significant residual impact to 2.26 ha of SCP3a. The impacts occur across fragmented patches of SCP3a vegetation within the Footprint. Overall the vegetation condition of the SCP3a impacted vegetation is:

- 0.02 ha in Excellent condition
- 0.06 ha in Very Good condition
- 1.68 ha in Good condition
- 0.50 ha in Degraded condition

3.1.2. *Corymbia calophylla - Xanthorrhoea preissii* woodlands and shrublands (SCP3c)

SCP3c is a woodland community located on heavy soils of the eastern side of the Swan Coastal Plain (SCP). Typical and common native taxa in SCP3c include *Corymbia calophylla*, and occasionally Eucalyptus wandoo; the shrubs *Xanthorrhoea preissii*, *Acacia pulchella* *Dryandra nivea*, *Gompholobium marginatum* and *Hypocalymma angustifolia*; and the herbs *Burchardia umbellata*, *Cyathochaeta avenacea* and *Neurachne allopecuroidea*. The introduced species *Briza maxima* and *Romulea rosea* are also common (Blyth & English 2000). SCP3c is located between Waterloo (near Bunbury) and Bullsbrook (near Perth) (Blyth & English 2000).

The Proposal will result in a significant residual impact to 0.48 ha of SCP3c. The impacts occur across fragmented patches of SCP3c vegetation within the Footprint. Overall the vegetation condition of the SCP3c impacted vegetation is:

- 0.22 ha in Good condition
- 0.26 ha in Degraded condition

3.1.3. SCP3a / SCP3c mosaic

Due to the location on the heavy soils, position in the landscape, condition of occurrences and presence of similar species the SCP3a and SCP3c communities can occur in a mosaic within an area or site (DBCA *pers. comm.*, Woodman *pers. comm.*).

3.2. Environmental objective

To maintain and enhance the quality and ecological function of the ecological community and contribute to the scientific understanding of the ecological community and methods for restoration and protection over the long-term.

3.3. Offset Sites

The PTA have identified Lambert Lane Nature Reserve, Brickwood Reserve and Roman Road Nature Reserve as offset sites for SCP3a and SCP3c where on-ground management will achieve the environmental objective. The PTA has also identified Fletcher Park as an offset where ecological restoration will achieve the environmental objective.

The PTA identified the sites following results of the reconnaissance survey and consultation with key stakeholders (outlined in Section 7.1). The sites have a high priority for management, have large occurrences of SCP3a or SCP3c, and are in close proximity to the impacts.

3.3.1. Lambert Lane Nature Reserve (R42044)

Lambert Lane Nature Reserve (R42044) is a 3.6 ha parcel of land vested with the Conservation Commission of WA for the purposes of conservation of flora and fauna and managed by the DBCA. The Reserve is located adjacent to the Development Envelope, on the west side of the existing Australind rail reserve, north of Eleventh Road (Figure 5).

Within the Reserve, there is 3.6 ha of SCP3a mapped by the DBCA. The Reserve overlies a 6.3 ha Conservation Category Wetland and is part of Bush Forever site 264. GHD (2021a, 2021b) indicated that, of the 3.33 ha of SCP3a in the Reserve; 2.6 ha is in Excellent condition, 0.11 ha is in Very Good condition and 0.62 ha is in Degraded condition.

Threats

Weed invasion and illegal recreational access pose the most significant threats to this occurrence (DEC 2011). Additional threats include increasing urbanisation, edge effects, weeds, *Phytophthora cinnamomi* (mapped in the north-eastern corner of the occurrence) and vandalism (*DBCA. pers. comm.*). On-ground conservation works at the Reserve has been limited to fence repairs and maintenance (when they are cut and vandalised) and fire break maintenance (as per the DBCA's Good Neighbour Policy).

Management actions

The DBCA consider that additional management actions and revegetation will provide long-term beneficial outcomes for this occurrence, which will achieve the environmental objective. Table 1 summarises on-ground management actions proposed by the DBCA and the anticipated environmental outcome.

Table 1: Lambert Lane Nature Reserve Proposed Management Actions

Management action	Anticipated environmental outcome	Requirements of the recovery plan for SCP3a (DEC 2011)
Weed survey	Weed mapping is an action consistent with the recovery plan for TEC SCP3a that will enable effective weed control to be undertaken. Baseline weed mapping produces quantifiable data to demonstrate that a reduction in weeds has been achieved through on-ground management actions.	Implement weed control
Dieback mapping and develop hygiene procedures	A *Phytophthora* management plan will document the *Phytophthora* mapping and set out actions to enable DBCA to target ongoing *Phytophthora* management. Adoption of hygiene procedures will assist in containing any current dieback infestations at this site and help prevent new infestations.	Ensure adequate hygiene conditions
Removal of old fence and replace with 1.6 km of DBCA style reserve fencing and gates. Maintenance and repairs of fencing and gate.	As the site is located in an area of an established special-rural area, limiting unauthorised access by vehicles and restricting pedestrian and pest animal access will help to reduce threatening processes. Limiting access also assists with limiting the introduction and spread of weeds and disease. Perimeter access controls in the form of upgraded fencing will be installed and maintained to minimise damage to vegetation and fauna through illegal rubbish dumping, site contamination and unauthorised clearing.	Fence remnants that contain the community
Monitor unauthorised access to the site by regular site visits by reserve officer.	Information on unauthorised access to, and use of, the site is obtained to better inform management actions. Enable the DBCA to enforce penalties to those accessing the site without proper authority.	N/A
Install basic reserve	Increased awareness in locals	N/A

Management action	Anticipated environmental outcome	Requirements of the recovery plan for SCP3a (DEC 2011)
identification signage.	who attempt to use the reserve for unauthorised uses. Reduced occurrences of illegal use.	
Manage and maintain all tracks within the site to allow safe site entry and access for authorised vehicles, where required. Management and maintenance to existing access tracks. Complete upgrade works where required.	The aim is to use the tracks as firebreaks (allowing fast access through the site for firefighting requirements), minimise damage to surrounding habitat and allow access to areas to carry out other management actions. Track maintenance, adequate access to site for maintenance and fire management. Less spread of weeds and/or disease. Less damage to vegetation from vehicles. Less impact on fauna from vehicles.	N/A
Weed control	Weed control will reduce current weed infestations from spreading to uninfested areas and allow natural regeneration of native vegetation.	Implement weed control
Conduct annual and ad-hoc rubbish removal. Complete removal of illegally dumped and windblown litter on-site.	Reduce the presence of rubbish on the site will increase the area available for regeneration of native vegetation. Will help to prevent illness or injuries to fauna from rubbish. Will reduce potential for soil, surface water and ground water to become contaminated.	N/A
Rehabilitation of areas within the site in Degraded condition.	Increasing native vegetation will provide a buffer to the TEC, reducing edge effects and minimising the recolonisation or extent of cover of weeds.	N/A

The PTA and DBCA will enter into a Memorandum of Understanding in which the PTA agrees to fund the DBCA to conduct these on-ground management actions for seven years.

Offset quantification

Based on the information provided above and application of the Commonwealth *Offsets Assessment Guide*, Lambert Lane Nature Reserve would provide 41% of the offset requirement. A description of the calculation is in Table 2 and in the Commonwealth Offsets Assessment Guide (Appendix B).

Table 2: Commonwealth Offset Assessment Guide – Lambert Lane Nature Reserve

Factor	Rating	Explanation
Impacted Area		
Area (ha)	2.26	The Proposal will result in the clearing of 2.26 ha of SCP3a within the Development Envelope.
Initial quality	5	The PTA has applied an overall quality of 5 to the SCP3a impact area as follows: • 0.02 ha (1%) of Excellent condition vegetation – applied quality score of 8 • 0.06 ha (3%) of Very Good condition vegetation – applied quality score of 7 • 1.68 ha (74%) of Good condition vegetation – applied quality score of 5 • 0.5 ha (22%) of Degraded condition vegetation – applied quality score of 3 The PTA applied vegetation condition qualities scores based on the Byford Rail Extension Environmental Review Document (ERD) (PTA 2021).
Quantum of impact (ha)	1.13	Adjusted based on assessment of quality.
Offset Area – Lambert Lane Nature Reserve		
Start area (ha)	3.3	The area of SCP3a in Lambert Lane Nature Reserve reported by GHD (2021a, 2021b).
Start quality	7	The PTA has applied an overall quality of 7 to the offset site as follows: • 2.6 ha (78%) of Excellent condition vegetation – applied quality score of 8 • 0.11 ha (3%) of Very Good condition vegetation – applied quality score of 7 • 0.62 ha (19%) of Degraded condition vegetation – applied quality score of 3 The PTA applied vegetation condition qualities scores based on PTA 2021.
Future quality without offset	6	Without the resourcing provided by the offset, on-ground management at the Lambert Lane Nature Reserve will be limited and therefore some decline in the condition of the native vegetation is likely (for example from weed incursion, public access, dieback incursion and edge effects) over the risk-related time horizon of 20 years.
Future quality with offset	8	Additional on-ground management and revegetation at Lambert Lane Nature Reserve will prevent decline and enhance the condition of the ecological community. The provision of funding and resources as part of the offset allows for intervention and mitigation measures that otherwise would not normally occur.

Factor	Rating	Explanation
Risk of loss (%) without offset	0%	The likelihood of the risk of loss of the entire occurrence due to anthropological impacts (e.g. clearing) is very low as the site is in the conservation estate and contains a threatened ecological community.
Risk of loss (%) with offset	0%	DWER will list the Reserve on the Offsets Register, which will inform any future applications to clear the site.
Confidence in result (averted loss) (%)	90%	The site is in the conservation estate and will be listed on the DWER Offsets Register. The confidence that there is a very low risk of loss is relatively high.
Confidence in result (habitat quality) (%)	75%	The DBCA has advised that management at the Lambert Lane Nature Reserve is restricted to ad-hoc maintenance and that a decline in the condition of the ecological community over time at the current management level is expected. The DBCA are confident they can enhance condition of the ecological community with funding to provide resources for additional management. The confidence rating is tempered due to possible influences outside of the land manager's control for example climate, environmental or other factors.
Time over which loss is averted (years)	20 years	The offset site is DBCA conservation reserve and therefore the maximum time over averted loss is applied.
Time until ecological benefit (years)	5 years	The outcome of on-ground management actions performed in the first five years of the offset management period will achieve the aim of preventing decline and maintain the current condition of the ecological community at the site. Actions to meet these criteria include installation of fencing and signage, removal of rubbish, weed control and implementation of dieback hygiene protocols.
Percent of offset requirement	41.27%	Calculated by the Commonwealth *Offsets Assessment Guide*.

3.3.2. Brickwood Reserve (R17490)

Brickwood Reserve is a 50 ha site that contains a sporting complex, an aged care facility and bushland (Figure 6). The Reserve is located approximately 1.4 km southwest of Byford town centre in the Shire of Serpentine Jarrahdale Local Government Area (LGA) and approximately 1.3 km south of the proposed Byford train station.

The Metropolitan Region Scheme (MRS) reserves Brickwood Reserve as Parks and Recreation while the Local Planning Scheme (LPS) No. 3 classifies the Reserve as a C class reserve for the purpose of recreation.

The DBCA Corporate Database mapping shows there are two occurrences of SCP3a within the Reserve. North of Turner Road contains 26.7 ha and south of Turner Road contains 13.4 ha of SCP3a. The DBCA mapping is derived from the regional surveys conducted by Keighery and Trudgen (1992), Keighery and Keighery (1993) and Gibson et al. (1994) (cited in Shire of Serpentine Jarrahdale 2016). The Reserve is also Bush Forever site (No. 321) and contains 17.7 ha of Conservation Category Wetlands.

Threats

Threatening processes include dieback, weeds, encroaching urban development, access by motorbikes, vandalism (including arson), domestic dogs and cats, rubbish dumping, uplifting of vegetation by land managers other than the Shire and the lack of a boundary between the sporting area and vegetation.

The mapped occurrence of SCP3a North of Turner Road overlaps some privately owned cadastral parcels and therefore there is some risk of clearing at these sites.

- Approximately 0.5 ha of SCP3a within Recreation Road is at risk of clearing. This land parcel is zoned as road in an area zoned urban under the MRS and is subject to clearing when the area is developed.
- Approximately 3 ha of SCP3a within land parcels Lot 106 Gordin Way and 18 Turner Road is at risk of clearing. The Baptistcare aged care home is located on 18 Turner Road. Baptistcare also have management authority over the neighbouring Lot 106 Gordin Way. The aged care facility is moving to a new location within the Shire; however, Baptistcare will continue to use the facility (SSJ, *pers. comm*.). The Shire informally manages the SCP3a but PTA understands there have been instances of clearing as part of fire mitigation measures. A review of aerial photography shows two cleared areas of 0.02 ha and 0.09 ha.

Management actions

The Shire consider that additional management actions and revegetation will provide long-term beneficial outcomes for this occurrence, which will achieve the environmental objective. Table 3 summarises on-ground management actions proposed by the Shire and the anticipated environmental outcome.

Table 3: Brickwood Reserve Proposed Management Actions

Management action	Anticipated environmental outcome	Requirements of the recovery plan for SCP3a (DEC 2011)
Fencing around the sporting complex to provide a demarcation between the recreational and conservation areas of the Reserve. Installation of protective fencing to DBCA standards in high population areas of the Reserve.	The Reserve is used for recreation and conservation. Limiting access by vehicles and horse riders will help to reduce threatening processes. Limiting access also assists with limiting the introduction and spread of weeds and disease. Perimeter access controls in the form of upgraded fencing will be installed and maintained to minimise damage to vegetation and fauna through illegal rubbish dumping, site contamination, illegal fires and unauthorised clearing.	Fence remnants that contain the community
Weed survey	Weed mapping is an action consistent with the recovery plan for TEC SCP3a that will enable effective weed control to be undertaken. The Shire has not conducted a	Implement weed control

Management action	Anticipated environmental outcome	Requirements of the recovery plan for SCP3a (DEC 2011)
	weed survey at the Reserve for over a decade. The PTA will conduct baseline weed mapping to produce quantifiable data to demonstrate that a reduction in weeds has been achieved.	
Weed control	The Shire performs weed control in some portions of the Reserve. The PTA will target weed control in areas containing invasive weeds to reduce current weed infestations from spreading to uninfested areas and allow natural regeneration of native vegetation.	Implement weed control
Dieback mapping and develop hygiene procedures	*Phytophthora* occurs in some areas of the Reserve. A *Phytophthora* management plan will document mapped *Phytophthora* occurrences and set out actions to enable the Shire to target ongoing *Phytophthora* management. Areas of dieback infestation will be known and inform management. Adoption of hygiene procedures assists in containing any current dieback infestations at this site and helps to prevent new infestations.	Ensure adequate hygiene conditions
Manage and maintain all tracks within the site to allow safe site entry and access for authorised vehicles, where required. Management and maintenance to existing access tracks. Complete upgrade works where required.	The aim is to use the existing tracks as firebreaks (allowing fast access through the site for firefighting requirements), to minimise damage to surrounding habitat and allow access to areas to carry out other management actions. Track maintenance, adequate access to site for maintenance and fire management. Less spread of weeds and/or disease. Less damage to vegetation from vehicles. Less impact on fauna from vehicles.	N/A

Management action	Anticipated environmental outcome	Requirements of the recovery plan for SCP3a (DEC 2011)
Conduct annual and ad-hoc rubbish removal. Complete removal of illegally dumped and windblown litter on-site.	Reduce the presence of rubbish on the site will increase the area available for regeneration of native vegetation. Will help to prevent illness or injuries to fauna from rubbish. Will reduce potential for soil, surface water and ground water to become contaminated.	N/A
Rehabilitation of areas within the site in Degraded condition.	Increasing native vegetation will provide a buffer to the TEC, reducing edge effects and minimising the recolonisation or extent of cover of weeds.	N/A
Fire management.	Reduces the impacts from hot burns from wildfires. Reduces the cover and extent of weeds and therefore fuel loads. Promotes regular seeding and reproduction of obligate seeders.	Develop and implement fire management strategy.
Flora and fauna monitoring.	Increased understanding of environmental values at the site. Understand how any unwanted animals are gaining access to the site. This will prevent predation of native vegetation and fauna and allow natural regeneration at the site.	N/A

The PTA and Shire will enter into a Memorandum of Understanding in which the PTA agrees to fund the Shire to conduct these on-ground management actions for seven years.

Offset quantification

Based on the information provided above and application of the Commonwealth *Offsets Assessment Guide*, Brickwood Reserve provides the remaining 58.81% of the offset requirement. A description of the calculation is in Table 4 and in the Commonwealth Offsets Assessment Guide (Appendix B).

Table 4: Commonwealth Offset Assessment Guide – Brickwood Reserve

Factor	Rating	Explanation
Impacted Area		
Area (ha)	2.26	The Proposal will result in the clearing of 2.26 ha of SCP3a within the Development Envelope.
Initial quality	5	The PTA has applied an overall quality of 5 to the SCP3a impact area as follows: • 0.02 ha (1%) of Excellent condition vegetation – applied quality score of 8 • 0.06 ha (3%) of Very Good condition vegetation – applied quality score of 7 • 1.68 ha (74%) of Good condition vegetation – applied quality score of 5 • 0.5 ha (22%) of Degraded condition vegetation – applied quality score of 3 The PTA applied vegetation condition qualities scores based on PTA 2021.
Quantum of impact (ha)	1.13	Adjusted based on assessment of quality.
Offset Area – Brickwood Reserve		
Start area (ha)	6.5	The area of SCP3a required in Brickwood Reserve to offset 58.95% of the offset requirement for SCP3a. Lambert Lane Nature Reserve provides 41.27% of the offset requirement for SCP3a.
Start quality	7	The PTA has applied an overall quality of 7 to the offset site as follows: • approximately 15 ha (38%) of Excellent condition vegetation – applied quality score of 8 • approximately 20 ha (50%) of Very Good condition vegetation – applied quality score of 7 • approximately 3 ha (8%) of Degraded condition vegetation – applied quality score of 3 • approximately 2 ha (5%) of Completely Degraded condition vegetation – applied quality score of 2 The PTA applied vegetation condition qualities scores based on information in the management plan for Brickwood Reserve (Shire of Serpentine Jarrahdale 2016). The Degraded and Completely Degraded condition takes into account tracks, cleared areas and areas with high weed infestations. The PTA will conduct a baseline flora and vegetation survey at the Reserve to map the extent and condition of the TEC prior to the commencement of the offset management period.
Future quality without offset*	6	Without the resourcing provided by the offset, on-ground management at the Brickwood Reserve will be limited and therefore some decline in the condition of the native vegetation is likely (for example from weed incursion, public access, dieback incursion and edge effects) over the risk-related time horizon of 20 years.
Future quality with offset	7	Additional on-ground management and revegetation Brickwood Reserve will prevent decline and maintain the condition of the ecological community. The provision of funding and resources as part of the offset allows for intervention and mitigation measures that otherwise would not normally occur.

Factor	Rating	Explanation
Risk of loss (%) without offset	4.31%	The Reserve is: • Zoned under the MRS as Reserve as Parks and Recreation. • Listed under the Shire's LPS No.3 lists as C class reserve for the purpose of recreation. • Bush Forever site No. 321. • An Environmentally Sensitive Area (under the EP Act). • Contains threatened ecological communities and significant flora taxa. However, there is evidence that some clearing of the SCP3a has or is occurring and there is potential future clearing of the SCP3a occurrence. Therefore, the PTA have derived the risk of loss from UQ (2017) for the Shire of Serpentine Jarrahdale.
Risk of loss (%) with offset	0%	DWER will list the Reserve on the Offsets Register, which will inform any future applications to clear the Reserve (or portion of the Reserve).
Confidence in result (averted loss) (%)	90%	The Reserve will be listed on the DWER Offsets Register. The confidence that there is a very low risk of loss is relatively high.
Confidence in result (habitat quality) (%)	90%	The Shire are confident they can maintain the condition of the ecological community with funding to provide resources for enhanced management. The confidence rating is tempered due to possible influences outside of the land manager's control for example climate, environmental or other factors.
Time over which loss is averted (years)	20 years	The offset site is a C class reserve and therefore the maximum time over averted loss is applied.
Time until ecological benefit (years)	5 years	The outcome of on-ground management actions performed in the first five years of the offset management period will achieve the aim of preventing decline and maintain the current condition of the ecological community at the site. Actions to meet this criteria include installation of fencing and signage, removal of rubbish and weed control.
Percent of offset requirement	58.81%	Calculated by the Commonwealth *Offsets Assessment Guide*.

3.3.3. Roman Road Nature Reserve (R 46818)

Roman Road Nature Reserve (R 46818) is an 8.2 ha parcel of land vested with the Conservation Commission of WA for the purposes of conservation of flora and fauna and managed by the DBCA. The Reserve is located approximately 1.4 km east of Mundijong in the Shire of Serpentine Jarrahdale and around 8.4 km south of the southern extent of the Proposal's Development Envelope (Figure 7).

The DBCA has mapped the Reserve as containing 3.04 ha of SCP3c and 5.06 ha of SCP3b (*Eucalyptus calophylla - Eucalyptus marginata* woodlands on sandy clay soils of the southern Swan Coastal Plain). The Reserve is part of Bush Forever site 362. A 3.09 ha resource enhancement category wetland underlies the SCP3c portion of the Reserve.

Threats

Weed invasion and increasing urbanisation poses the most significant threat to this occurrence (DBCA *pers. comm.*). Additional threats include increasing edge effects, *Phytophthora cinnamomi* and vandalism (including arson). On-ground conservation works at the Reserve has been limited to fire break maintenance (as per the DBCA's Good Neighbour Policy) and some weed control (DBCA *pers. comm.*).

Management actions

The DBCA consider that additional management actions and revegetation will provide long-term beneficial outcomes for this occurrence, which will achieve the environmental objective. Table 5 summarises on-ground management actions proposed by the DBCA and the anticipated environmental outcome.

Table 5: Roman Road Nature Reserve Proposed Management Actions

Indicative Management action	Anticipated environmental outcome	Requirements of the recovery plan for SCP3c (Blythe & English 2000)
Weed survey	Weed mapping is an action consistent with the recovery plan for TEC SCP3c that will enable effective weed control to be undertaken. Baseline weed mapping produces quantifiable data to demonstrate that a reduction in weeds has been achieved.	Monitor weed populations
Dieback mapping and develop hygiene procedures	*Phytophthora* management plan will document the *Phytophthora* mapping and set out actions to enable DBCA to target ongoing *Phytophthora* management. Areas of dieback infestation are known to inform management. Adoption of hygiene procedures assists in containing any current dieback infestations at this site and helps to prevent new infestations.	Monitor for dieback
Removal of inadequate fencing and replace with DBCA style reserve fencing and gates. Maintenance and repairs of fencing and gate.	As the site is located in an area of increasing development, limiting unauthorised access by vehicles and restricting other pedestrian and pest animal access will help to reduce threatening processes. Limiting access also assists with limiting the introduction and spread of weeds and disease. Perimeter access controls in the form of	Fence occurrences

Indicative Management action	Anticipated environmental outcome	Requirements of the recovery plan for SCP3c (Blythe & English 2000)
	upgraded fencing will be installed and maintained to minimise damage to vegetation and fauna through illegal rubbish dumping, illegal fires, site contamination and unauthorised clearing.	
Monitor unauthorised access to the site by regular site visits by reserve officer.	Information on unauthorised access to, and use of, the site is obtained to better inform management actions. Enable the DBCA to enforce penalties to those accessing the site without proper authority	N/A
Install basic reserve identification signage.	Increased awareness in locals who attempt to use the reserve for unauthorised uses. Reduced occurrences of illegal use.	Disseminate information about the community
Manage and maintain tracks within the site to allow safe site entry and access for authorised vehicles, where required. Management and maintenance to existing access tracks. Complete upgrade works where required.	The aim is to use the tracks as firebreaks (allowing fast access through the site for firefighting requirements), minimise damage to surrounding habitat and allow access to areas to carry out other management actions. Track maintenance, adequate access to site for maintenance and fire management. Less spread of weeds and/or disease. Less damage to vegetation from vehicles. Less impact on fauna from vehicles.	Install markers to indicate the locations of occurrences of the community alongside tracks, fire-breaks or roads
Weed control	Weed control will reduce current weed infestations from spreading to uninfested areas and allow natural regeneration of native vegetation. Reducing the extent and cover of weeds will also reduce the risk of fire.	Implement weed control
Conduct annual and ad-hoc rubbish removal. Complete removal of illegally dumped and windblown litter on-site.	Reduce the presence of rubbish on the site will increase the area available for regeneration of native vegetation. Will help to prevent illness or injuries to fauna from rubbish.	N/A

Indicative Management action	Anticipated environmental outcome	Requirements of the recovery plan for SCP3c (Blythe & English 2000)
	Will reduce potential for soil, surface water and ground water to become contaminated.	
Rehabilitation of areas within the site in Degraded condition.	Increasing native vegetation will provide a buffer to the TEC, reducing edge effects and minimising the recolonisation or extent of cover of weeds.	Replant / rehabilitate

The PTA and DBCA will enter into a Memorandum of Understanding in which the PTA agrees to fund the DBCA to conduct these on-ground management actions for seven years.

Offset quantification

Based on the information provided above and application of the Commonwealth *Offsets Assessment Guide*, Roman Road Nature Reserve would provide 110.4% of the offset requirement. A description of the calculation is in Table 6 and in the Commonwealth Offsets Assessment Guide (Appendix B).

Table 6: Commonwealth Offset Assessment Guide – Roman Road Nature Reserve

Factor	Rating	Explanation
Impacted Area		
Area (ha)	0.48	The Proposal will result in the clearing of 0.48 ha of SCP3c within the Development Envelope.
Initial quality	4	The PTA has applied an overall quality of 4 to the SCP3c impact area as follows: • 0.22 ha (46%) of Good condition vegetation – applied quality score of 5 • 0.26 ha (54%) of Degraded condition vegetation – applied quality score of 3 The PTA applied vegetation condition qualities scores based on PTA (2021) and GHD (2021c).
Quantum of impact (ha)	0.19	Adjusted based on assessment of quality.
Offset Area – Roman Road Nature Reserve		
Start area (ha)	3	The area of SCP3c required in Roman Road Nature Reserve in to offset 100% of the offset requirement for SCP3c.
Start quality	8	The PTA has applied an overall quality of 8 to the offset site as follows: • approximately 2.7 ha (90%) of Excellent condition vegetation – applied quality score of 8 • approximately 0.3 ha (10%) of Very Good condition vegetation – applied quality score of 7 The PTA applied vegetation condition qualities scores based on indicative advice by Umwelt Consulting (*pers. comm.*). The PTA will conduct a flora and vegetation at the Reserve to confirm the vegetation

Factor	Rating	Explanation
		community and map the extent and condition of the TECs.
Future quality without offset	7	Without the resourcing provided by the offset, on-ground management at the Roman Road Nature Reserve will be limited and therefore some decline in the condition of the native vegetation may be expected (for example from weed incursion, public access, dieback incursion and edge effects) over the risk-related time horizon of 20 years.
Future quality with offset	8	Additional on-ground management and revegetation at Roman Road Nature Reserve will prevent decline and maintain the condition of the ecological community. The provision of funding and resources as part of the offset allows for intervention and mitigation measures that otherwise would not normally occur.
Risk of loss (%) without offset	0%	The likelihood of the risk of loss of the entire occurrence due to anthropological impacts (e.g. clearing) is very low as the site is in the conservation estate and contains a threatened ecological community.
Risk of loss (%) with offset	0%	DWER will list the Reserve on the Offsets Register, which will inform any future applications to clear the site.
Confidence in result (averted loss) (%)	90%	The site is in the conservation estate and will be listed on the DWER Offsets Register. The confidence that there is a very low risk of loss is relatively high.
Confidence in result (habitat quality) (%)	75%	The DBCA has advised that management at the Roman Road Nature Reserve is restricted to ad-hoc maintenance and that a decline in the condition of the ecological community over time at the current management level is expected. The DBCA are confident they can maintain the condition of the ecological community with funding to provide resources for enhanced management. The confidence rating is tempered due to possible influences outside of the land manager's control for example climate, environmental or other factors. State agencies
Time over which loss is averted (years)	20 years	The offset site is DBCA conservation reserve and therefore the maximum time over averted loss is applied.
Time until ecological benefit (years)	5 years	The outcome of on-ground management actions performed in the first five years of the offset management period will achieve the aim of preventing decline and maintain the current condition of the ecological community at the site. Actions to meet these criteria include installation of fencing and signage, removal of rubbish, weed control and implementation of dieback hygiene protocols.
Percent of offset requirement	110.4%	Calculated by the Commonwealth *Offsets Assessment Guide*.

3.4. Environmental outcomes

The management actions will result in the following environmental outcomes, which will achieve the environmental objective:

- A reduction in the threatening processes
- Increase resilience of the ecological community to respond to threatening processes
- Improve condition of the ecological community
- Prevent the spread of weeds and new weed incursions
- Minimise the spread of *Phytophthora* and prevent new *Phytophthora* infestations

The effectiveness of the management actions will be measured by the monitoring and measurement of success criteria described in section 3.5 and 3.6.

3.5. Monitoring

The PTA will undertake the following monitoring throughout the offset management period to confirm the environmental objective and outcomes are met:

- Site inspections.
- Periodic engagement with sites Reserve Officer.
- Dieback surveys.
- Weed surveys.
- DBCA operational planning weed mapping.
- Monitoring of revegetation.
- Vegetation monitoring.
- Annual reporting.

3.6. Measurement for success

The PTA will undertake vegetation and site context assessments throughout the offset management period to confirm the environmental objective and outcomes are met. This will include:

- Vegetation condition (as per the Keighery 1994 scale)
- Average species richness at the Reserve
- Presence or absence of threatened taxa
- Weed coverage (using the Braun-Blanquet scale detailed in the Standard Operating Procedure Techniques for mapping weed distribution and cover in bushland and wetlands (SOP 22.1) (DEC 2011))
- Extent/Location of *Phytophthora* dieback disease present at the Reserve
- Patch size (up to 10 ha)
- Patch connectivity (for example to Bush Forever sites, nature reserves, state forest, regional parks or national parks).

3.7. Other compensatory measures - Research offset

3.7.1. Research project

The *Approved Conservation Advice for Corymbia calophylla – Kingia australis woodlands on heavy soils of the Swan Coastal Plain* (DotEE, 2017) lists research and monitoring as one of four key approaches to mitigate the risk of extinction or collapse of the SCP3a community. Research and monitoring aims to improve the understanding of the ecological community and methods for restoration and protection over the long-term (DotEE 2017).

The PTA will provide a financial contribution towards one or more research activities that advance practical knowledge about the restoration and enhancement of degraded areas within the SCP3a ecological community.

3.7.2. Research focus

Fletcher Park (Figure 5) has been identified as a suitable site for a research project to investigate the factors, which may impact upon the successful restoration of degraded areas within SCP3a (may also be applicable to SCP3c given similarity to type SCP3a). The 19 ha reserve (No. 14217) in Wungong is vested with the City of Armadale for 'Recreation'. GHD (2021) have confirmed the presence of SCP3a and SCP3b and mapped the extent of each ecological community within Fletcher Park. The vegetation is in variable condition (ranging from Very Good to Completely Degraded) and has been impacted in part by past activities such as clearing, unmanaged access, weed invasion and recreational activities. The southern section of the reserve (Figure 5) is currently Degraded and would benefit from on-ground actions that aims to improve its current condition, species composition and structural diversity.

A Bushland Management Plan (ENV 2010) has been prepared for the site, though is dated and may benefit from review. ENV (2010) reported that rehabilitation activities, such as weed control and revegetation, have been conducted in Fletcher Park by various groups including a local land care group, the City of Armadale and a commercial revegetation company. The work completed by the revegetation company was a component of an offset.

The DBCA advised that regeneration of ecological communities in heavy soil conditions (such as clay pan communities) has been difficult in the past, with a high risk of failure. Further research into the factors that influence restoration outcomes will advance current knowledge about effective revegetation techniques in ecological communities such as SCP3a.

The development of guidance for restoration in these types of ecological communities will help guide on-ground management, reduce the risk of restoration failure and lead to an improved understanding of what is achievable within the context of a site's constraints. The research will help inform to what extent ecological restoration may be achieved.

A restoration research project could utilise a section of Fletcher Park, such as the southern extent near Eleventh Road, to conduct a series of small experiments in a controlled manner. The suitability of this site will be further investigated and discussed with current land managers. Should Fletcher Park not be suitable for the project, an alternative site will be identified. It is expected that DBCA's involvement will be particularly important to the development of the research project and the identification of restoration procedures to be investigated.

Factors that might be investigated include the role of fire in stimulating natural regeneration, evaluation of various weed control strategies, the impact of reduced grazing pressure on natural recruitment and an assessment of the in situ seed bank in the context of whether supplementary planting is needed. Understanding the impact of the site's physical conditions and constraints as well as the management of threats in the context of the SCP3a ecological community is an

important consideration when seeking an improvement in a site's species composition, structural diversity, resilience and ecosystem function.

The proximity of Fletcher Park to Lambert Lane Nature Reserve (which has SCP3a) will be beneficial for this type of research. Lambert Lane Nature Reserve could be used as a reference site to compare and contrast restoration outcomes within Fletcher Park.

3.7.3. Principles for research offset

The research project will involve reputable organisations that have the capacity and technical knowledge to design and deliver the research in a robust manner. Any research funded through PTA will comply with the following principles:

- Must be focused on improving the long-term viability of the ecological community.
- Be consistent with the research priorities identified in the *Corymbia calophylla – Kingia australis woodlands on heavy soil Interim Recovery Plan* (DEC, 2011) and the DoEE (2017) *Conservation Advice for Corymbia calophylla – Kingia australis woodlands on heavy soils of the Swan Coastal Plain.*
- Consider best practice research approaches.
- Be conducted in a transparent, scientifically robust and timely manner.
- Be able to be completed within a timeframe that is appropriate to the delivery of the offsets program.
- Results must be shared and made publicly available to assist with an improved understanding of the ecological community and the factors that contribute to successful restoration or enhancement of the community. Progress reporting and key findings must be provided through periodic reporting.
- Detailed project budget to be prepared and funds are to be expended in an appropriate manner. Auditable financial records are to be kept and maintained.

3.7.4. Research offset outcome

Although the details for the research project are not finalised, the primary outcome being sought is to improve current restoration practices within the SCP3a ecological community. The critical factors for successful restoration could be presented as a set of guidelines for land managers to use as a reference for planning the restoration or enhancement of SCP3a ecological community. The outputs from research will help shape appropriate ecological restoration approaches (e.g. natural regeneration, assisted regeneration or reconstruction – or a combination of these) to suit areas of SCP3a with different conditions or threat situations. It is expected that the knowledge developed from this research will also benefit other Type 3 communities (i.e. 3b and 3c) and potentially other communities found on heavy soils.

3.7.5. Relevance to approved conservation advice

Section 6.2.2 of the *Approved Conservation Advice for Corymbia calophylla – Kingia australis woodlands on heavy soils of the Swan Coastal Plain* (DoEE, 2017) lists restoration as a priority action required to support the recovery of remnant bushland containing SCP3a ecological community. The objective for research and monitoring is to improve the understanding of the ecological community and methods for restoration and protection over the long-term (DoEE, 2017).

Relevant and well-targeted research and other information gathering activities are important in informing the protection and management of the ecological community (DoEE, 2017). A PTA funded research project will advance current knowledge and understanding of the factors that contribute to the successful restoration of SCP3a ecological community. Improved restoration

outcomes will contribute to the improvement of existing remnants of SCP3a and improve the resilience of these remnants to withstand pressures from external threats.

A research project specific to restoring SCP3a is relevant to the following high priority research areas listed in the Approved Conservation Advice (DoEE, 2017):

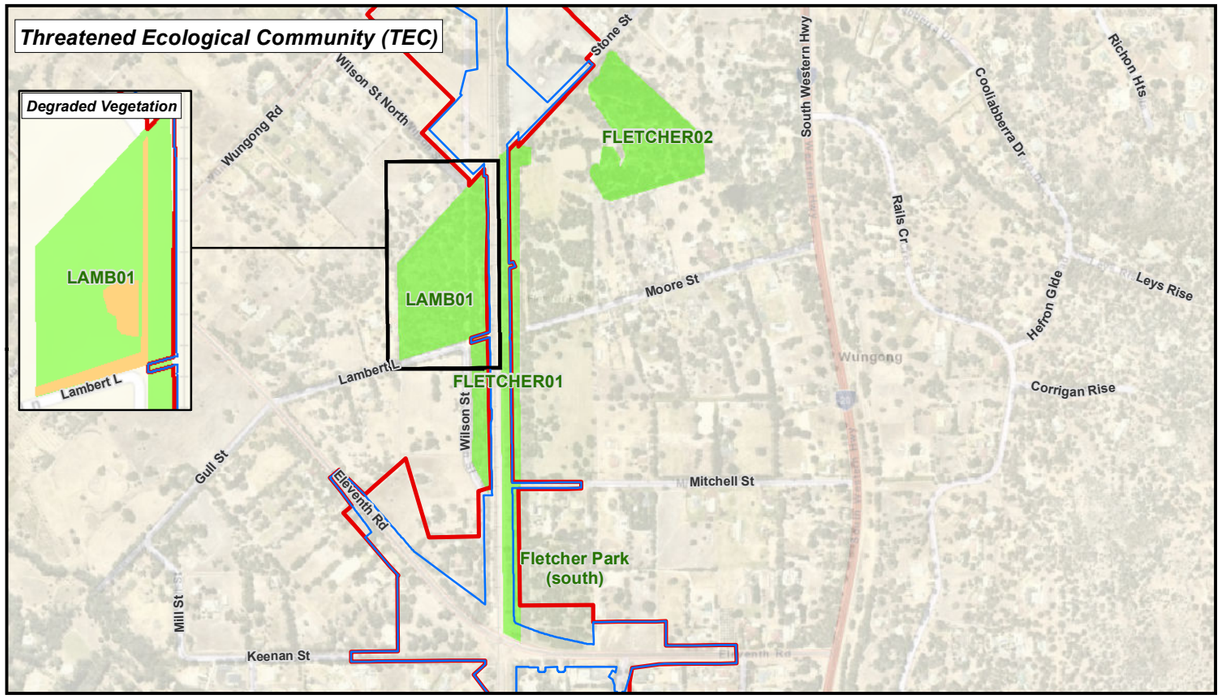
- On-going research aimed at managing major weeds and feral animals.
- Researching the effects of fire and fauna on floristics and structure of the community.
- Monitoring changes in condition including response to all types of management actions and use this information to increase the understanding of the ecological community and inform recommendations for future management.
- Conduct research leading to the development of effective landscape-scale rehabilitation and maintenance of vegetation condition for the ecological community. Investigate the interactions between threats (e.g. fire regimes, climate change, dieback, hydrological changes) to determine how an integrated approach to threat management can be implemented.
- Investigate the most cost-effective options for restoring landscape function.

3.7.6. Next steps

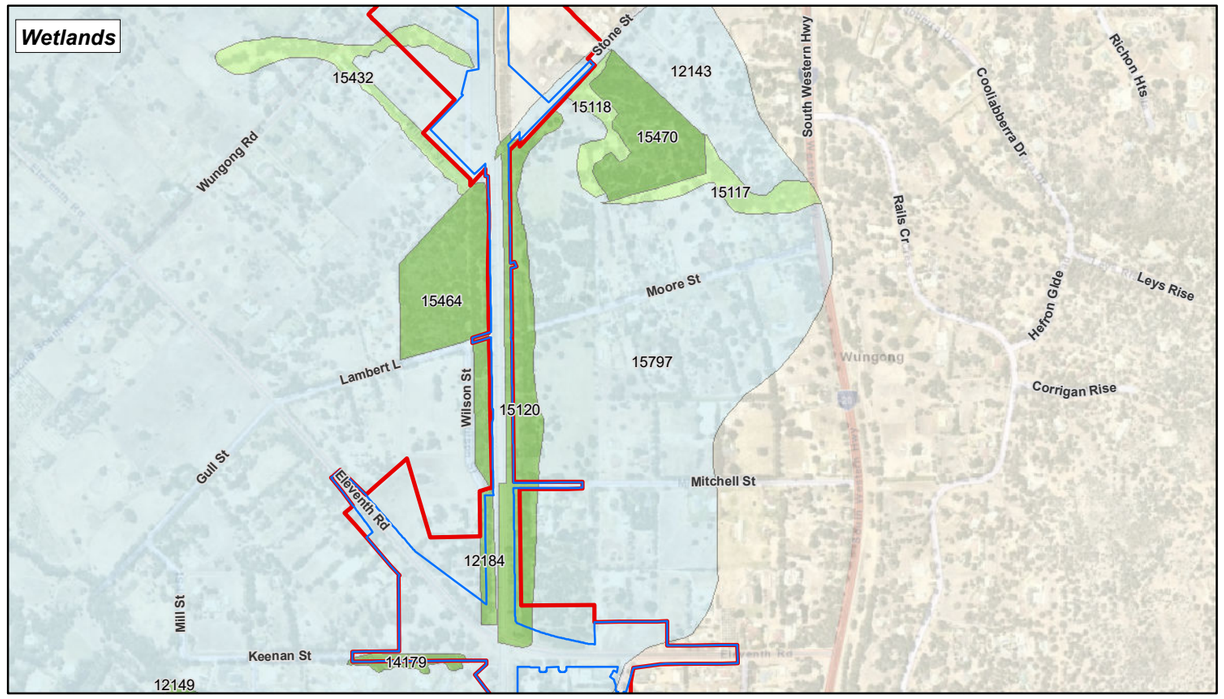
The research project concept is in the early stages of development and conceptualisation. The PTA has identified the following steps to be completed:

- Identify key stakeholders such as the DBCA (Threatened Species and Communities Branch, Botanic Gardens and Parks Authority), the City of Armadale, the Armadale Bushcare Environment Working Group and the Armadale-Gosnells Landcare Group. Note that preliminary contact has been made with the Botanic Gardens and Park Authority who were involved in researching the restoration of Banksia woodlands.
- Engage with stakeholders to confirm interest and in-principle support to participate in the research project.
- Establish a reference group to guide the development and implementation of the research project.
- Identify a lead organisation responsible for the delivery of the research project.
- Confirm suitable a location (or locations) ensuring land tenure and access arrangements.
- Prepare a detailed research project plan that:
  - Articulates the project purpose and objectives including key research questions.
  - Describes the current knowledge and limitations relating to restoration of SCP3a.
  - Identifies the knowledge and resources required to deliver the project including an estimated budget.
  - Provides an overview of the project design and a timeline for key activities.
  - Describes the expected outcomes and impact to be derived from the research.
  - Outlines a communication plan.
- Provide draft project plan to DWER and DAWE.
- Implement project.

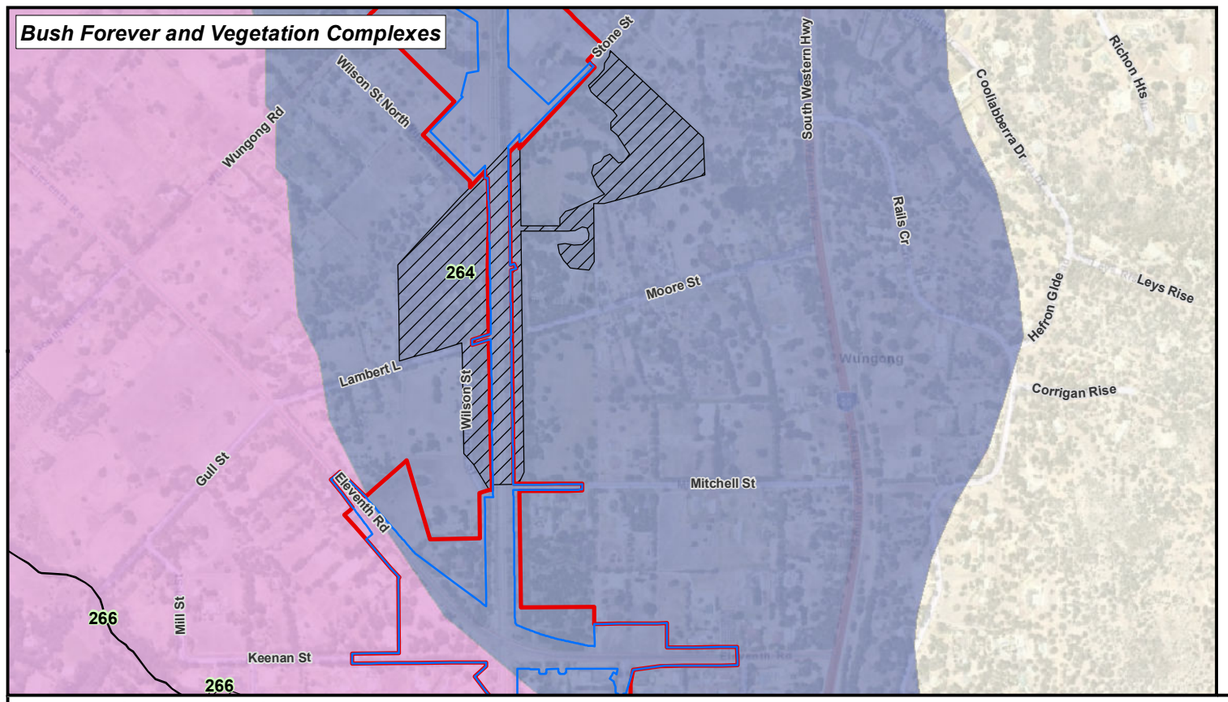
Threatened Ecological Community (TEC)



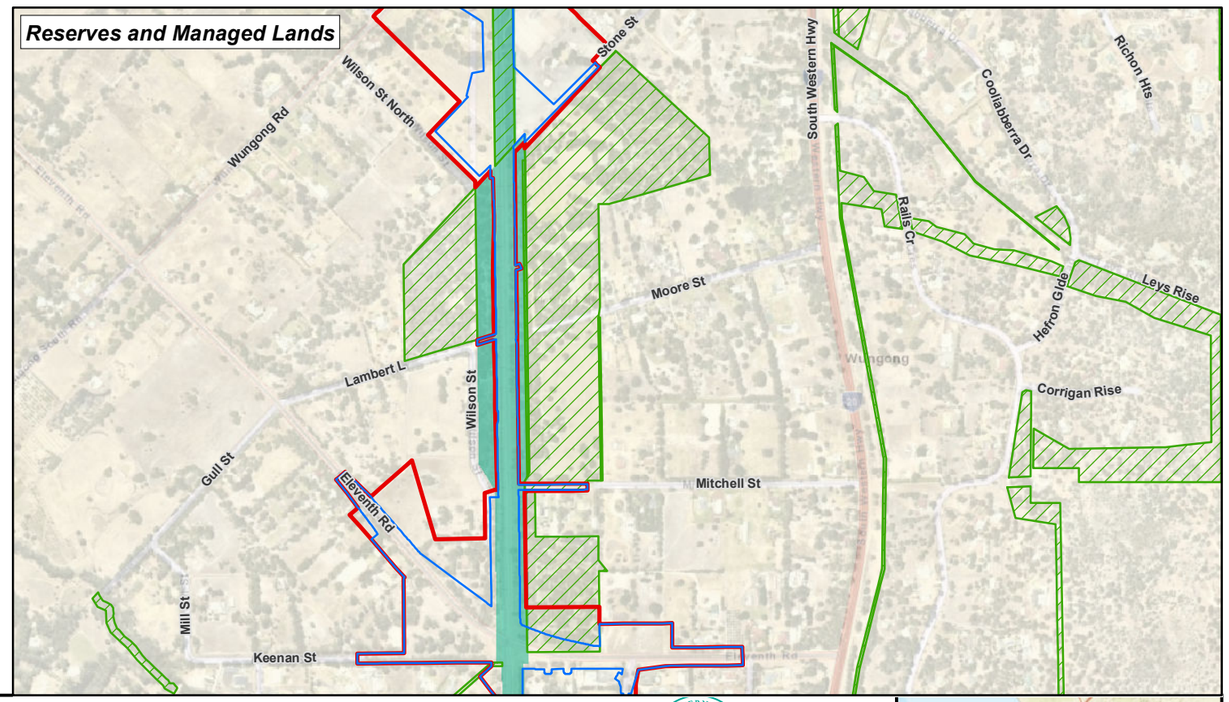
Wetlands



Bush Forever and Vegetation Complexes



Reserves and Managed Lands



METRONET | Byford Rail Extension

Figure 5 | **Lambert Lane Nature Reserve and Fletcher Park Offset Site**

Public Transport Authority

Legend

- Footprint
- Development Envelope

DBCA Database
- SCP3a

Vegetation Condition (GHD, 2021)
- Degraded

Geomorphic Wetlands (UFI Labelled)
- Conservation
- Multiple Use
- Resource Enhancement

- Bush Forever

Vegetation Complexes (Heddle et al. 1980)
- Forrestfield Complex
- Guildford Complex

- Reserves
- PTA Land Rail Reserve

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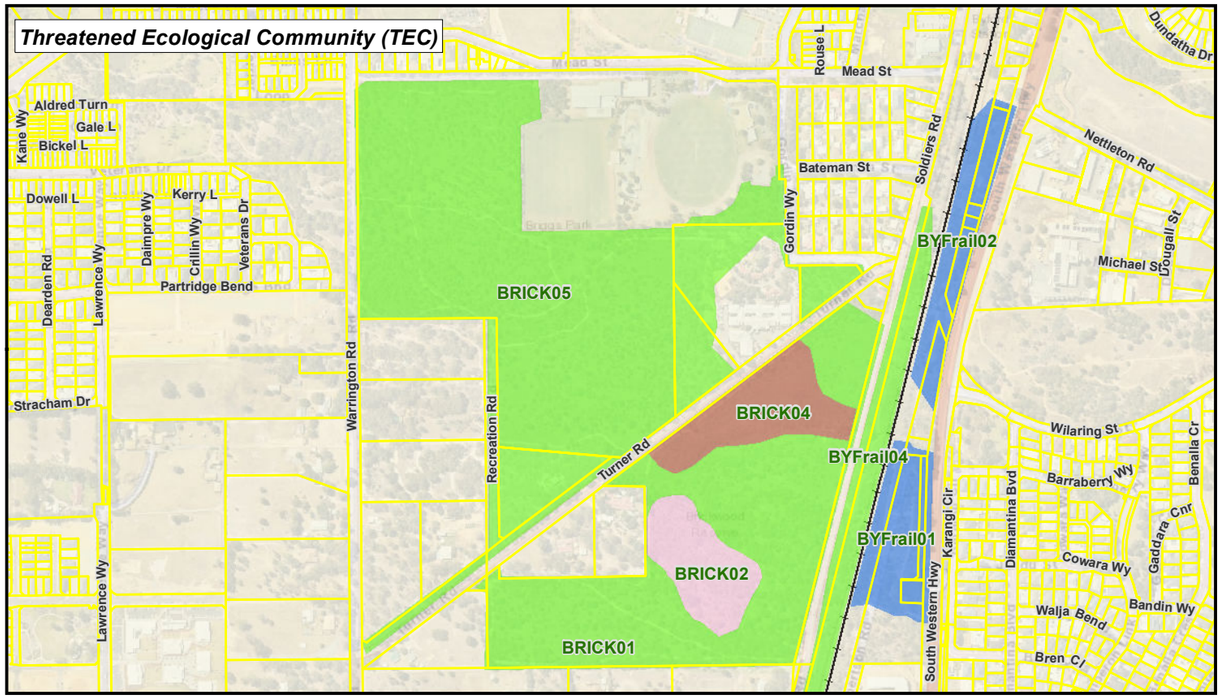

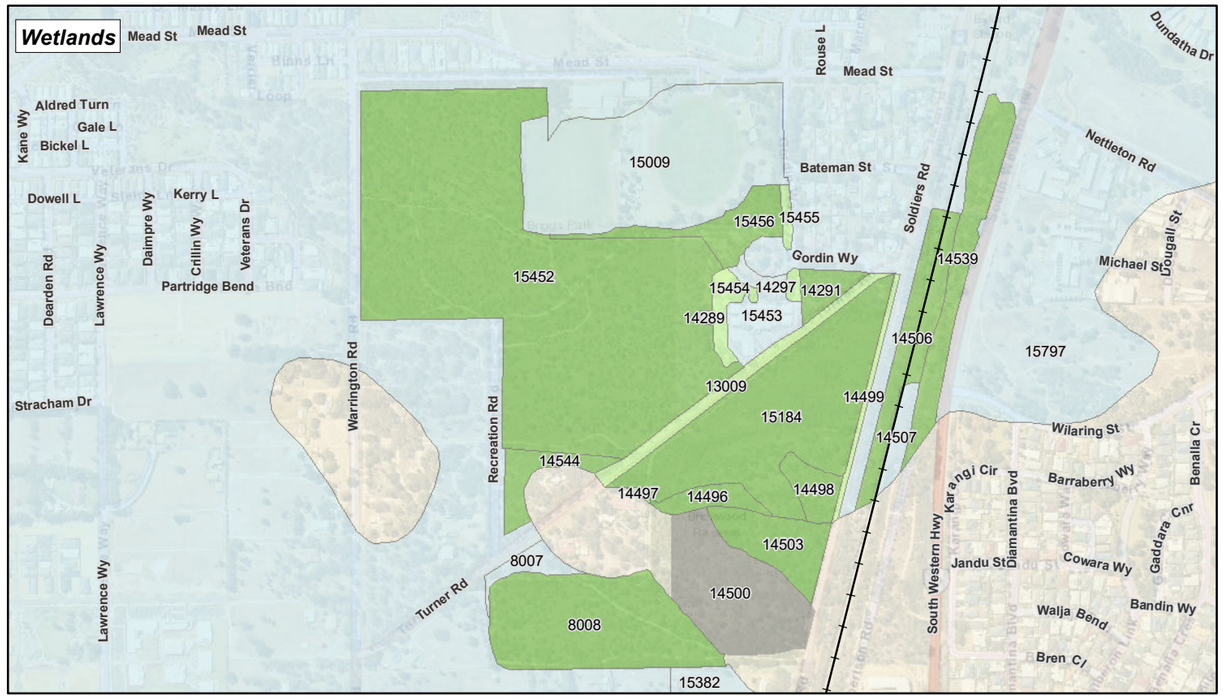

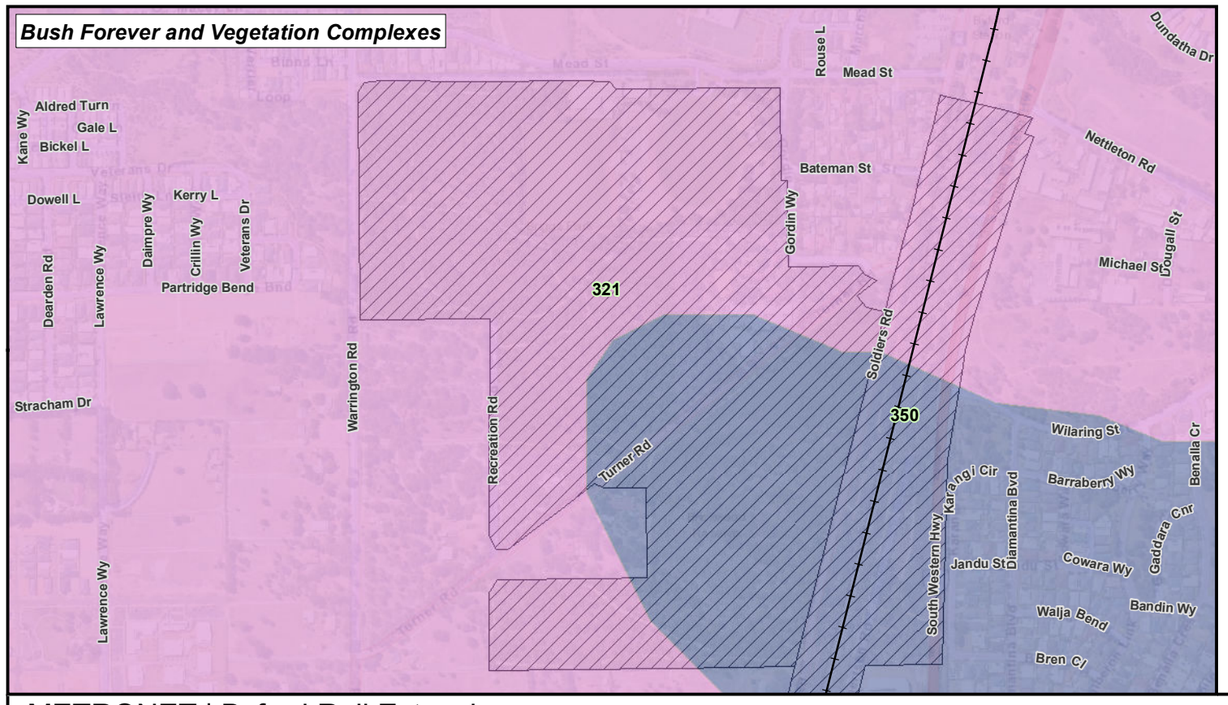

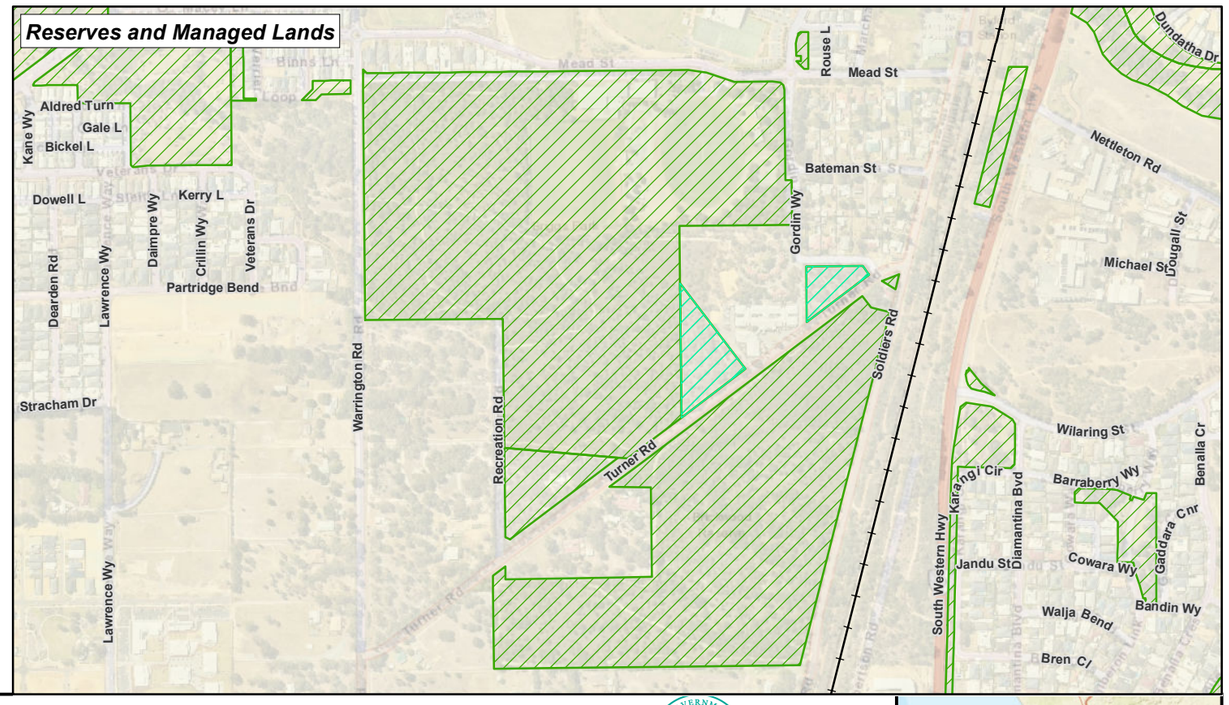

METRONET | Byford Rail Extension

Figure 6 | **Brickwood Reserve Offset Site**

Public Transport Authority

Legend

- Railway
- Cadastral Boundary

DBCA Database
- SCP3a
- SCP3c
- SCP09
- SCP20b

Geomorphic Wetlands (UFI Labelled)
- Conservation
- Multiple Use
- Not Applicable
- Resource Enhancement

- Bush Forever

Vegetation Complexes (Heddle et al. 1980)
- Forrestfield Complex
- Guildford Complex

- Reserves
- Reserves (Not under Shire Management)

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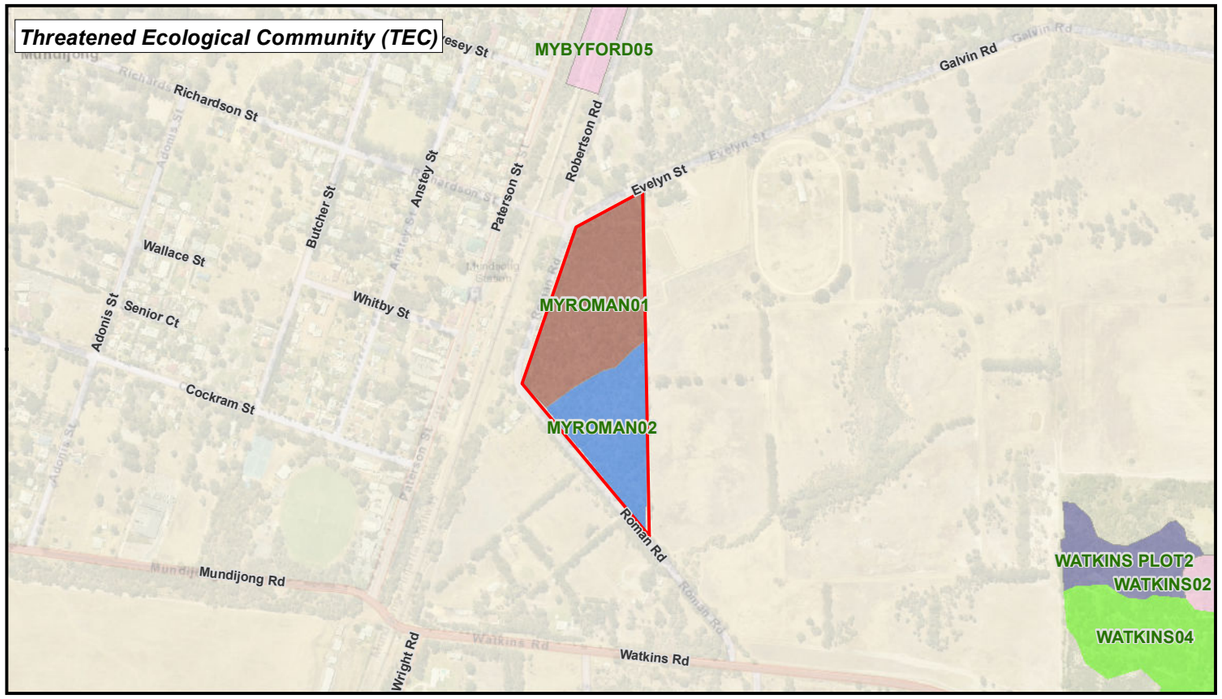
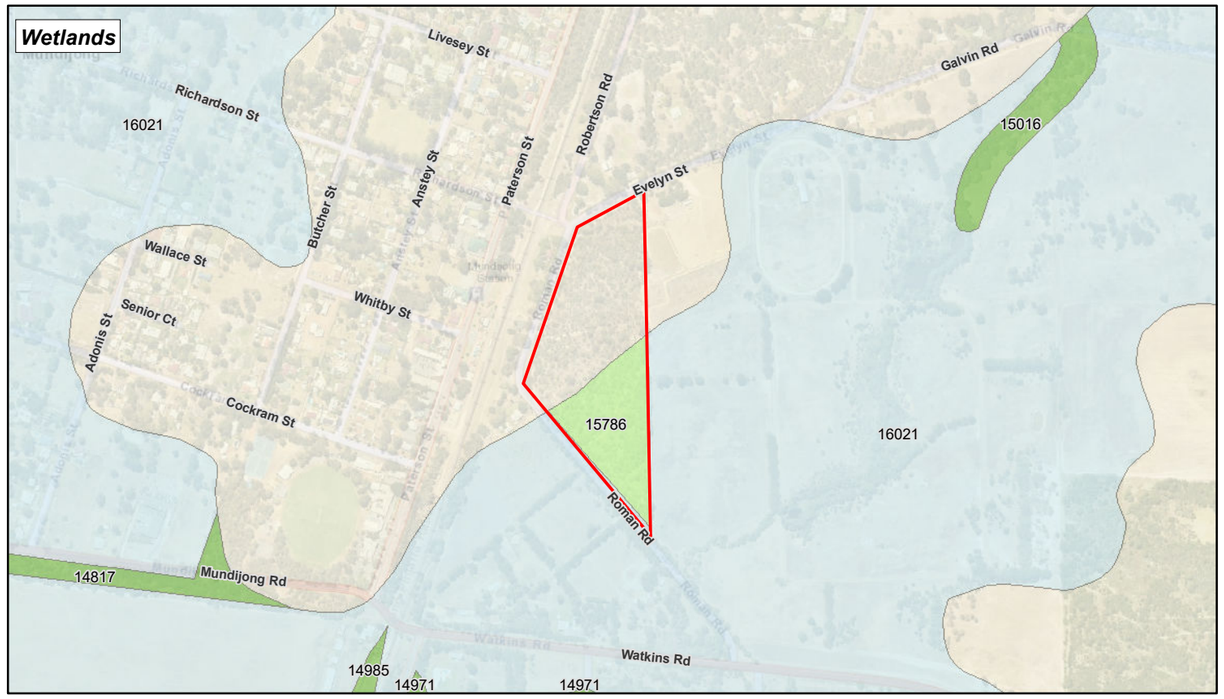
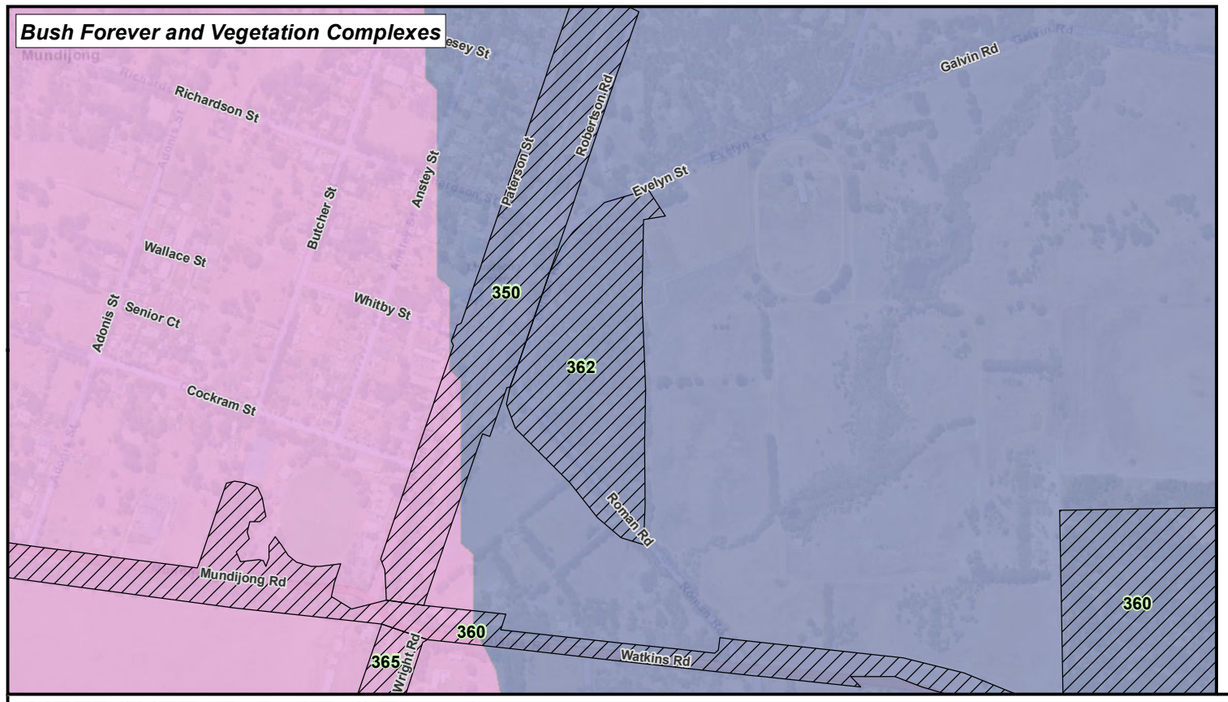
Threatened Ecological Community (TEC)



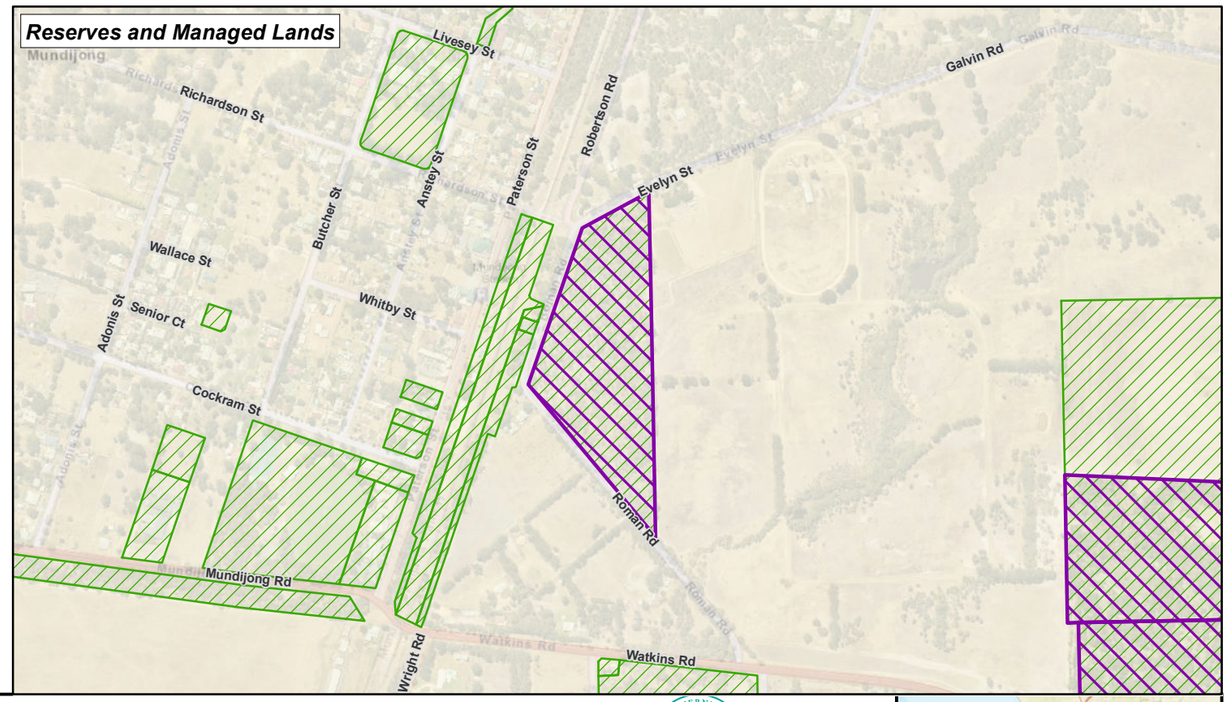
Wetlands



Bush Forever and Vegetation Complexes



Reserves and Managed Lands



METRONET | Byford Rail Extension

Figure 7 | **Roman Road Nature Reserve Offset Site**

Public Transport Authority

Legend

- Offset Site Boundary

DBCA Database
- SCP02
- SCP20b
- SCP3a
- SCP3b
- SCP3c

Geomorphic Wetlands (UFI Labelled)
- Conservation
- Multiple Use
- Resource Enhancement

- Bush Forever

Vegetation Complexes (Heddle et al. 1980)
- Forrestfield Complex
- Guildford Complex

- DBCA Legislated Lands and Waters
- Reserves

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4. Black cockatoo habitat

4.1. Significant residual impacts

The Proposal will result in a significant residual impact to black cockatoo foraging habitat and potential black cockatoo breeding trees. The impacts occur across fragmented patches of vegetation within the Footprint. Overall, the foraging habitat quality for each species of black cockatoo is as follows:

- 10.67 ha of Low and 8.65 ha of Moderate quality foraging habitat for Carnaby's cockatoo
- 8.65 ha of Moderate to High and 52.49 ha of Low quality foraging habitat for forest red-tailed black cockatoos
- 8.65 ha of Moderate to High quality foraging habitat for Baudin's cockatoo
- 139 black cockatoo potential breeding trees

4.2. Environmental objective

To maintain and enhance the quality and ecological function of black cockatoo habitat over the long-term.

4.3. Lowlands Nature Reserve offset site

The PTA will use the 1,138 ha Lowlands Nature Reserve in Mardella (Figure 8) as an offset to counterbalance significant residual impacts to black cockatoo habitat from the Proposal.

The Western Australian (WA) Government purchased the Lowlands Nature Reserve in 2014 to offset residual environmental impacts from the Strategic Assessment of Perth and Peel Regions (SAPPR), of which the METRONET program was included. The State of Western Australia owns the site. The DBCA is the responsible entity. The site is a Class 'A' conservation reserve. In 2019, the WA Government allocated the entirety of the Lowlands Nature Reserve to the PTA to meet METRONET offset requirements.

Lowlands is one of the most strategic conservation areas remaining on the Swan Coastal Plain, representing multiple ecological values, threatened flora habitat as well as habitat for the three species of black cockatoos.

Lowlands is located approximately 12 km southwest of the Byford train station location, within the known range of Carnaby's cockatoos when feeding chicks in the nest (Bamford 2021). Lowlands contains foraging habitat for all three species of black cockatoo and over 7,000 potential breeding trees (see section 4.3.2). Black cockatoos are mobile and follow tree lines (Bamford 2021). While Lowlands appears isolated, there are ecological corridors between the impact area and Lowlands in the form of rail and road corridors (with black cockatoo roosting and foraging vegetation), nature reserves and rivers.

By funding a reserve officer, the PTA is significantly contributing to DBCA's conservation efforts at Lowlands and believes the Lowlands offset is more valuable than other potential black cockatoo offsets involving smaller land parcels closer to the Proposal.

Threats

Lowlands is large consolidated patch of native vegetation located in an area historically cleared for agricultural purposes. Prior to the State acquiring Lowlands, it was in private ownership. The former owners are conservation minded and still hold an interest in the property; however, the property was at risk of degradation, as they did not have the resources to conduct on-ground management to protect the site's numerous ecological values, including black cockatoo habitat.

Once assuming management responsibility for the site, the DBCA performed limited management at the Reserve. Mainly when funding was available through grants and performed with the assistance of volunteer groups.

Threats at the Reserve include dieback, weeds, access to the size by neighbouring grazing animals (goats) and limited past monitoring of the on-ground site conditions.

4.3.1. Management actions

The PTA and the DBCA have entered a memorandum of understanding (MOU) in which the PTA agreed to provide funding to the DBCA to perform on-ground management at the Reserve for seven years. The DBCA commenced management of the Reserve under this agreement on 1 January 2021.

Table 7 summarises on-ground management actions the DBCA will perform and the anticipated outcome or tangible benefit. Management actions align with:

- Action 1 of the Carnaby's Cockatoo Recovery Plan (DPaW 2013), to protect and manage important habitat; and
- Section 14.9 of the Forest Black Cockatoo and Forest Red-tailed Black Cockatoo Recovery Plan (DEC 2008), to identify and manage important sites and protect from threatening processes.

Table 7: Lowlands Nature Reserve Management Actions

Management action	Anticipated outcome or tangible benefit
Removal of old fence and replace with DBCA style reserve fencing and gates. Maintenance and repairs of fencing and gate.	As the site is located in an area of an established rural area, limiting unauthorised access by vehicles and restricting other pedestrian and pest animal access will help to reduce threatening processes. Limiting access also assists with limiting the introduction and spread of weeds and disease. Perimeter access controls in the form of upgraded fencing will be installed and maintained to minimise damage to vegetation and fauna through illegal rubbish dumping, site contamination and unauthorised clearing.
Monitor unauthorised access to the site by regular site visits by reserve officer.	Information on unauthorised access to, and use of, the site is obtained to better inform management actions. Enable the DBCA to enforce penalties to those accessing the site without proper authority.
Manage and maintain all tracks within the site to allow safe site entry and access for authorised vehicles, where required. Management and maintenance to existing access tracks. Complete upgrade works where required.	The aim is to use the tracks as firebreaks (allowing fast access through the site for firefighting requirements), minimise damage to surrounding habitat and allow access to areas to carry out other management actions. Track maintenance, adequate access to site for maintenance and fire management. Less spread of weeds and/or disease. Less damage to vegetation from vehicles. Less impact on fauna from vehicles.

Management action	Anticipated outcome or tangible benefit
Install basic reserve identification signage.	Increased awareness in locals who attempt to use the reserve for unauthorised uses. Reduced occurrences of illegal use.
Dieback mapping and develop hygiene procedures.	*Phytophthora* management plan will document the *Phytophthora* mapping and set out actions to enable DBCA to target ongoing *Phytophthora* management. Areas of dieback infestation is known to inform management. Adoption of hygiene procedures assists in containing any current dieback infestations at this site and helps to prevent new infestations.
Weed survey.	Weed mapping will enable effective weed control to be undertaken. Baseline weed mapping conducted by the PTA prior to and following the on-ground offset management period produces quantifiable data to demonstrate that a reduction in weeds has been achieved.
Weed control.	Weed control will reduce current weed infestations from spreading to uninfested areas and allow natural regeneration of native vegetation.
Flora and vegetation survey.	Increased understanding of environmental values at the site.
Conduct annual and ad-hoc rubbish removal. Complete removal of illegally dumped and windblown litter on-site.	Reduce the presence of rubbish on the site will increase the area available for regeneration of native vegetation. Will help to prevent illness or injuries to fauna from rubbish. Will reduce potential for soil, surface water and ground water to become contaminated.
Fire management.	Reduces the impacts from hot burns from wildfires. Reduces the weeds and therefore fuel loads. Promotes regular seeding and reproduction of obligate seeders.
Feral animal monitoring and control.	Understand how the unwanted animals are gaining access to the site. Reduce the presence of unwanted grazers at the site. This will prevent predation of native vegetation and fauna and allow natural regeneration at the site.
Carnaby's cockatoo watering point establishment.	A permanent water source at the Reserve will increase the use of the site by black cockatoos.

4.3.2. Black cockatoo habitat assessment

Bamford Consulting Ecologists conducted a black cockatoo habitat assessment at the Lowlands Nature Reserve (Bamford 2021). The black cockatoo assessment is summarised in Table 8 and the Black Cockatoo Habitat Assessment report in Appendix C.

Table 8: Lowlands Nature Reserve black cockatoo habitat

Black cockatoo habitat	Description
Foraging habitat	Carnaby's cockatoo (Figure 9) • 921.9 ha of moderate-high foraging value • 37.5 ha of moderate foraging value • 153.5 of low foraging value Forest red-tailed black cockatoo (Figure 10) • 84.3 ha of high foraging value • 639.7 ha of moderate-high foraging value • 18 ha of moderate foraging value • 254 of low foraging value Baudin's black cockatoo (Figure 11) • 16.2 ha of high foraging value • 657.7 ha of moderate foraging value • 322.1 of low foraging value
Roosting habitat	Present. Roosting likely to occur at the Reserve.
Potential breeding trees	Bamford recorded 3,609 potential breeding trees across 523.3 ha of the Reserve (Figure 12). Based on tree density (stems per hectare) Bamford estimates there are 9,748 potential breeding trees at the site, of which 7,823 are likely hollow-bearing species.

4.3.3. Environmental outcome

The management actions will result in the following environmental outcomes, which will achieve the environmental objective:

- A reduction in the threatening processes
- Increase resilience of the ecological community to respond to threatening processes
- Improve condition of the ecological community
- Prevent the spread of weeds and new weed incursions
- Minimise the spread of *Phytophthora* and prevent new *Phytophthora* infestations

The effectiveness of the management actions will be measured by the monitoring and measurement of success criteria described in section 4.3.4 and 4.3.5.

4.3.4. Monitoring

The PTA will undertake the following monitoring throughout the offset management period to confirm the environmental objective and outcomes are met:

- Site inspections.
- Periodic engagement with the sites Reserve Officer.
- DBCA operational planning weed mapping.
- Annual reporting.

4.3.5. Measurement for success

The PTA will measure the success of the Lowlands Nature Reserve black cockatoo habitat offset through habitat quality mapping and site context using the Bamford's (or a comparable) methodology. Bamford's methodology reflects the significance of vegetation as foraging habitat for black cockatoos, where the foraging value of the vegetation depends upon the type, density and condition of trees and shrubs in an area and the influence of the site context (for example the proximity of nearby foraging habitat).

The Lowlands Nature Reserve black cockatoo offset will be successful if the black cockatoo foraging habitat quality and/or extent at the Reserve is the same as, or improved, at the end of the on-ground management offset period. The PTA will assess this through a final black cockatoo foraging habitat assessment.

4.3.6. Offset quantification

Based on the information provided above and application of the Commonwealth *Offsets Assessment Guide*, 78.8 ha of Carnaby's cockatoo foraging habitat provides 100% of the offset requirement. A description of the calculation is in Table 9 and in the Commonwealth Offsets Assessment Guide (Appendix B).

Table 9: Commonwealth Offset Assessment Guide – Carnaby's cockatoo foraging habitat

Factor	Rating	Explanation
Impacted Area		
Area (ha)	19.32	The Proposal will result in the clearing of 19.3 ha of Carnaby's cockatoo foraging habitat within the Footprint.
Initial quality	3	The PTA has applied an overall quality of 3 to the Carnaby's cockatoo foraging habitat impact area as follows: • 8.65 ha (45%) of moderate quality Carnaby's cockatoo foraging habitat – applied quality score of 4 • 10.67 ha (55%) of low quality Carnaby's cockatoo foraging habitat – applied quality score of 2 The PTA applied foraging habitat qualities scores based on PTA 2021.
Quantum of impact (ha)	5.8	Adjusted based on assessment of quality.
Offset Area – Lowlands Nature Reserve		
Start area (ha)	78.8	The extent of Carnaby's cockatoo foraging habitat required at Lowlands Nature Reserve to meet 100% of the offset requirement.
Start quality	6	The PTA has applied an overall quality of 6 to the Carnaby's cockatoo foraging habitat impact area as follows:

Factor	Rating	Explanation
		• 921.9 ha (82.8%) of moderate to high quality Carnaby's cockatoo foraging habitat – applied quality score of 7 • 37.5 ha (3.4%) of moderate quality Carnaby's cockatoo foraging habitat – applied quality score of 5 • 153.5 ha (13.8%) of low quality Carnaby's cockatoo foraging habitat – applied quality score of 3 The PTA applied foraging habitat qualities scores based on Bamford 2021.
Future quality without offset*	5	Without active on-ground management measures there will be a small reduction in quality due to weed incursion and other impacts. The provision of funding and resources as part of the offset allows for intervention and mitigation measures that otherwise would not normally occur.
Future quality with offset	6	Security of the offset and provision of capped funds to the DBCA to provide seven years of on-ground management of the Lowlands Nature Reserve will maintain the start quality of the offset.
Risk of loss (%) without offset	0%	The likelihood of the risk of loss of the entire occurrence due to anthropological impacts (e.g. clearing) is very low as the site is in the conservation estate and contains a threatened ecological community.
Risk of loss (%) with offset	0%	DWER will list the Reserve on the Offsets Register, which will inform any future applications to clear the site.
Confidence in result (averted loss) (%)	90%	The site is in the conservation estate and listed on the DWER Offsets Register. The confidence that there is a very low risk of loss is high.
Confidence in result (habitat quality) (%)	80%	The DBCA are confident they can maintain (or improve) the condition of the habitat at Lowlands Nature Reserve with funding from the offset however the lower confidence reflects the inability to control environmental events such as fire, drought or climate change.
Time over which loss is averted (years)	20	The offset site is DBCA conservation reserve and therefore the maximum time over averted loss is applied.
Time until ecological benefit (years)	7	Although ecological benefit was gained at the time the land was acquired, the overall offset package provided for seven years of on-ground management, therefore the time until ecological benefit has been set to seven years. The ecological benefit from seven years of on-ground management includes reduction in weed cover, fencing, feral animal control and dieback management.
Percent of offset requirement	100%	Calculated by the Commonwealth *Offsets Assessment Guide*.

Based on the information provided above and application of the Commonwealth *Offsets Assessment Guide*, 232.5 ha of forest red-tailed black cockatoo foraging habitat provides 100% of the offset requirement. A description of the calculation is in Table 10 and in the Commonwealth Offsets Assessment Guide (Appendix B).

Table 10: Commonwealth Offset Assessment Guide – forest red-tailed black cockatoo foraging habitat

Factor	Rating	Explanation
Impacted Area		
Area (ha)	61.14	The Proposal will result in the clearing of forest red-tailed black cockatoo foraging habitat within the Footprint.
Initial quality	3	The PTA has applied an overall quality of 3 to the forest red-tailed black cockatoo foraging habitat impact area as follows: • 8.65 ha (14%) of moderate to high quality forest red-tailed black cockatoo foraging habitat – applied quality score of 7 • 52.49 ha (86%) of low quality forest red-tailed black cockatoo foraging habitat – applied quality score of 2 The PTA applied foraging habitat qualities scores based on PTA 2021.
Quantum of impact (ha)	18.34	Adjusted based on assessment of quality.
Offset Area – Lowlands Nature Reserve		
Start area (ha)	232.5	The extent of forest red-tailed black cockatoo required at Lowlands Nature Reserve to meet 100% of the offset requirement.
Start quality	6	The PTA has applied an overall quality of 6 to the forest red-tailed black cockatoo foraging habitat impact area as follows: • 16.2 ha (1.6%) of very high quality forest red-tailed black cockatoo foraging habitat – applied quality score of 9 • 68.1 ha (6.8%) of high quality forest red-tailed black cockatoo foraging habitat – applied quality score of 8 • 639.7 ha (64.2%) of moderate to high quality forest red-tailed black cockatoo foraging habitat – applied quality score of 7 • 18 ha (1.8%) of moderate quality forest red-tailed black cockatoo foraging habitat – applied quality score of 6 • 254 ha (25.5%) of low quality forest red-tailed black cockatoo habitat – applied quality score of 3 The PTA applied foraging habitat qualities scores based on Bamford 2021.
Future quality without offset*	5	Without active on-ground management measures there will be a small reduction in quality due to weed incursion and other impacts.
Future quality with offset	6	Security of the offset and provision of capped funds to the DBCA to provide seven years of on-ground management of the Lowlands Nature Reserve will maintain the start quality of the offset.
Risk of loss (%) without offset	0%	The likelihood of the risk of loss of the entire occurrence due to anthropological impacts (e.g. clearing) is very low as the site is in the conservation estate and contains a threatened ecological community.
Risk of loss (%) with offset	0%	DWER will list the Reserve on the Offsets Register, which will inform any future applications to clear the site.
Confidence in result (averted loss) (%)	90%	The site is in the conservation estate and listed on the DWER Offsets Register. The confidence that there is a very low risk of loss is high.

Factor	Rating	Explanation
Confidence in result (habitat quality) (%)	80%	The DBCA are confident they can maintain (or improve) the condition of the habitat at Lowlands Nature Reserve with funding from the offset however the lower confidence reflects the inability to control environmental events such as fire, drought or climate change.
Time over which loss is averted (years)	20	The offset site is DBCA conservation reserve and therefore the maximum time over averted loss is applied.
Time until ecological benefit (years)	7	Although ecological benefit was gained at the time the land was acquired, the overall offset package provided for seven years of on-ground management, therefore the time until ecological benefit has been set to seven years. The ecological benefit from seven years of on-ground management includes reduction in weed cover, fencing, feral animal control and dieback management.
Percent of offset requirement	100%	Calculated by the Commonwealth *Offsets Assessment Guide*.

Based on the information provided above and application of the Commonwealth *Offsets Assessment Guide*, 70.6 ha of Baudin's cockatoo foraging habitat provides 100% of the offset requirement. A description of the calculation is in Table 11 and in the Commonwealth Offsets Assessment Guide (Appendix B).

Table 11: Commonwealth Offset Assessment Guide – Baudin's cockatoo foraging habitat

Factor	Rating	Explanation
Impacted Area		
Area (ha)	8.65	The Proposal will result in the clearing of 8.65 ha of Baudin's cockatoo within the Footprint.
Initial quality	6	The PTA has applied an overall quality of 6 to the Baudin's cockatoo foraging habitat impact area as follows: • 8.65 ha (100%) of moderate quality Baudin's cockatoo foraging habitat – applied quality score of 6 The PTA applied foraging habitat qualities scores based on PTA 2021.
Quantum of impact (ha)	5.19	Adjusted based on assessment of quality.
Offset Area – Lowlands Nature Reserve		
Start area (ha)	70.6	The extent of Baudin's cockatoo required at Lowlands Nature Reserve to meet 100% of the offset requirement.
Start quality	5	The PTA has applied an overall quality of 6 to Baudin's cockatoo foraging habitat impact area as follows: • 16.2 ha (1.6%) of high quality Baudin's cockatoo foraging habitat – applied quality score of 8 • 657.7 ha (66%) of moderate quality Baudin's cockatoo foraging habitat – applied quality score of 6 for 639.7 ha and 5 for 18 ha • 322.1 ha (32.3%) of low quality Baudin's cockatoo habitat – applied quality score of 3

Factor	Rating	Explanation
		The PTA applied foraging habitat qualities scores based on Bamford 2021.
Future quality without offset*	4	Without active on-ground management measures there will be a small reduction in quality due to weed incursion and other impacts.
Future quality with offset	5	Security of the offset and provision of capped funds to the DBCA to provide seven years of on-ground management of the Lowlands Nature Reserve will maintain the start quality of the offset.
Risk of loss (%) without offset	0%	The likelihood of the risk of loss of the entire occurrence due to anthropological impacts (e.g. clearing) is very low as the site is in the conservation estate and contains a threatened ecological community.
Risk of loss (%) with offset	0%	DWER will list the Reserve on the Offsets Register, which will inform any future applications to clear the site.
Confidence in result (averted loss) (%)	90%	The site is in the conservation estate and listed on the DWER Offsets Register. The confidence that there is a very low risk of loss is high.
Confidence in result (habitat quality) (%)	80%	The DBCA are confident they can maintain (or improve) the condition of the habitat at Lowlands Nature Reserve with funding from the offset however the lower confidence reflects the inability to control environmental events such as fire, drought or climate change.
Time over which loss is averted (years)	20	The offset site is DBCA conservation reserve and therefore the maximum time over averted loss is applied.
Time until ecological benefit (years)	7	Although ecological benefit was gained at the time the land was acquired, the overall offset package provided for seven years of on-ground management, therefore the time until ecological benefit has been set to seven years. The ecological benefit from seven years of on-ground management includes reduction in weed cover, fencing, feral animal control and dieback management.
Percent of offset requirement	100%	Calculated by the Commonwealth *Offsets Assessment Guide*.

4.3.7. Black cockatoo potential breeding trees offset extent

The PTA apply a ratio of 3:1 to determine the black cockatoo potential breeding trees offset extent. Both DAWE and the EPA have accepted this ratio in previous PTA METRONET offset strategies (Yanchep Rail Extension, Thornlie-Cockburn Link, Malaga to Ellenbrook Rail Works). The PTA will counterbalance significant residual impacts to 139 black cockatoo potential breeding trees by offsetting 417 black cockatoo potential breeding trees (100%) at the Lowlands Nature Reserve.

4.3.8. Overlapping environmental values

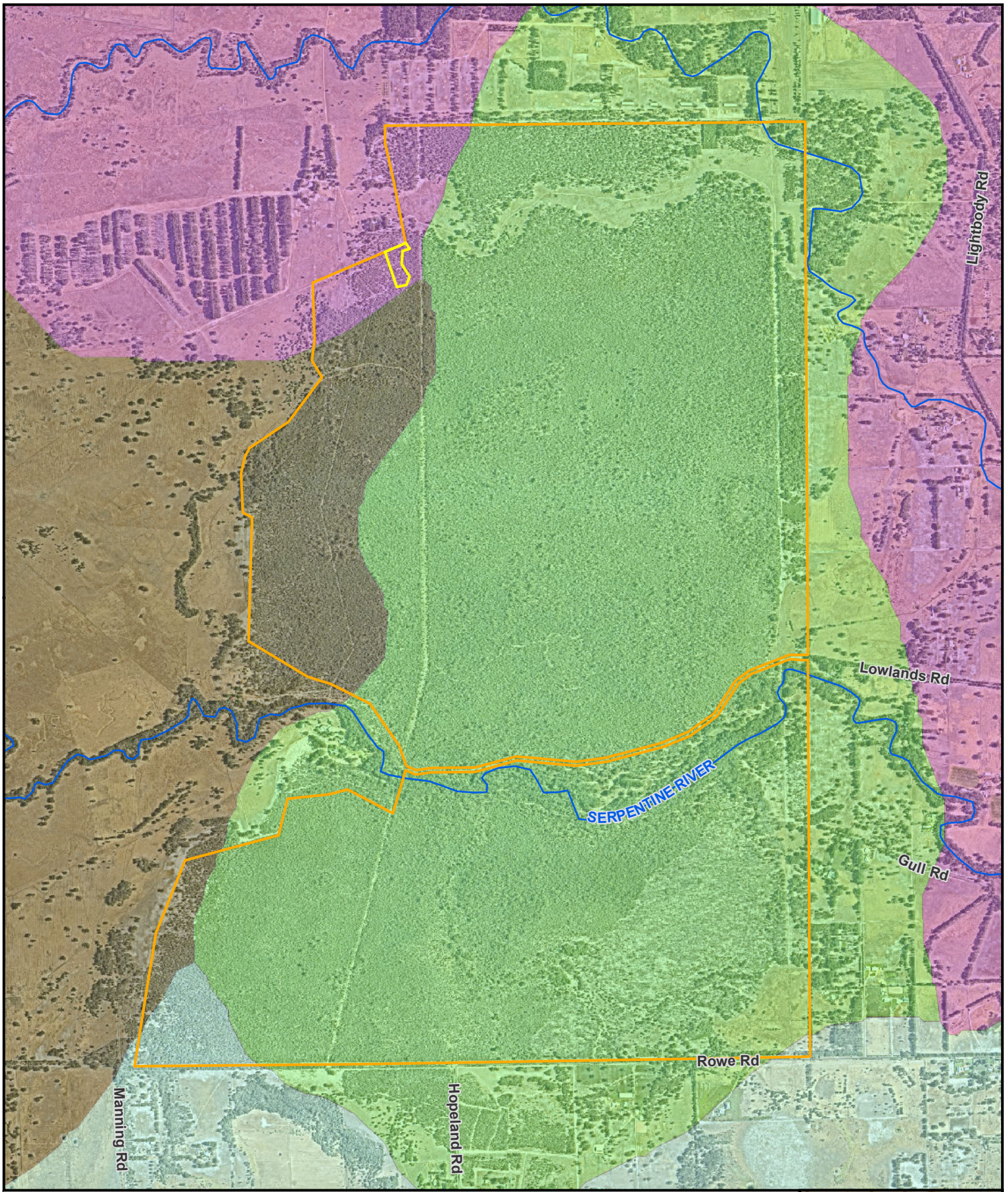
Carnaby's, Baudin's and forest red-tailed black cockatoo foraging habitat and potential breeding trees have been identified by Bamford (2021) and the DBCA as occurring within the low lying Banksia Woodlands of the SCP TEC mapped within the Lowlands Nature Reserve. Therefore, the proposed physical portions applied as the offset for black cockatoo habitat will overlap in the Reserve.

4.3.9. Quantification of allocation of black cockatoo habitat at the Lowlands Nature reserve

The WAPC allocated the entirety of the Lowlands Nature Reserve to the PTA to offset significant residual impacts from METRONET proposals. The PTA has used portions of this Reserve in previous METRONET offset strategies, however sufficient extent of black cockatoo habitat remains available to offset the impacts from this Proposal as evidenced in Table 12.

Table 12: Quantification of black cockatoo habitat remaining in the Lowlands Nature Reserve

Species habitat	Black cockatoo habitat at Lowlands	Black cockatoo habitat allocated to METRONET Proposals	Unallocated black cockatoo habitat	Black cockatoo habitat required for this Proposal
Carnaby's cockatoo foraging habitat	1,112.9 ha	536.45 ha	513.42 ha	78.8 ha
Forest red-tailed black cockatoo foraging habitat	996 ha	371.31 ha	568.72 ha	232.5 ha
Baudin's cockatoo foraging habitat	996 ha	434.28 ha	933.3 ha	70.6 ha
Potential breeding trees	9,748 trees	1,413 trees	7,918 trees	417 trees



METRONET | Byford Rail Extension

Figure 8 | **Lowlands Nature Reserve Offset Site**

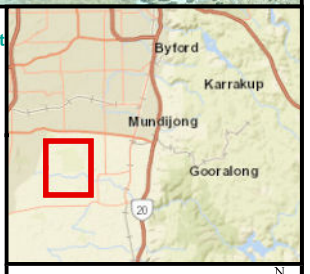
Public Transport Authority

Legend

- Lowlands Nature Reserve Offset Site Boundary
- METRONET Guildford Complex Offset Allocated Area (BRE)

Vegetation Complexes (Heddle et al. 1980)

- Bassendean Complex-Central and South
- Dardanup Complex
- Guildford Complex
- Southern River Complex



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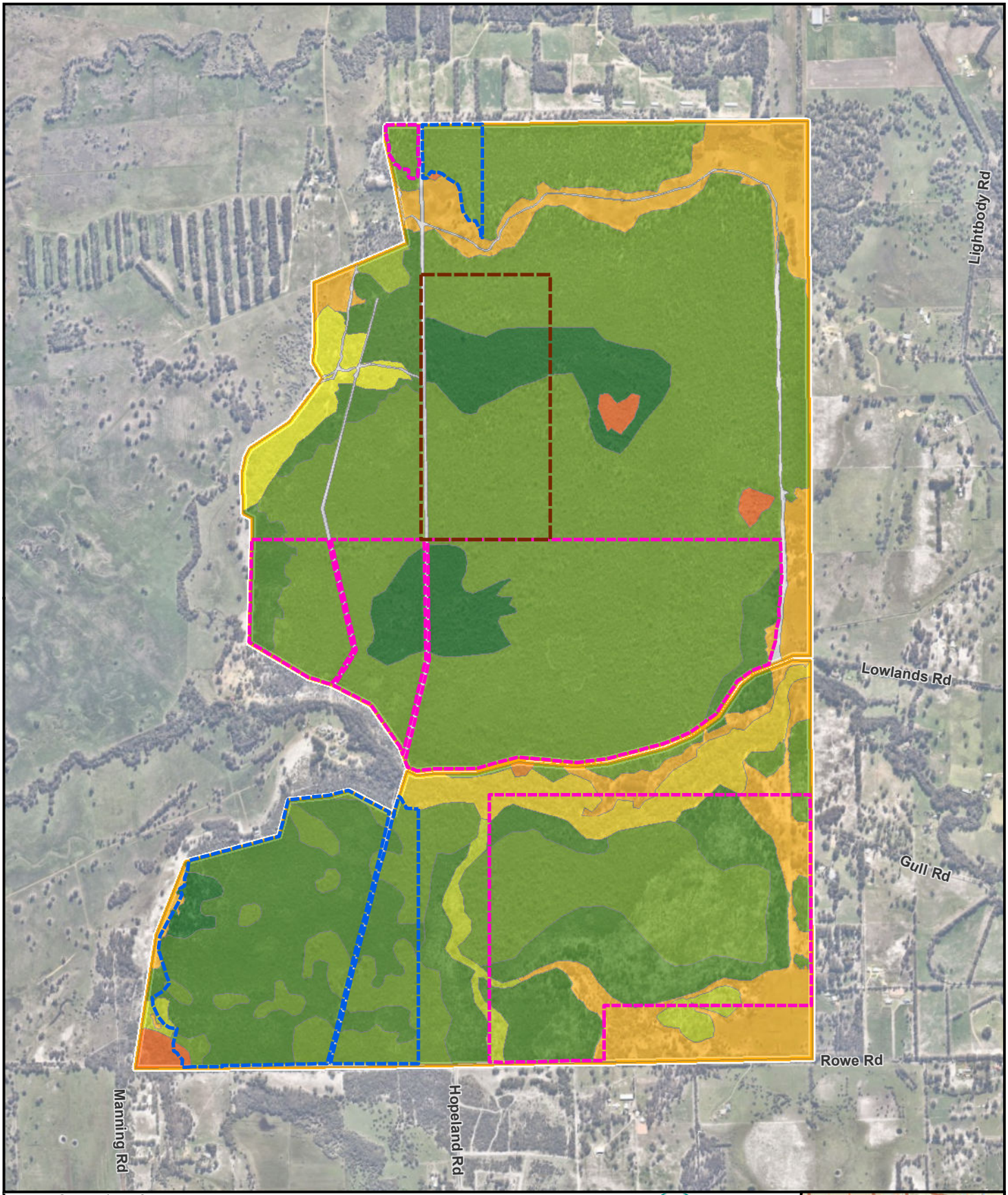


METRONET | Byford Rail Extensiony

Figure 9 | **Lowlands Nature Reserve Carnaby's Cockatoo Foraging Habitat**

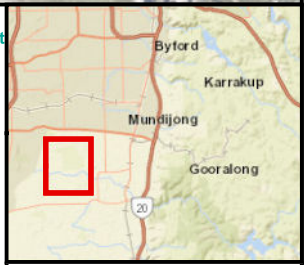
Public Transport Authority

Legend

- Lowlands Nature Reserve Offset Site Boundary
- METRONET Carnaby's Foraging Habitat Offset Allocated Area (BRE)
- METRONET Carnaby's Foraging Habitat Offset Allocated Area (TCL)
- METRONET Carnaby's Foraging Habitat Offset Allocation Area (MEL)

CBC Foraging Habitat Quality (Bamford, 2021)

- 7 - ABw
- 7 - BKw
- 7 - EBw
- 5 - Biw
- 5 - Cw
- 5 - EMw
- 3 - Ef
- 3 - Sn
- 3 - Tw
- 1 - Mw
- 0 - Track



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Approved by: B.Lockley
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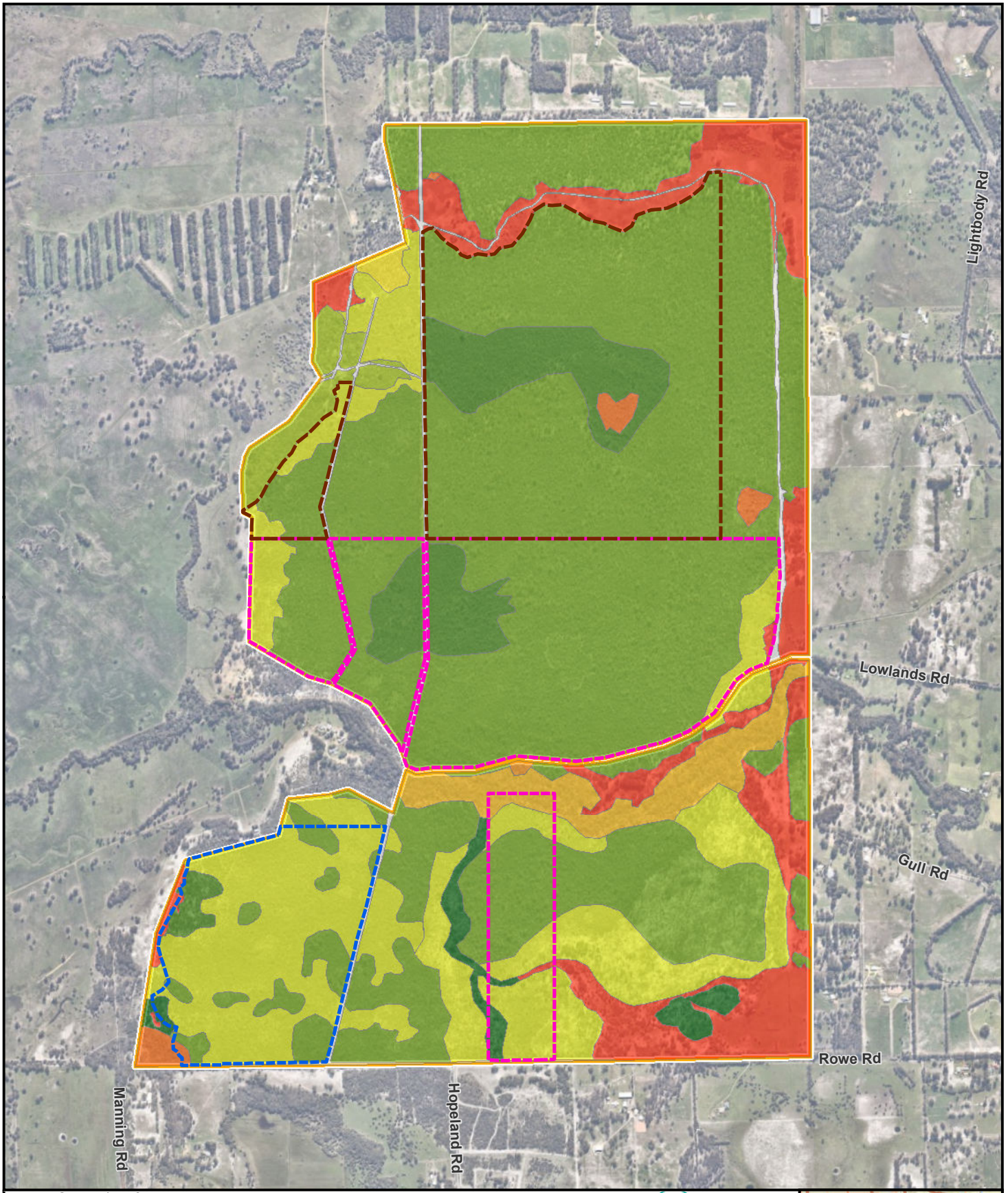


METRONET | Byford Rail Extension

Figure 10 | **Lowlands Nature Reserve Forest Red-tailed Black Cockatoo Foraging Habitat**

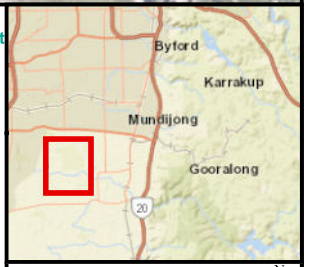
Public Transport Authority

Legend

- Lowlands Nature Reserve Offset Site Boundary
- METRONET Forest Red-tailed Foraging Habitat Offset Allocated Area (BRE)
- METRONET Forest Red-tailed Foraging Habitat Offset Allocated Area (TCL)
- METRONET Forest Red-tailed Foraging Habitat Offset Allocation Area (MEL)

FRT Foraging Habitat Quality (Bamford, 2021)

- 9 - Cw
- 8 - ABw
- 7 - EBw
- 6 - EMw
- 3 - BKw
- 3 - Biw
- 3 - Ef
- 3 - Tw
- 1 - Mw
- 1 - Sn
- 0 - Track



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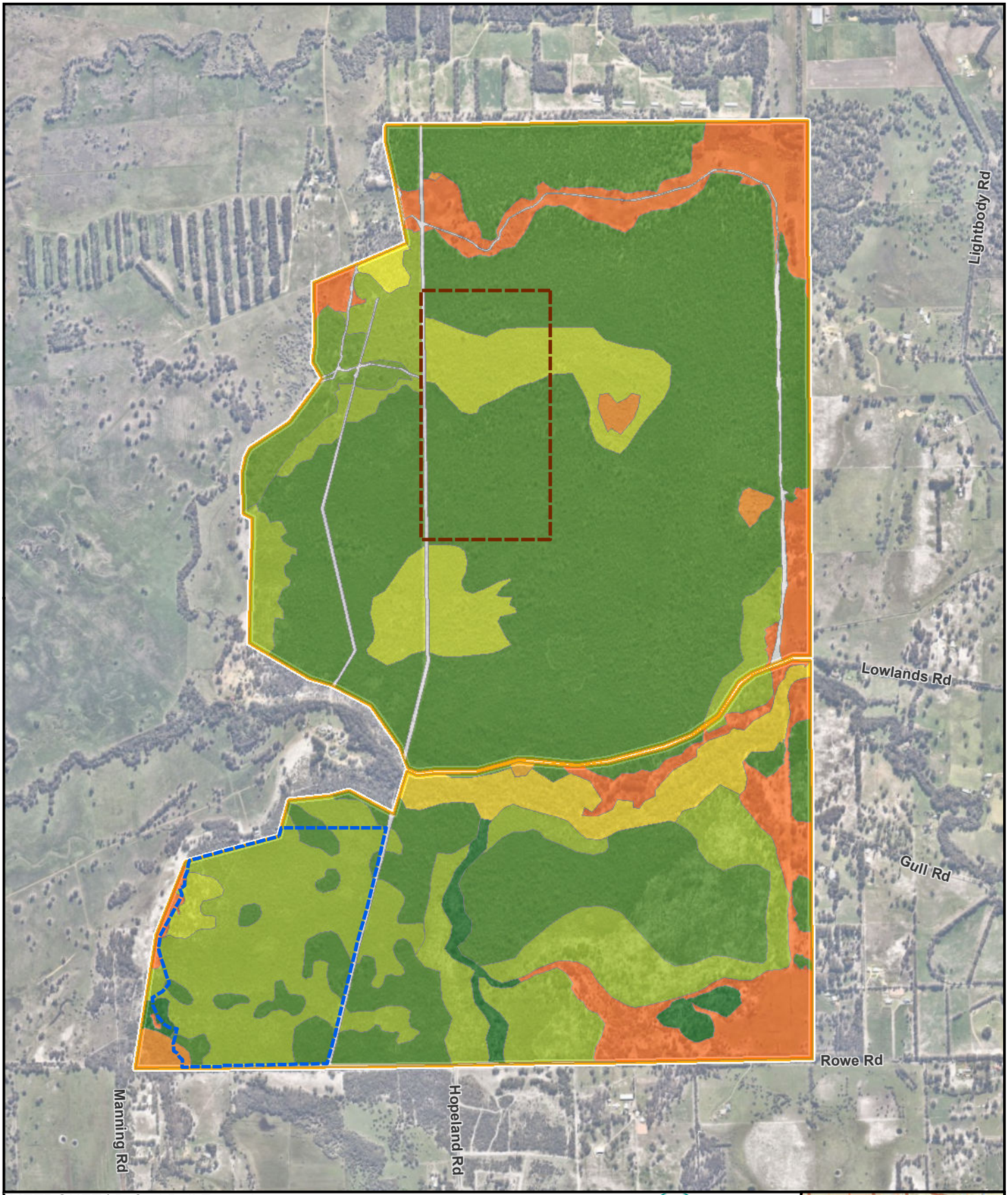


METRONET | Byford Rail Extension

Figure 11 | **Lowlands Nature Reserve Baudin's Cockatoo Foraging Habitat**

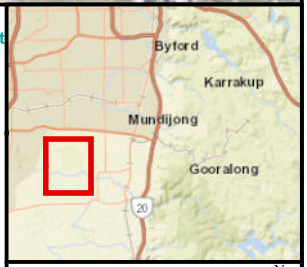
Public Transport Authority

Legend

- Lowlands Nature Reserve Offset Site Boundary
- METRONET Baudin's Foraging Habitat Offset Allocated Area (BRE)
- METRONET Baudin's Foraging Habitat Offset Allocated Area (TCL)

Baudin's Foraging Habitat Quality (Bamford, 2021)

- 9 - Cw
- 7 - EBw
- 6 - EMw
- 3 - BKw
- 3 - ABw
- 3 - Biw
- 3 - Ef
- 3 - Tw
- 1 - Mw
- 1 - Sn
- 0 - Track



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Created By: K.Du
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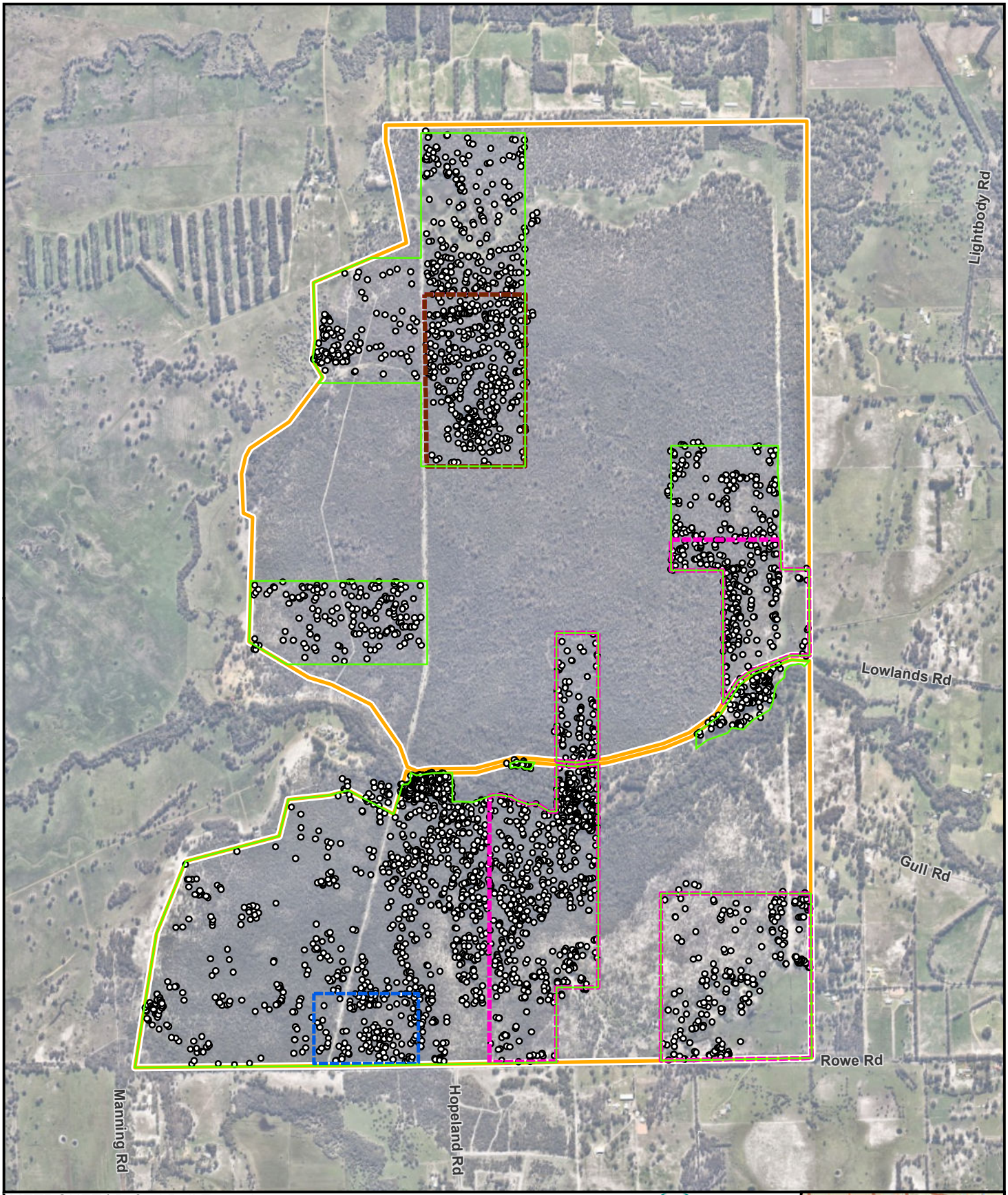


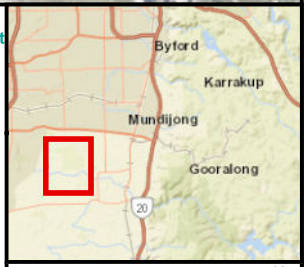
METRONET | Byford Rail Extension

Figure 12 | **Lowlands Nature Reserve Black Cockatoo Potential Breeding Trees**

Public Transport Authority

Legend

- Lowlands Nature Reserve Offset Site Boundary
- METRONET Black Cockatoo Potential Breeding Tree Offset Allocation Area (BRE)
- METRONET Black Cockatoo Potential Breeding Tree Offset Allocated Area (TCL)
- METRONET Black Cockatoo Potential Breeding Tree Offset Allocation Area (MEL)
- Black Cockatoo Potential Breeding Trees (Bamford, 2021)
- Potential Black Cockatoo Breeding Tree Survey Extent (Bamford, 2021)



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5. Wetlands, Bush Forever and Guildford Complex

5.1. Wetlands offset

5.1.1. Significant residual impact

The Proposal will result in a significant residual impact to 2.6 ha of Conservation Category Wetlands. The impacts occur across six Conservation Category Wetlands within the Footprint. Overall the vegetation condition of the Conservation Category Wetlands is:

- 0.02 ha in Excellent condition
- 0.05 ha in Very Good condition
- 1.11 ha in Good condition
- 0.44 ha in Degraded condition
- 0.9 ha in Completely Degraded condition.

5.1.2. Environmental objective

To retain or improve the ecological values and functions of a Conservation Category Wetland.

5.1.3. Offset extent

The PTA calculated the offset extent required for wetlands as 7.8 ha using a 3:1 ratio. The EPA has accepted this ratio in previous PTA METRONET offset strategies (Yanchep Rail Extension, Thornlie-Cockburn Link and Malaga to Ellenbrook Rail Works).

5.1.4. Offset site

The Conservation Category Wetlands impacted by the Proposal primarily underlay the SCP3a ecological community, and therefore the PTA propose to offset the Conservation Category Wetland impacts with the SCP3a offset as follows:

- Lambert Lane Nature Reserve contains 3.6 ha of Conservation Category Wetlands.
- Brickwood Reserve contains 17.7 ha of Conservation Category Wetlands.

Therefore, the PTA offset for Lambert Lane Nature Reserve and Brickwood Reserve will contribute to the Conservation Category Wetland offset.

5.2. Bush Forever offset

5.2.1. Significant residual impact

The Proposal will result in a significant residual impact to 1.54 ha of Bush Forever. The Footprint includes 4.1 ha of Bush Forever; of this 1.54 ha is native vegetation and 2.59 ha has is cleared. The 1.54 ha of significant residual impact (i.e. native vegetation) on each Bush Forever site is in Table 13.

Table 13: Impacts on Bush Forever

Bush Forever site	Vegetation complex	Bush Forever impacts	Ecological function
Lambert Lane Nature Reserve (Bush Forever site 264)	Forrestfield Complex	1.29 ha of native vegetation	SCP3a conservation category wetland black cockatoo habitat
Wungong Brook, Byford (Bush Forever site 266)	Guildford Complex	0.21 ha of native vegetation	conservation category wetland black cockatoo habitat
Byford to Serpentine Rail/Road Reserves and Adjacent Bushland (Bush Forever site 350)	Guildford Complex	0.04 ha of native vegetation	multiple use wetland

5.2.2. Environmental objective

To maintain or improve the overall quality and ecological function of the vegetation within the Bush Forever site.

5.2.3. Offset extent

Impacts on Bush Forever from the Proposal are of high conservation significance as the impacted areas contain either one or more of the following attributes:

- Forrestfield and Guildford vegetation complex type, of which approximately 12% and 5% of their pre-European extents remaining on the Swan Coastal Plain, respectively
- a threatened ecological community (SCP3a or SCP3c)
- black cockatoo habitat
- Conservation Category Wetlands.

The PTA will provide an offset of 3.08 ha, calculated by applying the ratio of 2:1, specified in State Planning Policy 2.8 (WAPC 2010) for very high conservation significant vegetation.

5.2.4. Offset site

Lambert Lane Nature Reserve is a Bush Forever site (No. 264) and contains the same ecological functions as the impacted Bush Forever (SCP3a, Forrestfield Complex, wetlands and black cockatoo habitat). Therefore, the PTA offset for Lambert Lane Nature Reserve will contribute to the Bush Forever offset.

5.3. Guildford Complex offset

5.3.1. Significant residual impacts

The Proposal will result in a significant residual impact to 4.4 ha of Guildford Complex vegetation. The impacts occur across fragmented patches of Guildford Complex vegetation within the Footprint. The vegetation associated with the Guildford Complex vegetation is:

- 3.76 ha in Completely Degraded condition
- 0.68 ha in Degraded condition

5.3.2. Environmental objective

To retain sites that align with Guildford Complex vegetation in the conservation estate to prevent against further loss of this vegetation complex.

5.3.3. Offset extent

The EPA (2016) define Completely Degraded vegetation as vegetation that has lost its structure and is completely, or almost completely, without native species.

The Completely Degraded vegetation within the Footprint consists of Scattered *Corymbia calophylla* and *Eucalyptus marginata* trees with occasional *Eucalyptus wandoo* or *Eucalyptus rudis* in paddocks and grazed areas, *Corymbia calophylla* and *Eucalyptus rudis* woodland on drainage line and Scattered *Corymbia calophylla* and *Eucalyptus marginata*. The Completely Degraded vegetation in the Footprint is sparse and fragmented.

Previous METRONET projects have offset vegetation in Degraded or better condition. Therefore, the PTA do not propose to offset the Completely Degraded vegetation within Guildford Complex.

The PTA will offset the 0.68 ha of Degraded vegetation with the Guildford Complex. The PTA has applied State Planning Policy 2.8 to establish an offset requirement of 1.36 ha (that is, by applying a 2:1 ratio for vegetation of high significance).

5.3.4. Offset site

Lowlands Nature Reserve contains 27.75 ha of Guildford Complex in the north-western corner of the site. Therefore, the PTA will offset the 1.36 ha of Guildford Complex at the Lowlands Nature Reserve offset site (Figure 8).

6. Governance, Reporting and Contingency

6.1. Monitoring, reporting, timing and financial and governance arrangements

The PTA will appoint an appropriate land manager to manage each offset. A governance document, for example a memorandum of understanding (MOU) or similar, will be developed and executed between the PTA and the land manager. The governance document will outline the following:

- Governance arrangements.
- Management actions to implement the offset.
- Financial arrangements.
- Reporting requirements and timing.

The PTA have developed memoranda of understanding with the DBCA for other offset sites and are confident that similar MOUs can be developed and implemented for the Proposal's offsets. MOUs require the land manager to provide the PTA with an annual report on the progress in undertaking the activities contained within the MOU, allocation and use of funds and proposed activities for the following year.

Management plans will adopt an adaptive management approach, allowing reallocation of resources and funding to the most threatening process over the course of the offset period. For example following a bushfire the priority might be to manage weed infestations.

The PTA will provide regulators with progress of management actions in accordance with any annual compliance assessment reporting requirements.

The PTA will provide the governance arrangements for each offset to the regulators at the conclusion of negotiations. This will include the roles and responsibilities of the PTA and the management body and any legal obligations.

6.2. Risks and contingency measures

The PTA consider the risk of not being able to provide an appropriate offset for SCP3a, SCP3c, black cockatoo habitat, Conservation Category Wetlands, Bush Forever and Guildford Complex as low. However, the PTA will continue to investigate other occurrences of SCP3a and SCP3c as potential offsets for the Proposal.

7. Stakeholder consultation

7.1. Key stakeholders

Key stakeholders identified by the PTA are in the Stakeholder Engagement section of the Environmental Review Document (PTA 2021). The WAPC, DBCA, Shire of Serpentine Jarrahdale and City of Armadale are key stakeholders that assisted in locating and defining potential offsets for the Proposal (Table 14). Main Roads WA (MRWA) have also provided assistance and guidance to locate offset sites. The PTA are committed to on-going consultation with stakeholders to develop the Offset Strategy for the Proposal.

Table 14: Key stakeholders

Stakeholder	Role
PTA	Develop an Offset Strategy that meets the requirements of the regulators, considers key stakeholder input and is cost-effective for the State.
DBCA	Provide technical guidance on the suitability of potential offset sites including management actions, likelihood of success and indicative costs. Provide advice on the DBCA's willingness to accept land into the conservation estate and agree to manage the land. Propose management actions, risks and cost considerations.
City of Armadale	Identify potential offset sites within the City. Determine land manager and management, conservation status. Propose management actions, risks and cost considerations.
Shire of Serpentine Jarrahdale	Identify potential offset sites within the Shire. Determine land manager and management, conservation status. Propose management actions, risks and cost considerations.
Western Australian Planning Commission	Identify potential offset sites containing factors that require offsetting that are available to METRONET.
Main Roads Western Australia	Provide advice on SCP3a and SCP3c occurrences within road reserves.
Department of Agriculture, Water and the Environment (DAWE)	Review the Proposal and Offset Strategy to determine whether significant residual impacts on Matters of National Environmental Significance under the EPCA Act have been sufficiently offset.
Environmental Protection Authority (EPA)	Assess the Proposal under an accredited assessment on behalf of the Commonwealth and for the State.

8. Justification of offsets

The principles of the WA Environmental Offsets Policy 2011, completion of the WA Offsets Template, as described in the WA Environmental Offsets Guidelines 2014, and the *Environment Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy Assessment Guide 2012 have been applied to the proposed offsets to justify the offset counterbalances the significant residual impacts.

8.1. Consistency of the Proposal with the principles of the *WA Environmental Offsets Policy*

Table 15 demonstrates how the Proposal is consistent with the six principles identified in the *WA Environmental Offset Policy* (GoWA 2011).

Table 15: Consistency of the Proposal to the principles of the WA Environmental Offset Policy (GoWA 2011)

Principle	Consideration
Environmental offsets will only be considered after avoidance and mitigation options have been pursued	This Environmental Review Document (PTA 2021) demonstrates how the PTA has applied avoidance and minimisation strategies to the Proposal. The PTA will continue to revise the Footprint wherever possible to reduce impacts (for example, the positioning of laydown areas). The PTA only proposed offsets to counterbalance the significant residual impacts after avoidance and minimisation strategies were pursued.
Environmental offsets are not appropriate for all Proposals	Environmental offsets are appropriate for this Proposal. This Proposal is for a major public works program. The PTA has considered reducing the environmental impacts wherever possible. The proposed offsets for this Proposal are appropriate to counter balance the significant residual impacts.
Environmental offsets will be cost-effective, as well as relevant and proportionate to the significance of the environmental value being impacted	An on-ground offset is considered cost-effective as it negates the requirement to acquire land within the Perth Metropolitan Area, which is difficult to obtain (especially with similar values to the impact area). In addition, provision of resources (through offset funding to land managers) ensures areas of high conservation value are maintained and are not at risk of degrading due to insufficient resources within other organisations. Application of the Commonwealth Offsets Assessment Guide (DSEWPaC 2012b) and/or ratios stated within Western Australian offset guidance documents (GoWA 2011, 2014 and WAPC 2010) ensure the offset is proportionate to the significance of the environmental value impacted.
Environmental offsets will be based on sound environmental information and knowledge	Expert knowledge, experienced land managers and ecological surveys have formed the basis of potential offset site selection. Stakeholders have extensive knowledge of the area, the impacts and threatening processes and experience in management of the areas. Ongoing information gathering on each potential offset site will allow decisions based on sound environmental knowledge.

Principle	Consideration
	The research project will increase the scientific knowledge available to proponents and land managers to improve management and rehabilitation of SCP3a.
Environmental offsets will be applied within a framework of adaptive management	On-ground management actions performed at Lambert Lane Nature Reserve, Brickwood Reserve and Roman Road Nature Reserve will use adaptive management. The PTA will share outcomes from the research project as they become available so land managers can adapt management at the Reserves. The DBCA and PTA have adopted an adaptive management approach for the Lowlands Nature Reserve site, understanding that funding and resources may diverted to other sections or values within the site across the management period if the site is subject to fire, weed infestation or other damaging processes.
Environmental offsets will be focused on longer-term strategic outcomes	The environmental outcomes at each of the Reserves aims to establish the Reserves, mitigate against current and anticipated future threatening process and create self-sustaining ecological communities that will perisist in the long-term, long after the offset management period has ceased.

8.2. Application of the WA Environmental Offsets Guidelines to proposed offsets

Table 16 provides a summary of how the PTA applied the key concepts and requirements of the *WA Environmental Offsets Guidelines* (GoWA 2014) in the development of this Offset Strategy, ensuring the offsets are relevant and proportionate to the significance of the environmental values impacted.

Preliminary justification for the use of on-ground management at offset sites in accordance with the requirements of the *WA Offsets Template* (EPA 2014) are in Appendix D.

Table 16: Evaluation of offset sites in accordance with WA Environmental Offsets Guidelines

Concept	Application
SCP3a, SCP3c, Guildford Complex, wetland and Bush Forever offset sites: Lambert Lane Nature Reserve, Brickwood Reserve and Roman Road Nature Reserve.	
Type	On-ground management and revegetation.
In proximity to the area of impact	All proposed offset sites are located within 10 km of the Proposal.
Similar or better vegetation condition than area impacted	All proposed on-ground management offset sites contain SCP3a or SCP3c in similar or better condition than the impacted vegetation.
Similar habitat structure to undisturbed examples of impacted vegetation type	All proposed on-ground management offset sites contain SCP3a or SCP3c, the same ecological community impacted by the Proposal.
Has a better area to perimeter ratio that the area impacted	The impacted areas of SCP3a/SCP3c are smaller, long, narrow strips of vegetation along or

Concept	Application
	adjacent to the rail corridor. Lambert Lane Nature Reserve is a rectangular patch of SCP3a and has no native vegetation buffer, although revegetation within the Reserve will reduce the internal edge effects. Brickwood Reserve has two large patches of native vegetation. The patch of SCP3c in Roman Road Nature Reserve is triangular. All offset sites have a better area to perimeter ratio due to the size of the patches in the offset site.
Contains additional rare or otherwise significant species and threatened species or community compared with the impact site	Brickwood Reserve contains vegetation representative of the vulnerable threatened ecological community SCP09 Dense shrublands on clay flats, endangered threatened ecological community SCP20b *Banksia attenuata* and/or *Eucalyptus marginata* woodlands of the eastern side of the Swan Coastal Plain as well as significant flora taxa. Roman Road Nature Reserve contains SCP3b *Eucalyptus calophylla - Eucalyptus marginata* woodlands on sandy clay soils of the southern Swan Coastal Plain and SCP20b *Banksia attenuata* and/or *Eucalyptus marginata* woodlands of the eastern side of the Swan Coastal Plain.
Close to or contiguous with an existing conservation area (e.g. Bush Forever)	Lambert Lane Nature Reserve, Roman Road Nature Reserve and Brickwood Reserve are all Bush Forever sites within a 10 km radius. Additional Bush Forever sites including Watkins Road Nature Reserve, Cardup Nature Reserve and Fletcher Park are all located within close proximity (5 km) to the Reserves.
Likely to enhance biological corridors or ecological linkages between conservation areas	Lambert Lane Nature Reserve, Roman Road Nature Reserve and Brickwood Reserve are within Greenways ecological linkages (Tingay & Associates 1998). The rail reserve provides a north-south corridor of vegetation (PTA 2021). This north-south corridor intersects other Greenways ecological linkages: Wungong Brook (No. 119), Oakland's drain (No. 114), Beenyup Brook (No. 62) and Cardup Brook (No. 61) (Tingay & Associates 1998), providing an east-west linkage. The offset sites enhance the ecological corridors and linkages in the wider landscape. The Lambert Lane Nature Reserve area provides connectivity with Bungendore Park, approximately 1.25 km to the east (PTA 2021).
It includes actions to address threatening processes	On-ground revegetation and management actions address current and anticipated future

Concept		Application
		threatening processes. This includes actions to mitigate against increasing urban development and consists of fencing to reduce illegal entry, especially with vehicles that can damage vegetation and spread weeds. The actions implements feral animal, weed and dieback controls and consider appropriate fire regimes. The research project will provide outcomes that land managers (current and future) can apply when addressing threatening processes.
Allows for secure management arrangements in place that will provide for long term conservation		Lambert Lane Nature Reserve, Brickwood Reserve and Roman Road Nature Reserve are DBCA or LGA Reserves. Governance of the land management will be between the PTA and the DBCA or the Shire, all government agencies. Governance will be through a memorandum of understanding, or similar document. Funding for on-ground management at each site will provide short and long-term management actions that establish a self-sustaining site that provides for long-term conservation.
Sound knowledge and adaptive management		The PTA has used the DBCA Corporate database, GHD (2021) assessments and visual assessment advice from an experienced botanist to determine the floristic community type at Lambert Lane Nature Reserve, Brickwood Reserve and Roman Road Nature Reserve. Management actions are specific enough to meet offset objectives whilst containing sufficient flexibility to enable the land manager to respond to changes over the offset period. This may be to incorporate new best practice methods, new technology or respond to external environmental pressures and events such as drought, lowering of the water table and fire.
Likely offset success	Can the values be defined and measured?	The vegetation type, condition and extent are measureable.
	Operator experience/Evidence?	The DBCA and Shire both have extensive experience managing existing reserves for conversation purposes.
Time lag		By implementing management actions at existing occurrences the time lag is minimal. Key management actions will occur within the first three to five years of implementation.
Long term strategic outcomes		Long-term strategic outcomes will be achieved through management of large occurrences in DBCA conservation reserves or local government reserves.
Offset quantification		The PTA has quantified the extent each offset

Concept	Application
	site using the Commonwealth Offsets Assessment Guide. Justification for variables used in the Commonwealth Offsets Assessment Guide are in Table 2, Table 4 and Table 6 of this Strategy.
Black cockatoo offset – Lowlands Nature Reserve	
Type	On-ground management
In proximity to the area of impact	The Lowlands Nature Reserve is located approximately 12 km south of the Proposal, within the known range of Carnaby's cockatoos when feeding chicks in the nest (Bamford 2021)
Similar or better vegetation condition than area impacted	The Lowlands Nature Reserve contains high-moderate quality black cockatoo foraging habitat, which is better than the low-moderate black cockatoo foraging habitat impacted by the Proposal.
Similar habitat structure to undisturbed examples of impacted vegetation type	The black cockatoo foraging habitat at the Lowlands Nature Reserve is generally Banksia woodland, which is different to the habitat structure impacted however this still provides suitable foraging habitat and is offset in sufficient quantity for each of the three species of black cockatoos to counter balance the significant residual impact to foraging habitat.
Has a better area to perimeter ratio that the area impacted	The black cockatoo habitat impacted by the Proposal is a long narrow strip that follows the current rail corridor. Lowlands Nature Reserve is a 1,138 ha parcel of land that contains moderate-high quality black cockatoo foraging habitat and over 9,000 black cockatoo potential breeding trees. The Lowlands Nature Reserve northern perimeter is approximately 2 km wide and the eastern perimeter approximately 4 km long, providing a significantly better perimeter ratio than the area impacted.
Contains additional rare or otherwise significant species and threatened species or community compared with the impact site	The Lowlands Nature Reserve contains • vegetation representative of Banksia woodlands of the Swan Coastal Plain threatened ecological community • Low lying *Banksia attenuata* woodlands or shrublands (SCP21c) priority ecological community • Banksia dominated woodlands of the Swan Coastal Plain IBRA region priority ecological community • Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain threatened ecological community • significant flora taxa and fauna habitat.

Concept	Application
	Offset funding provided to the DBCA to manage the Reserve as a whole, will provide benefits to these additional significant environmental values.
Close to or contiguous with an existing conservation area (e.g. Bush Forever)	The Lowlands Nature Reserve is regionally significant being the only large area of its type remaining on the Swan Coastal Plain between Perth and Bunbury. The Reserve is the largest area of mature, long unburnt Banksia woodlands typical of the Bassendean complex remaining on the southern Swan Coastal Plain. It also has a combination of floristic types not known to occur elsewhere (DBCA, 2021). Humus Swamp (Bush Forever 372) is located approximately 2.1 km east and the Rapids Road Bushland is located approximately 1.6 km to the south-east of the Lowlands Nature Reserve offset site. The east-west linkage along Mundijong Road is approximately 1.7 km north of the Lowlands Nature Reserve offset site.
Likely to enhance ecological linkages between conservation areas	Lowlands Nature Reserve provides a highly valued bushland/wetland link between the bushland within the Serpentine-Jarrahdale area and along the Serpentine River to the lakes in the Peel-Yalgorup Ramsar wetlands. The riverine vegetation on the Serpentine River provides one of the few examples of essentially intact upriver riverine vegetation on the Harvey, Murray, Serpentine, southern Canning and Swan Rivers on the Swan Coastal Plain (DBCA, 2021).
It includes actions to address threatening processes	The PTA and DBCA developed specific on-ground management actions at the Lowlands Nature Reserve to address threatening processes. This including fencing to reduce illegal entry, rubbish dumping and unwanted fauna, weed and dieback control measures and installation of a Carnaby's cockatoo watering point.
Allows for secure management arrangements in place that will provide for long term conservation	Lowlands Nature Reserve is in the conservation estate, providing long-term security. In addition, the PTA is providing funding to the DBCA to implement management actions for a period of seven years. Management is secure as the memorandum of understanding is between two State government bodies.
Sound knowledge and adaptive management	Bamford (2021) mapped the presence, extent and condition of black cockatoo habitat at Lowlands Nature Reserve. Management actions are specific enough to meet the offset objectives whilst containing sufficient flexibility to enable the DBCA to respond to changes over the seven year period. This may be to incorporate new best practice methods,

Concept		Application
		new technology or respond to external environmental pressures and events such as drought, lowering of the water table and fire.
Likely offset success	Can the values be defined and measured?	Black cockatoo habitat condition and extent are measurable.
	Operator experience/Evidence?	The DBCA has extensive experience managing existing reserves for conversation purposes.
Time lag		There is no time lag. The site already contains existing mature trees that provide foraging and breeding habitat.
Long term strategic outcomes		The benefits of the on-ground management actions at the Lowland Nature Reserve will continue to provide long-term strategic outcomes after the management period. For example, the baseline weed cover is reduced to manageable levels given weed management includes eradication, containment and reduction. Fencing will last post the management period. Cameras acquired feral animals monitoring will be used by DBCA at the site post-management period.
Offset quantification		The PTA has provided 100% of the black cockatoo habitat offset requirement at the Lowlands Nature Reserve, calculated using the Commonwealth Offsets Assessment Guide. Justification for variables used in the Commonwealth Offsets Assessment Guide are in Table 9, Table 10, and Table 11 of this Offset Strategy.
Research offset – Fletcher Park		
Type		Research project
In proximity to the area of impact		Fletcher Park is located adjacent to the Proposal Development Envelope.
Similar or better vegetation condition than area impacted		The majority (74%) of the impacted SCP3c vegetation is in Good condition. Fletcher Park (south) vegetation is in Degraded condition. The purpose of the Fletcher Park research offset is to inform management actions and strategies for rehabilitating Degraded patches of SCP3a or similar ecological communities.
Similar habitat structure to undisturbed examples of impacted vegetation type		The vegetation structure at Fletcher Park (south) is highly disturbed. *Watsonia meriana* and *Moraea flaccida* dominate the understorey. This area no longer represents a functioning occurrence of SCP3a (GHD 2021). The purpose of the Fletcher Park offset is to inform management actions and strategies for rehabilitating Degraded patches of SCP3a.

Concept		Application
Has a better area to perimeter ratio that the area impacted		The impacted areas of SCP3a are long narrow strips of vegetation along or adjacent to the rail corridor. Fletcher Park (south) is a rectangular patch and therefore has a better area to perimeter area ratio than the impacted area.
Contains additional rare or otherwise significant species and threatened species or community compared with the impact site		No additional rare or otherwise significant species and threatened species or community are present in Fletcher Park (south) compared with the impact site.
Close to or contiguous with an existing conservation area (e.g. Bush Forever)		Fletcher Park (south) is contiguous with the rest of Fletcher Park and forms part of Bush Forever site 264, Lambert Lane Bushland, Wungong.
Likely to enhance ecological linkages between conservation areas		Fletcher Park (south) is within Greenways ecological linkages (Tingay & Associates 1998). The rail reserve provides a north-south corridor of vegetation (PTA 2021). This north-south corridor intersects other Greenways ecological linkages: Wungong Brook (No. 119), Oakland's drain (No. 114), Beenyup Brook (No. 62) and Cardup Brook (No. 61) (Tingay & Associates 1998), providing east-west linkages. Fletcher Park provides connectivity with Bungendore Park, approximately 1.25 km to the east (PTA 2021).
It includes actions to address threatening processes		The research project will consider weed management and fire regimes, major threatening processes to SCP3a.
Allows for secure management arrangements in place that will provide for long term conservation		The outcomes from the research project will contribute to long-term conservation outcomes for SCP3a. These outcomes can be applied to SCP3c.
Sound knowledge and adaptive management		The research project will be designed and implemented through a collaborative program including DBCA Species and Communities branch, experienced contractors and the PTA. The PTA will design the research project to be responsive to interim findings and learnings throughout the research period.
Likely offset success	Can the values be defined and measured?	Yes, the success of the research project will be a measured as the production of a prescriptive paper and/or information around management and rehabilitation actions that preserve the TEC.
	Operator experience/Evidence?	The research project will be designed and implemented through a collaborative program including DBCA species and communities branch, experienced contractors and the PTA.
Time lag		There will be a time lag in obtaining final outcomes, however interim findings and learnings throughout the research period will be available.

Concept	Application
Long term strategic outcomes	The benefits of research project will contribute to long-term conservation outcomes for SCP3a. These outcomes can be applied to SCP3c.
Offset quantification	The research project will be within a portion of Fletcher Park. This will keep the research to a manageable area.

8.3. Consistency of the Proposal with the principles in the Commonwealth *Environmental Offsets Policy 2012*

Table 17 demonstrates how the Proposal is consistent with the eight principles identified in the Commonwealth *Environmental Offsets Policy* (DSEWPaC 2012a).

Table 17: Consistency of the Proposal to the principles of the Commonwealth *Environmental Offsets Policy* (DSEWPaC 2012a)

Principle	Consideration
1. deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action	The proposed SCP3-type community offsets will deliver an overall conservation outcome to SCP3-type communities, both within the area of the impact and across the Swan Coastal Plain. The PTA will provide funding to maintain two existing occurrences of SCP3a and one occurrence of SCP3c. While these occurrences are in conservation tenure, using these SCP3-type community occurrences as offsets allows funding to be provided for on-ground management actions, including some revegetation, that actively manage the occurrences. The aim of the management is to mitigate or reduce the impacts of the threatening processes, predominantly from increasing urban development in the area. The PTA will also conduct a research project that aims to increase the knowledge and understanding of the threats to, and management and rehabilitation of, SCP3-type communities. The PTA consider the offset package will maintain the viability of the SCP3-type occurrences persisting on the Swan Coastal Plain. The Lowlands Nature Reserve contains high-moderate quality black cockatoo foraging habitat in a predominately-cleared area for agriculture. Large areas of black cockatoo habitat on the Swan Coastal Plain are becoming increasing rare. The opportunity to conserve and maintain this large (1,138 ha) patch of native vegetation in the long term, including funding to support the maintenance and improvement at the site (for example installing a black cockatoo watering point) provides valuable black cockatoo habitat in the area.
2. be built around direct offsets but may include other compensatory	The PTA will provide direct on-ground land management offsets for SCP3a and SCP3c. Management and revegetation will provide additional knowledge and insights into managing and revegetating SCP3a and/or SCP3c

Principle	Consideration
measures	habitat. In addition, the PTA will provide an indirect offset through a research project to increase the knowledge and understanding of management and rehabilitation of SCP3-type ecological communities. The PTA will provide a direct on-ground land management offset for black cockatoo habitat. All proposed offsets target the maintenance of the protected matter by reducing or mitigating the threatening processes.
3. be in proportion to the level of statutory protection that applies to the protected matter	The PTA calculated the offset extent using the Commonwealth Offsets Assessment Guide, applying the International Union for Conservation of Nature (IUCN) probability of annual extinction for each protected matter.
4. be of a size and scale proportionate to the residual impacts on the protected matter	The PTA calculated offset extents using the Commonwealth Offsets Assessment Guide. The PTA considered: • the level of statutory protection that applies to the protected matter (IUCN rating for SCP3a/SCP3c and Carnaby's, Baudin's and forest red-tailed black cockatoos) • the extent of SCP3a, SCP3c and black cockatoo impacted compared to the remaining extents • the vegetation condition and habitat quality • the contextual siting of the protected matter (i.e. proximity to cleared areas including the current rail corridor, industrial and rural areas) • access to ecological corridors or proximity of similar suitable habitat quality • permanent impacts and impacts that are temporary (construction) impacts • the level of threat (risk of loss) that each proposed offset site is under • that on-ground management offsets yield a significant conservation gain within the first five years of active on-ground management commencing • revegetation offsets provide a conservation gain soon after commencement (weed reduction, ground cover, plant growth), however may take longer for the overall conservation gain (plants and trees potentially take time to reach a comparable height to impacted vegetation)
5. effectively account for and manage the risks of the offset not succeeding	The PTA has considered the risk of the conservation gain not being realised by developing an offset package where direct on-ground management offsets, which are predominantly low in risk and have a high confidence in outcome, form 100% of the offset requirements. The research project will be in addition to the direct offset requirements. The PTA has contingency options should the offsets described in this Offset Strategy become, due to any unforeseen circumstances, unavailable.

Principle	Consideration
6. be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of state or territory offsets that may be suitable as offsets under the EPBC Act for the same action, see section 7.6)	The PTA will use DBCA Legislated Lands and Waters nature reserves - Lambert Lane Nature Reserve and Roman Road Nature Reserve - as offset sites for SCP3-type communities. The PTA understand the DBCA is not legislated to perform management at these sites. DBCA currently perform ad-hoc maintenance and management and therefore the stated on-ground management actions for Lambert Lane Nature Reserve and Roman Road Nature Reserve exceed management actions currently required by the DBCA. The Shire manages Brickwood Reserve. The Shire does not conducted all of the management actions listed in the Management Plan (Shire of Serpentine Jarrahdale 2016). For example, the Shire only conduct weed control and dieback monitoring in small areas of the Reserve. Therefore, the stated on-ground management actions for Brickwood Reserve exceed management actions currently performed by the Shire. Lowlands Nature Reserve management actions exceed the management performed by the DBCA prior to offset funding. This includes replacement of fencing, installation of black cockatoo watering points and intensive weed and dieback control.
7. be efficient, effective, timely, transparent, scientifically robust and reasonable	The Brickwood Reserve, Lambert Lane Nature Reserve and Roman Road Nature Reserve are efficient, effective, timely, transparent, scientifically robust and reasonable as the PTA will commence the offset prior to the impacts occurring. The offsets are effective as they have a high chance of success to maintain or improve the condition of the SCP3-type ecological communities. The Lowlands Nature Reserve offset is efficient, effective, timely, transparent, scientifically robust and reasonable as the site is an advanced offset. The PTA has implemented the offset prior to the impacts occurring.
8. have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.	The PTA will govern the offsets through Memorandum of Understandings with the DBCA and the Shire. The PTA, DBCA and Shire are government agencies, and therefore the governance will be secure. The environmental values (SCP3a, SCP3c and black cockatoo habitat) are measurable through vegetation and habitat quality assessments. The Memorandum of Understanding will include provisions to ensure monitoring, auditing and the implementation of the offset is in accordance with approved Offset Strategies. This includes submission of compliance reports to regulators on an annual basis.

8.4. Recovery Plans and Conservation Advice

8.4.1. How the offset aligns with the Interim Recovery Plan for SCP3a

The objective of the *Corymbia calophylla - Kingia australis* woodlands on heavy soil (Swan Coastal Plain Community type 3a - Gibson et al. 1994) Interim Recovery Plan 2011-2016 (DEC 2011) is to maintain or improve the overall condition of this plant community in the known locations and reduce the level of threat.

The Lambert Lane Nature Reserve and Brickwood Reserve offset meets the objective of the Interim Recovery Plan by providing funding for management actions that aim to improve the overall condition of the SCP3a in the occurrences through weed and/or dieback mapping and control, fencing and revegetation. The research project meets the recovery action to develop management guidelines.

The SCP3a offset addresses the recovery actions as outlined in Table 18.

Table 18: Relevance to the Interim Recovery Plan for SCP3a

Recovery Plan action	Relevance to offset
Criteria for success	
Representative areas of the community across its geographical range with condition rank maintained, or with improved condition rank (Bush Forever 2000 scales).	On-ground management will maintain or improve the current condition rank at Lambert Lane Nature Reserve and Brickwood Reserve.
Recovery actions	
Continue to monitor extent and boundaries	The PTA conducted a vegetation assessment at Lambert Lane Nature Reserve as part of the Proposal assessment (PTA 2021). The DBCA Corporate Database defined the vegetation extents and boundaries at Brickwood Reserve. The PTA will conduct vegetation monitoring at Lambert Lane Nature Reserve and Brickwood Reserve throughout the management period.
Survey for dieback	The PTA conducted a dieback survey at Lambert Lane Nature Reserve as part of the Proposal assessment (PTA 2021). The Shire have dieback mapping and treatment reports for Brickwood Reserve. The PTA will conduct dieback mapping at Lambert Lane Nature Reserve and Brickwood Reserve throughout the management period.
Ensure adequate hygiene conditions	The on-ground management actions include hygiene management including mapping, management plans and signage.
Develop and implement fire management strategy	Fire management at Lambert Lane Nature Reserve will be through weed control (reducing the fuel load) and firebreak maintenance. Fire management at Brickwood Reserve will include prescribed burns, as appropriate.

Recovery Plan action	Relevance to offset
Implement weed control	Funding for weed surveys and weed control is part of the on-ground management actions for all reserves. This is one of the most significant threats to the community and therefore will be of the highest priority for management.
Fence remnants that contain the community	Fencing the Lambert Lane Nature Reserve is included as a management action. Fencing at Brickwood Reserve will be for areas where fencing is required, for example to delineate the sporting grounds from the conservation areas.
Clarify the floristic community present at specified occurrences	The DBCA Corporate Database provides the floristic community present at Lambert Lane Nature Reserve and Brickwood Reserve. GHD (2021) clarified the floristic community present at Lambert Lane Nature Reserve.
Seek long term protection of areas of the community	The State's Offset Register provides additional protection to offset sites as it facilitate transparency and accountability of offsets, provides a single cross-Government record for environmental offsets, monitors offset implementation and outcomes, improves auditing and quality control of offsets; and provides for efficient retrieval of offset information in flexible ways to meet Government, industry and community needs (DWER 2021). Management measures (weed control, fencing, access control, dieback measures and revegetation) will provide long-term protection to the community.
Report on success of management strategies	The PTA will obtain reports from the land manager detailing the implementation of the management actions. The PTA will conduct vegetation and habitat assessments at the conclusion of the offset management period to demonstrate the success of the management strategies. The PTA will report these outcomes to the regulators.
Develop management guidelines	The PTA will conduct a research project that will provide a set of management and rehabilitation guidelines for SCP3a. The research outcomes will also be applicable to SCP3c.

8.4.2. How the offset aligns with the Approved Conservation Advice for SCP3a

The approved conservation advice (DotEE 2017a) states that "…it is more cost-effective to retain an intact remnant than to allow degradation and then attempt to restore it or another area".

The approved conservation advice (DotEE 2017a) reports that within the ecological community weeds are a major threat and a key management action should be weed management. It also notes threats to the ecological community from grazing of plant communities by feral herbivores such as rabbits. The management actions described within this Offset Strategy, weed and feral animal control are the key management actions for Lambert Lane Nature Reserve and Brickwood Reserve.

The SCP3a offset addresses the key approaches to achieve the conservation objective as follows:

- Protect – on-ground management at Lambert Lane Nature Reserve and Brickwood Reserve will protect the ecological community to prevent further loss of extent and condition.
- Restore – on-ground management at Lambert Lane Nature Reserve and Brickwood Reserve will mitigate against increasing threats and include some revegetation. The purpose of the revegetation is to provide a native vegetation buffer to the ecological community. The weed control will provide opportunities for nature regeneration at each of the Reserves.
- Research and Monitoring – the learnings attained from the on-ground management and revegetation at Lambert Lane Nature Reserve and Brickwood Reserve and the research project will improve the understanding of the ecological community and methods for restoration and protection over the long-term.

8.4.3. How the offset aligns with the Interim Recovery Plan for SCP3c

The objective of the *Corymbia calophylla - Xanthorrhoea preissii* woodlands and shrublands (Swan Coastal Plain Community type 3c - Gibson et al. 1994) Interim Recovery Plan 2000-2003 (Blythe & English 2000) is:

> "To maintain or improve the overall condition of this plant community in the known locations and reduce the severity of threat, with the aim of reclassifying it from Critically Endangered to Endangered."

The Roman Road Nature Reserve offset meets the objective of the Interim Recovery Plan by providing funding for management actions that aim to improve the overall condition of the SCP3c in through weed and/or dieback mapping and control, fencing and revegetation.

The SCP3c offset addresses the recovery actions as outlined in Table 18.

Table 19: Relevance to the Interim Recovery Plan for SCP3c

Recovery Plan action	Relevance to offset
Criteria for success	
Maintenance in terms of diversity and basic composition of native species (as described by Gibson et al. 1994) as well as hydrological and biological processes, taking account of natural change of the community over time.	On-ground management will maintain or improve the current condition rank at Roman Road Nature Reserve.
Recovery actions	
Clarify and monitor boundaries	The DBCA Corporate Database defined the vegetation extents and boundaries at Roman Road Nature Reserve. The PTA will conduct vegetation monitoring at Roman Road Nature Reserve throughout the management period.
Monitor flora	The PTA will conduct vegetation monitoring at Roman Road Nature Reserve throughout the management period for weed levels, plant species diversity, and species composition of flora.

Recovery Plan action	Relevance to offset
Develop a Fire Management Strategy	Fire management at Roman Road Nature Reserve will be through weed control (reducing the fuel load) and firebreak maintenance. The research project for SCP3a will look at the recovery of the SCP3 community from fire. Outcomes from the research project will meet this recovery plan action for SCP3c.
Assess and monitor weed populations	Funding for weed surveys and weed control is part of the on-ground management actions for Roman Road Nature Reserve. This is one of the most significant threats to the community and therefore will be of the highest priority for management.
Implement weed control, and replanting where necessary	As above, Funding for weed surveys and weed control is part of the on-ground management actions for Roman Road Nature Reserve. On-ground management for Roman Road Nature Reserve includes revegetation.
Fence remnants that contain the community	Fencing the Roman Road Nature Reserve is included as a management action.
Monitor for dieback	The DBCA will conduct dieback mapping at Roman Road Nature Reserve throughout the management period.
Design and conduct research	The research project for SCP3a will be designed to increase the understanding of the characteristics of the SCP3a community to assist future management decisions. Outcomes from the research project will be applicable to SCP3c.
Report on success of management strategies	The PTA will obtain reports from the land manager detailing the implementation of the management actions. The PTA will conduct vegetation and habitat assessments at the conclusion of the offset management period to demonstrate the success of the management strategies. The PTA will report these outcomes to the regulators.

8.4.4. How the offset aligns with the Approved Conservation Advice for SCP3c

The approved conservation advice (DotEE 2017b), when referring to offsets states the offset should:

> Maintain (or increase) the overall area, quality and ecological function of the remaining extent of the ecological community and improve the formal protection of high quality areas through a combination of the following measures:
>
> - protecting and managing offset sites in perpetuity in areas dedicated under legislation for conservation purposes; that is, do not allow reduction in their size, condition and ecological function in the future through ongoing threat abatement measures and adaptive management based on monitoring; and/or

- increase the area and improve ecological function of the woodlands, for example by enhancing landscape connectivity (e.g. protecting and linking smaller remnants), habitat diversity and condition; and/or
- restoring patches to improve their condition, particularly to ensure that any offset sites add additional value to the remaining extent.

The Roman Road Nature Reserve meets this criteria through maintain or improving the condition and ecological function of the community through on-ground management action and threat abatement measures using an adaptive management approach.

The SCP3c offset addresses the priority actions as follows:

- Protect – on-ground management at Roman Road Nature Reserve will protect the ecological community to prevent further loss of extent and condition.
- Restore – on-ground management at Roman Road Nature Reserve will mitigate against increasing threats and include some revegetation. The purpose of the revegetation is to provide a native vegetation buffer to the ecological community. The weed control will provide opportunities for nature regeneration at the Reserve.
- Research and Monitoring – the learnings attained from the on-ground management and revegetation at Roman Road Nature Reserve and the research project will improve the understanding of the ecological community and methods for restoration and protection over the long-term.

8.4.5. How the offset aligns with the Carnaby's Cockatoo (*Calyptorhynchus latirostris*) Recovery Plan

The Carnaby's Cockatoo Recovery Plan (DPaW 2013) provides advice and guidance on management actions to protect the Carnaby's cockatoo. The protection of the Lowlands Nature Reserve aligns with the following section of the recovery plan:

- Section 14 Recovery Actions.
- Action 1 - Protect and Manage Important Habitat:

  Complete restoration of the original extent of Carnaby's cockatoo habitat is not possible. It is therefore important to identify those parts of the species' habitat most critical to survival and to protect and manage as much of this important habitat as possible to minimise the impacts of habitat loss. While planting of species that support Carnaby's cockatoo is effective over the long-term and encouraged, protection and regeneration of existing habitat is significantly more efficient and effective. Therefore efforts in this Recovery Plan are primarily directed towards protection and enhancement of existing habitat.

The Western Australian Government purchased the Lowlands Nature Reserve as an advanced offset site for METRONET offset purposes. The Lowlands Nature Reserve's conservation status has been increased to a Class A conservation estate and will be listed on the DWER Offset Register, further increasing the level of protection. Allocating the Lowlands Nature Reserve as an offset site will ensure achievement of Action 1 through further protection and management.

8.4.6. How the offset aligns with the EPA Technical Report: Carnaby's black cockatoo in Environmental Impact Assessment in the Perth and Peel Region

The EPA Technical Report: Carnaby's Black Cockatoo in Environmental Impact Assessment in the Perth and Peel Region (EPA 2019) provides guidance on habitat restoration and protection of

Carnaby's cockatoo habitat. The protection of the Lowlands Nature Reserve achieves both short and long term management options (detailed in Table 5 of EPA 2019).

8.4.7. How the offset aligns with the Forest Black Cockatoo (Baudin's Cockatoo *Calyptorhynchus baudinii* and Forest Red-tailed Black Cockatoo *Calyptorhynchus banksia naso*) Recovery Plan

The Forest Black Cockatoo and Forest Red-tailed Black Cockatoo Recovery Plan (DEC 2008) was developed as a joint recovery plan for both species as they both occur in the sub-humid forests and south-west of WA, having similar breeding and feeding requirements and face similar threats. The acquisition and management of the Lowlands Nature Reserve aligns with *Section 14.9 Identify and manage important sites and protect from threatening processes* of the Plan.

The Lowlands Nature Reserve is as an important site within the region for a range of species, including Baudin's and forest red-tailed black cockatoos. Acquiring the land and providing for management will conserve existing black cockatoo habitat within the Reserve in the long-term. Management actions such as fencing, weed management and fire management will reduce the risks of threatening processes such as dieback and weed spread.

9. Assessment of the offsets against the EPA's objective for each factor

The PTA's Offset Strategy will counterbalance significant residual impacts as a result of the Byford Rail Extension Proposal to threatened ecological communities SCP3a and SCP3c, black cockatoo habitat, wetlands, Bush Forever and Guildford Complex. The PTA have provided an assessment of how the proposed offsets are likely to counterbalance the significant residual impacts and meet the EPA's objective in Table 20.

Table 20: Assessment of the Offset Strategy

Environmental Factor	Is this offset sufficient?	Does the offset meet the EPA's objective?
Threatened Ecological Communities	The PTA will provide 100% of its offset requirements for SCP3a and SCP3c at Lambert Lane Nature Reserve, Brickwood Reserve and Roman Road Nature Reserve. The PTA used the Commonwealth Offset Assessment Guide to calculate the offset extents. In addition, the PTA will conduct a research project that will provide a greater understanding of management and rehabilitation of SCP3-type communities.	The PTA will meet the EPAs objective to protect flora and vegetation so that biological diversity and ecological integrity are maintained. The PTA have undertaken measures to avoid and minimise impacts, and will seek to reduce impacts to SCP3-type communities wherever possible. The PTA will provide offsets for SCP3a and SCP3c that are proportionate to the impact. The PTA will provide funding to maintain two existing SCP3a and one existing SCP3c occurrences within close proximity to the impacts. This will maintain the biological diversity within the area of the impacts. The PTA will provide funding for the research project.
Fauna habitat - Black Cockatoo habitat	The PTA will provide 100% of its offset requirements for black cockatoo foraging habitat at Lowlands Nature Reserve. The PTA used the Commonwealth Offset Assessment Guide to calculate the offset extents. The PTA applied a 3:1 ratio to offset black cockatoo potential breeding trees.	The PTA will meet the EPA's objective to protect terrestrial fauna so that biological diversity and ecological integrity are maintained. The PTA have undertaken measures to avoid and minimise impacts, and will seek to reduce impacts to black cockatoo wherever possible. The PTA will provide offsets for black cockatoo habitat that are proportionate to the impact and providing funding to maintain an existing black cockatoo foraging and breeding habitat site. Lowlands Nature Reserve was coming under increasing pressure from threatening processes including feral/pest species

Environmental Factor	Is this offset sufficient?	Does the offset meet the EPA's objective?
		(weeds, grazing and predatory fauna) which would have ultimately reduced the biological diversity and ecological integrity at the Reserve. With offset funding the land manager is able to resource and implement on-ground management actions to reduce or mitigate the threatening processes in order to maintain the sites foraging and breeding habitat for black cockatoos through maintaining plant health and diversity.
Conservation Category Wetlands	The PTA has applied a ratio of 3:1, the highest ratio to offset the impacts to Conservation Category Wetlands within the Footprint. Locating the Conservation Category Wetland offset with the SCP3a offset is likely to protect a larger area of wetland than required by the offset. On-ground management actions applied to the site as part of the offset, such as weed control, fencing to reduce grazing and fire management, provide positive environmental outcomes for the wetland as a whole. Maintaining or improving the health of a wetland in one area will provide flow-on effects to adjoining or nearby wetland areas (better water quality, less weed invasion, reduced risks from wild bush fires).	The PTA will provide on-ground management at offset sites containing Conservation Category Wetlands. The on-ground management measures proposed will help to maintain the quality of groundwater and surface water by implementing weed and dieback control, conducing appropriate fire measures, allowing native vegetation to regenerate and providing monitoring of the wetland condition. Early indications of degradation will allow management actions to be adapted to address threatening processes in an adaptive manner.
Bush Forever	The PTA has applied a ratio of 2:1, the highest ratio provided by SPP 2.8 (WAPC 2010) to offset the impacts to native vegetation within Bush Forever sites within the Footprint. Locating the Bush Forever offset with the SCP3a offset is likely to protect a larger area of Bush Forever than required by the offset calculation, as the offset extent required by SCP3a is larger than that required for Bush Forever.	The PTA will meet the EPA's objective to protect flora and vegetation in conservation areas so that biological diversity and ecological integrity are maintained. The PTA have undertaken measures to avoid and minimise impacts, and will seek to further reduce impacts to native vegetation within Bush Forever areas wherever possible. The PTA will provide offsets for Bush Forever that are proportionate to the impact. On-ground management at Bush Forever sites with the same vegetation complex as that

Environmental Factor	Is this offset sufficient?	Does the offset meet the EPA's objective?
		impacted by the Proposal will endeavour to maintain the biological diversity within the area of the impacts.
Guildford Complex	The PTA has applied a ratio of 2:1, the highest ratio provided by SPP 2.8 (WAPC 2010) to offset the impacts to native vegetation within Guildford Complex within the Footprint. Locating the Guildford Complex offset at Lowlands Nature Reserve will protect a larger area of Guildford Complex than required by the offset calculation, as the Reserve is managed as a whole, and therefore all of the Guildford Complex on-site (27.75 ha) will be managed as part of the Lowlands Nature Reserve offset.	The PTA will meet the EPA's objective to protect flora and vegetation in conservation areas so that biological diversity and ecological integrity are maintained. The PTA have undertaken measures to avoid and minimise impacts, and will seek to further reduce impacts to native vegetation within Guildford Complex wherever possible. The PTA will provide offsets for Guildford Complex that are proportionate to the impact. On-ground management at Lowlands Nature Reserve will maintain the biological diversity within the local region of the impacts.

10.Conclusion

The PTA have demonstrated that this Offset Strategy will counterbalance the significant residual impacts on threatened ecological communities (SCP3a, SCP3c), black cockatoo habitat, wetlands, Guildford Complex and Bush Forever resulting from the Byford Rail Extension Proposal.

The PTA applied Commonwealth and State offset policies, recovery plans and approved conservation advice in the development of this Offset Strategy.

The PTA have assessed the offsets proposed to counterbalance the significant residual impacts of the Proposal against the EPA's objective for each factor and consider that with the avoidance and mitigation measures undertaken and the proposed offsets, the EPA's objectives for each environmental factor are met. A summary of the offsets is in Table 21.

Table 21: Summary of proposed offsets

Environmental Value	Significant residual impact	Proposed offset(s)	Quantum of offset extent
SCP3a	2.26 ha	Lambert Lane Nature Reserve (3.3 ha) and Brickwood Reserve (6.5 ha) - on-ground management including revegetation Research Project.	9.8 ha
SCP3c	0.48 ha	Roman Road Nature Reserve - on-ground management including revegetation	3 ha
Carnaby's cockatoo foraging habitat	19.3 ha consisting of 8.65 ha of Moderate quality and 10.67 ha of Low quality	Lowlands Nature Reserve – on-ground management	78.8 ha
Forest red-tailed black cockatoo foraging habitat	61.1 ha consisting of 8.65 ha of Moderate to High quality and 52.49 ha of Low quality		232.5 ha
Baudin's cockatoo foraging habitat	8.65 ha of Moderate to High quality		70.6 ha
Black cockatoo potential breeding trees	139 trees		417 trees
Wetlands	2.6 ha	Lambert Lane Nature Reserve and Brickwood Reserve - on-ground management including revegetation	7.8 ha
Bush Forever	1.5 ha	Lambert Lane Nature Reserve - on-ground management including revegetation	3.0 ha
Guildford Complex	0.68 ha	Lowlands Nature Reserve – on-ground management	1.36 ha

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Appendix A – Residual impact significance model

Residual Impact Significance Model (adapted from Figure 3 on page 11 of the *WA Environmental Offsets Guidelines)*

Part IV Environmental Factors	Vegetation and flora			Benthic habitat and communities		Subterranean fauna	Marine fauna		Benthic habitat and communities	Terrestrial fauna		
Clearing Principles	Rare flora	Threatened ecological communities	Remnant vegetation	Wetlands and waterways	Conservation areas	High biological diversity	Black cockatoo habitat	Carter's freshwater mussel habitat	Quenda
Residual impact that is environmentally unacceptable and cannot be offset	None	None	None	None	None	None	None	None	None
Significant residual impacts that will require an offset - **All significant residual impacts to species and ecosystems are protected by statute or where the cumulative impact is already at a critical level**	None	Permanent loss of: • 2.26 ha of *Corymbia calophylla - Kingia australis* woodlands on heavy soils (SCP 3a) threatened ecological community • 0.48 ha of *Corymbia calophylla - Xanthorrhoea preissii* woodlands and shrublands (SCP3c) threatened ecological community	Permanent loss of: • 0.68 ha of Guildford Complex in Degraded condition	Permanent loss of: • 2.6 ha of Conservation Category Wetlands retaining conservation value including 2.6 ha of vegetation associated with Conservation Category Wetlands	Permanent loss of: • 1.5 ha of vegetation associated with Bush Forever sites no. 264 (1.29 ha), 266 (0.21 ha) and 350 (0.04 ha)	None	Permanent loss of: • 61.1 ha of black cockatoo foraging habitat including: - 8.7 ha of foraging habitat for Baudin's cockatoo classified entirely as moderate value foraging habitat - 19.3 ha of foraging habitat for Carnaby's cockatoo comprised of 8.7 ha of moderate value foraging habitat and 10.7 ha of low value foraging habitat - 61.1 ha of foraging habitat for forest red-tailed black cockatoo comprised of 8.7 ha of moderate to high value foraging habitat and 52.5 ha of low value foraging habitat • 139 black cockatoo potential breeding trees (trees with Diameter Breast Height (DBH)> 500mm); 8 with hollows not suitable for black cockatoos	None	None
Significant residual impacts that may require an offset - **Any significant residual impacts to potentially threatened species and ecosystems, areas of high environmental value or where the cumulative impact may reach critical levels if not managed**	None	None	None	None	None	None	None	None	None
Residual impacts that are not significant	Removal of up to three individuals of Priority 2 listed *Johnsonia pubescens* subsp. *cygnorm* , with the potential to indirectly impact on two additional individuals, one located within the Development Envelope and one located adjacent to the Development Envelope. The removal of three individuals represents an approximate 0.313% loss of the total estimated population of the taxon. The direct impact of the Proposal on *J. pubescens* subsp. *cygnorum* is therefore unlikely to be significant. Potential indirect impacts will be adequately managed to avoid signficant impacts.	None	• 5.7 ha of planted/ revegetation of both native, non-local natives and introduced species • 10.8 ha of native vegetation in Completely Degraded condition • 9.8 ha of native vegetation associated with Multiple Use Wetlands in Good to Completely Degraded Condition • 3.76 ha of Guildford Complex in Completely Degraded condition	• 9.8 ha of vegetation as associated with Multiple Use Wetlands. • 0.9 ha of Conservation Category Wetlands identified as being significantly altered and no longer representative of the Conservation Category Wetlands management category	• 2.6 ha of Bush Forever that is cleared land	None	• 61.4 ha of negligible black cockatoo foraging habitat	Temporary and localised direct impacts to part of a known population of Carter's freshwater mussel surrounding the bridge location. Susceptible populations will be translocated in accordance with relevant guidelines and best management practices.	Rail alignment provides Quenda habitat and movement corridors. Culverts will be installed to facilitate quenda movement between Lambert Lane Nature Reserve and Fletcher. Given the proximity of the Development Envelope to larger areas of similar or better quality habitat, the Proposal is not likely to significantly impact the species.
Assessment	EPA Objective: *To protect flora and vegetation so that biological diversity and ecological integrity are maintained* There are no impacts to rare flora. Impacts to Priority 2 flora are not likely to result in the species being listed as rare under the WA Act or listed as threatened under the EPBC Act. The PTA considers the EPA objective for flora will be met.	EPA Objective: *To protect flora and vegetation so that biological diversity and ecological integrity are maintained.* In considering potential impacts to flora and vegetation, and the avoidance and mitigation measures proposed to address those potential impacts of the Proposal and the implementation of the environmental offsets, the PTA considers the EPA objective for vegetation will be met.	EPA Objective: *To protect flora and vegetation so that biological diversity and ecological integrity are maintained.* In considering potential impacts to flora and vegetation, and the avoidance and mitigation measures proposed to address those potential impacts of the Proposal and the implementation of the environmental offsets, the PTA considers the EPA objective for flora and vegetation will be met.	EPA Objectives: *To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.* *To protect flora and vegetation so that biological diversity and ecological integrity are maintained.* The PTA is confident that all indirect impacts and construction related impacts can be managed through the implementation of mitigation measures so that adverse impacts on inland waters can be avoided or minimised. Where significant residual impacts to Conservation Category Wetlands remain, the PTA will counterbalance these impacts through an offset strategy. In considering potential impacts to flora and vegetation, and the avoidance and mitigation measures proposed to address those potential impacts of the Proposal and the implementation of the environmental offsets, the PTA considers the EPA objective for flora and vegetation will be met.	EPA Objective: *To protect flora and vegetation so that biological diversity and ecological integrity are maintained.* In considering potential impacts to flora and vegetation, and the avoidance and mitigation measures proposed to address those potential impacts of the Proposal and the implementation of the environmental offsets, the PTA considers the EPA objective for flora and vegetation will be met.	EPA Objective: *To protect flora and vegetation so that biological diversity and ecological integrity are maintained.* The survey area is representative of the floristic diversity of the local area - the project meets this objective. In considering potential impacts to flora and vegetation, and the avoidance and mitigation measures proposed to address those potential impacts of the Proposal and the implementation of the environmental offsets, the PTA considers the EPA objective for flora and vegetation will be met.	EPA Objective: *To protect terrestrial fauna so that biological diversity and ecological integrity are maintained* The PTA considers that through implementation of the mitigation hierarchy, application of the management actions, and implementation of offsets to compensate for significant residual impacts, the Terrestrial Fauna environmental factor can be managed during the construction and operation of the Proposal to meet the EPA's objective to protect terrestrial fauna so that biological diversity and ecological integrity are maintained.	EPA Objective: *To protect terrestrial fauna so that biological diversity and ecological integrity are maintained* The PTA considers that through implementation of the mitigation hierarchy and application of the management actions, the Terrestrial Fauna environmental factor can be managed during the construction and operation of the Proposal to meet the EPA's objective to protect terrestrial fauna so that biological diversity and ecological integrity are maintained.	EPA Objective: *To protect terrestrial fauna so that biological diversity and ecological integrity are maintained* The PTA considers that through implementation of the mitigation hierarchy and application of the management actions, the Terrestrial Fauna environmental factor can be managed during the construction and operation of the Proposal to meet the EPA's objective to protect terrestrial fauna so that biological diversity and ecological integrity are maintained.

Appendix B – Commonwealth Offsets Assessment Guide

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	SCP3a
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
Ecological communities						
Area of community	Yes	SCP3a: Excellent 0.02 ha (1%), Very Good 0.06 ha (3%), Good 1.68 ha (74%) and Degraded 0.50 ha (22%)	**Area**	2.26	Hectares	Detailed Flora and Vegetation Survey for Rail Reserves in the Shire of Serpentine-Jarrahdale (GHD 2021)
			Quality	**5**	Scale 0-10	
			Total quantum of impact	1.13	Adjusted hectares	
Threatened species habitat						
Area of habitat	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
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					
Threatened species						
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
Ecological Communities																				
Area of community	Yes	1.13	Adjusted hectares	On-ground management and revegetation at existing DBCA conservation reserve - Lambert Lane Nature Reserve	**Risk-related time horizon (max. 20 years)**	20	**Start area (hectares)**	3.3	**Risk of loss (%) without offset**	0%	**Risk of loss (%) with offset**	0%	0.00	90%	0.00	0.00	0.47	41.27%	No	
									Future area without offset (adjusted hectares)	3.3	**Future area with offset (adjusted hectares)**	3.3								
					Time until ecological benefit	5	**Start quality (scale of 0-10)**	**7**	**Future quality without offset (scale of 0-10)**	**6**	**Future quality with offset (scale of 0-10)**	**8**	2.00	75%	1.50	1.41				
Threatened species habitat																				
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**									
									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																			
Threatened species																				
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																			

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	SCP3a
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
Ecological communities						
Area of community	Yes	SCP3a: Excellent 0.02 ha (1%), Very Good 0.06 ha (3%), Good 1.68 ha (74%) and Degraded 0.50 ha (22%)	**Area**	2.26	Hectares	Detailed Flora and Vegetation Survey for Rail Reserves in the Shire of Serpentine-Jarrahdale (GHD 2021)
			Quality	**5**	Scale 0-10	
			Total quantum of impact	1.13	Adjusted hectares	
Threatened species habitat						
Area of habitat	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
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					
Threatened species						
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
Ecological Communities																				
Area of community	Yes	1.13	Adjusted hectares	On-ground management at exisiting Shire of Serpentine Jarrahdale reserve - Brickwood Reserve	**Risk-related time horizon (max. 20 years)**	20	**Start area (hectares)**	6.5	**Risk of loss (%) without offset**	4%	**Risk of loss (%) with offset**	0%	0.28	90%	0.25	0.67	58.95%	No		
									Future area without offset (adjusted hectares)	6.2	**Future area with offset (adjusted hectares)**	6.5								
					Time until ecological benefit	5	**Start quality (scale of 0-10)**	**7**	**Future quality without offset (scale of 0-10)**	**6**	**Future quality with offset (scale of 0-10)**	**7**	1.00	90%	0.90	0.85				
Threatened species habitat																				
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**									
									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																			
Threatened species																				
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																			

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	SCP3c
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
Ecological communities						
Area of community	Yes	46% (0.22 ha) of TEC 3c is Good condition; 54% (0.26 ha) is in Degraded condition.	**Area**	0.48	Hectares	Detailed Flora and Vegetation Survey for Rail Reserves in the Shire of Serpentine-Jarrahdale (GHD 2021)
			Quality	**4**	Scale 0-10	
			Total quantum of impact	0.19	Adjusted hectares	
Threatened species habitat						
Area of habitat	No		**Area**			
			Quality			
			Total quantum of impact	0.00		

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					
Threatened species						
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
Ecological Communities																				
Area of community	Yes	0.19	Adjusted hectares	On-ground management aar Roman Road Nature Reserve (DBCA)	**Risk-related time horizon (max. 20 years)**	20	**Start area (hectares)**	3	**Risk of loss (%) without offset**	0%	**Risk of loss (%) with offset**	0%	0.00	90%	0.00	0.00	0.21	110.40%	Yes	
									Future area without offset (adjusted hectares)	3.0	**Future area with offset (adjusted hectares)**	3.0								
					Time until ecological benefit	5	**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	75%	0.75	0.71				
Threatened species habitat																				
Area of habitat	No				**Time over which loss is averted (max. 20 years)**	20	**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)**									

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															
Threatened species																
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															

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
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
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	Carnaby's black cockatoo foraging habitat: 8.65 ha of moderate and 10.67 ha of low quality.	**Area**	19.32	Hectares	Lowlands black cockatoo habitat Assessment against 2017 revised draft guidelines GHD (2020b)
			Quality	**3**	Scale 0-10	
			Total quantum of impact	5.80	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					
Threatened species						
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
Ecological Communities																				
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)**									
Threatened species habitat																				
Area of habitat	Yes	5.80	Adjusted hectares	On-ground management at DBCA conservation site - Lowlands Nature Reserve	**Time over which loss is averted (max. 20 years)**	20	**Start area (hectares)**	78.8	**Risk of loss (%) without offset**	0%	**Risk of loss (%) with offset**	0%	0.00	90%	0.00	0.00	5.80	100.05%	Yes	
									Future area without offset (adjusted hectares)	78.8	**Future area with offset (adjusted hectares)**	78.8								
					Time until ecological benefit	7	**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	0.74				
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																			
Threatened species																				
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	5.796	5.80	100.05%	**Yes**	$0.00	N/A	$0.00
Area of community	0				$0.00		$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	Forest red-tailed black cockatoo
EPBC Act status	Vulnerable
Annual probability of extinction Based on IUCN category definitions	**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
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	Forest red-tailed black cockatoo foraging habitat: 8.65 ha moderate-high and 52.49 ha of low quality.	**Area**	61.14	Hectares	Lowlands black cockatoo habitat Assessment against 2017 revised draft guidelines GHD (2020b)
			Quality	**3**	Scale 0-10	
			Total quantum of impact	18.34	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					
Threatened species						
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
Ecological Communities																				
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)**									
Threatened species habitat																				
Area of habitat	Yes	18.34	Adjusted hectares	On-ground management at DBCA conservation site - Lowlands Nature Reserve	**Time over which loss is averted (max. 20 years)**	20	**Start area (hectares)**	232.5	**Risk of loss (%) without offset**	0%	**Risk of loss (%) with offset**	0%	0.00	90%	0.00	0.00	18.34	100.00%	Yes	
									Future area without offset (adjusted hectares)	232.5	**Future area with offset (adjusted hectares)**	232.5								
					Time until ecological benefit	7	**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	0.79				
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																			
Threatened species																				
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	18.342	18.34	100.00%	**Yes**	$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
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	Baudin's black cockatoo foraging habitat: 8.65 ha of moderate quality.	**Area**	8.65	Hectares	Lowlands black cockatoo habitat Assessment against 2017 revised draft guidelines GHD (2020b)
			Quality	**6**	Scale 0-10	
			Total quantum of impact	5.19	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					
Threatened species						
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
Ecological Communities																				
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)**									
Threatened species habitat																				
Area of habitat	Yes	5.19	Adjusted hectares	On-ground management at DBCA conservation site - Lowlands Nature Reserve	**Time over which loss is averted (max. 20 years)**	20	**Start area (hectares)**	70.6	**Risk of loss (%) without offset**	0%	**Risk of loss (%) with offset**	0%								
									Future area without offset (adjusted hectares)	70.6	**Future area with offset (adjusted hectares)**	70.6	0.00	90%	0.00	0.00	5.20	100.11%	Yes	
					Time until ecological benefit	7	**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	80%	0.80	0.74				
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																			
Threatened species																				
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	5.19	5.20	100.11%	**Yes**	$0.00	N/A	$0.00
Area of community	0				$0.00		$0.00
					$0.00	**$0.00**	**$0.00**

Appendix C – Lowlands Nature Reserve Black Cockatoo Habitat Assessment (Bamford 2021)

Public Transport Authority
Lowlands Nature Reserve
Black-Cockatoo Habitat Assessment

An ecologist's perspective when assessing black-cockatoo trees. Photo: W. Bancroft

Prepared for: Public Transport Authority
PO Box 8125
PERTH BUSINESS CENTRE WA 6849

Prepared by: Wes Bancroft and Mike Bamford
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12th May 2021

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1 Introduction

The Public Transport Authority (PTA) is using the Lowlands Nature Reserve (Lowlands) in Mardella, in the south-eastern suburbs of Perth (see Figure 1), as an offset for several METRONET projects that impact habitat used by black-cockatoos. It is possible that all three of the black-cockatoos that occur in the south-west of Western Australia may use the site:

- *Calyptorhynchus latirostris* (Carnaby's Black-Cockatoo) – listed as Endangered under the Federal *Environment Protection and Biodiversity Conservation Act 1999* and as Schedule 2 under the Western Australian *Biodiversity Conservation Act 2016* (see Appendix 1 for more details).
- *Calyptorhynchus baudinii* (Baudin's Black-Cockatoo) – Endangered, Schedule 2 (see Appendix 1).
- *Calyptorhynchus banksii naso* (Forest Red-tailed Black-Cockatoo) – Vulnerable, Schedule 3 (see Appendix 1).

The PTA commissioned Bamford Consulting Ecologists (BCE) to conduct a black-cockatoo habitat assessment of the Lowlands Nature Reserve offset site to inform their offset strategies. This included determining the value of (i) breeding, (ii) foraging and (iii) roosting habitat for all three of the black-cockatoo species.

This report presents the results of that assessment.

1.1 Background: black-cockatoo ecology

There is considerable published information on the ecology of, and threats to, Carnaby's, Baudin's and Forest Red-tailed black-cockatoos. Key references include:

- Action plans (Garnett *et al.* 2010);
- Recovery plans (DEC 2008; DPaW 2013);
- EPBC Act referral guidelines (DSEWPaC 2012; DEE 2017);
- Commonwealth listing and conservation advice (DEWHA 2009a, b; TSSC 2018);
- The federal Department of Agriculture, Water and the Environment's (DAWE) Species Profile and Threats (SPRAT) Database (DAWE 2021a, b, c);
- Scientific literature (Davies 1966; Saunders 1974, 1979a, b, 1980; Saunders *et al.* 1982; Saunders 1986; Johnstone and Storr 1998; Higgins 1999; Johnstone and Kirkby 1999, 2008; Johnstone *et al.* 2013a, b; Whitford *et al.* 2015; Johnston *et al.* 2016; Williams *et al.* 2016; Williams *et al.* 2017); and
- Major reports (Johnstone *et al.* 2011; Kabat *et al.* 2012; Peck *et al.* 2016).

Much of this information has been compiled by DAWE (2021a, b, c). Summarising this work further, there are several salient points for assessing the potential value of the site for black-cockatoos:

Key ecology

- All species are long-lived with low annual reproduction rates and cannot, therefore, rapidly increase their population size.

- Carnaby's and Baudin's Black-Cockatoos undergo regular, seasonal migration between breeding and non-breeding areas.
- Forest Red-tailed Black-Cockatoos are currently considered not to undergo regular migration. In recent years there appears to have been a distinct expansion of the range of this species on to the Swan Coastal Plain, including many suburbs within the Perth metropolitan area.
- It is possible that, as at 2021, Baudin's Black-Cockatoo is also beginning a similar expansion of its range on to the Swan Coastal Plain.
- In recent years there have been considerable shifts in the breeding ecology, distribution and movement patterns of Forest Red-tailed and Carnaby's Black-Cockatoos. These may be a response to habitat degradation/clearing and/or climatic factors.

Key habitat requirements

- All species are reliant on large tree-hollows in eucalypts, in which they breed. Each species has its own preference for nesting tree species and its own geographical breeding range (although these overlap between species). There is a solid understanding of these preferences (see Appendix 2 for summary).
- All species primarily feed on plant seeds and flowers, but also consume wood-boring insect larvae when available. Each species has its own preference for food plant species (with considerable overlap). There is a solid understanding of these preferences (see Appendix 2 for summary).

Key threats

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

1.2 Site description

The Lowlands site is located on the Swan Coastal Plain, in the suburb of Mardella (Shire of Serpentine-Jarrahdale), as shown in Figure 1. Lowlands is c. 40 km south of the Perth Central Business District and c. 17 km east of Rockingham. The main site entrance is accessed by Lowlands Road, but access to the southern boundary is also possible along Rowe Road. The Lowlands Nature Reserve (R 51784, Class A) also forms the Bush Forever (DEP 2000) site number 368 (Lowlands Bushland – Eastern Block, Peel Estate), which recently had boundary amendments (WAPC 2019; State of Western Australia 2020). This site also connects to Bush Forever site number 371 (Serpentine River, Peel Estate to Serpentine).

The vegetation complexes of the site identified by GHD (2020) include:

- Dardanup Complex: Mosaic of vegetation types characteristic of adjacent vegetation complexes such as Serpentine River, Southern River and Guildford.
- Guildford Complex: A mixture of open forest to tall open forest of *Corymbia calophylla-Eucalyptus wandoo - E. marginata* and woodland of *E. wandoo* (with rare occurrences of *E. lane-poolei*). Minor components include *E. rudis – Melaleuca rhaphiophylla.*
- Southern River Complex: Open-woodland of *Corymbia calophylla*, *Eucalyptus marginata*, *Banksia* on the elevated areas and a fringing woodland of *E. rudis*, *Melaleuca rhaphiophylla*

along the streams. South of the Murray River *Agonis flexuosa* occurs in association with the *E. rudis* and *Melaleuca rhaphiophylla*.

- Bassendean Complex-Central and South: Vegetation ranges from woodland of *Eucalyptus marginata - Allocasuarina fraseriana - Banksia* species to low woodland of *Melaleuca* species, and sedgelands on the moister sites. This area includes the transition of *Eucalyptus marginata* to *E. todtiana* in the vicinity of Perth.

Heald *et al.* (2018) provided an assessment of the condition of the Serpentine River that flows through the Lowlands site, finding that the riparian zone was wide (40-50 m) and intact, and that all structural layers were present and in good condition.

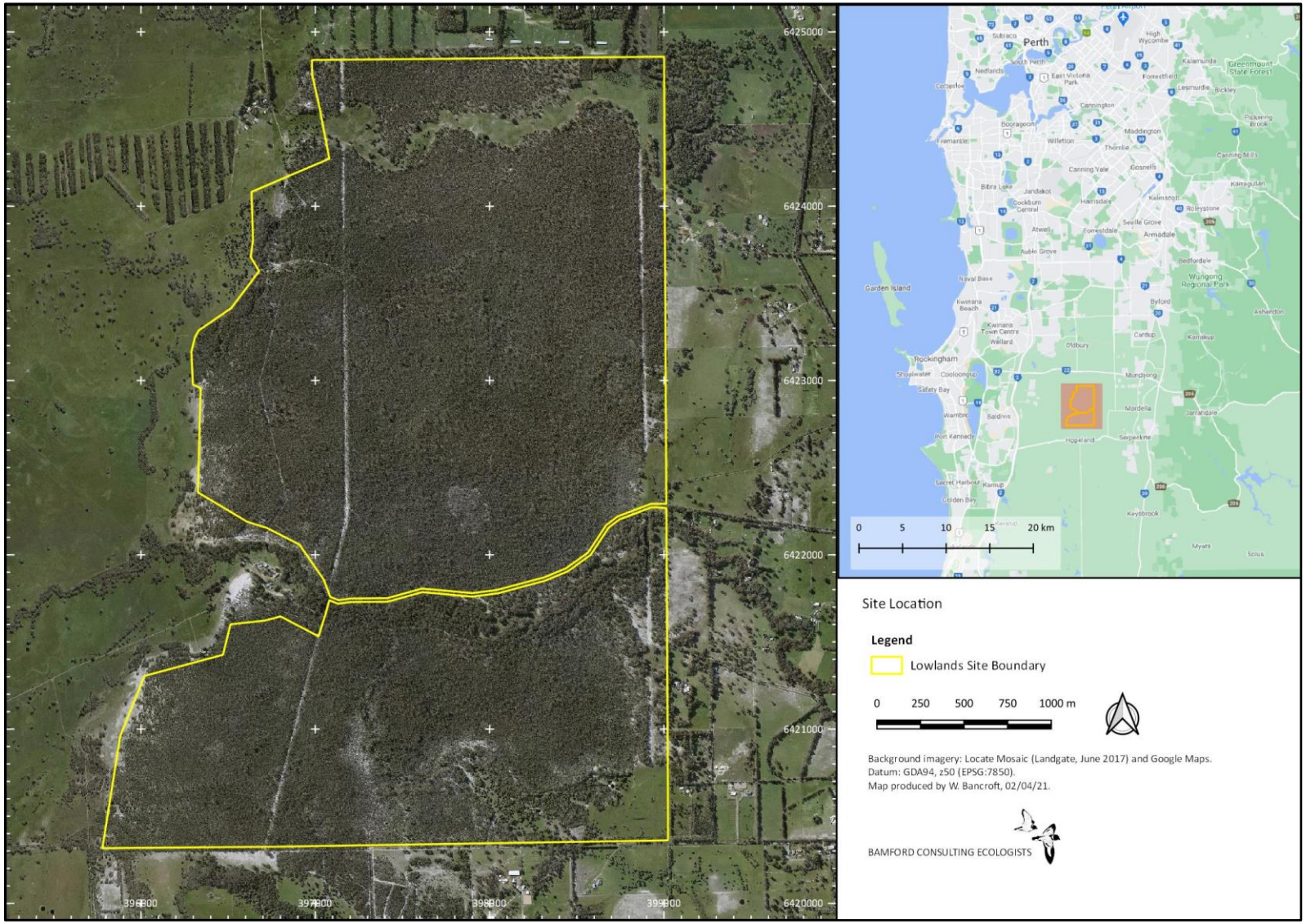

Figure 1. Location of the Lowlands site.

2 Methods

2.1 Personnel

Personnel involved in the field investigations and report preparation are listed in Table 1.

Table 1. Personnel involved in the field investigations and report preparation.

Personnel	Consulting Experience	Field Investigations	Report Preparation
Dr Mike Bamford *BSc (Biol.), Hons (Biol.), PhD (Biol.)*	41 years	+	+
Mrs Mandy Bamford *BSc (Zool.), Hons (Zool.)*	41 years	+	
Dr Wes Bancroft *BSc (Zool./Microbiol.), Hons (Zool.), PhD (Zool.)*	24 years	+	+
Mr Tim Gamblin *BSc (Zool.), Cert Env Mngmt*	25 years	+	

2.2 Identification of vegetation and substrate associations (VSAs)

Vegetation and substrate associations (VSAs) combine vegetation types, the soils or other substrate with which they are associated, and the landform. In the context of fauna assessment, VSAs are the environments that provide habitats for fauna.

BCE deliberately makes the distinction between 'habitat' (a species-specific term that may encompass the whole or part of one or more VSAs and is the physical subset of an ecosystem that a given species, or species group, utilises) and 'VSA' (a general, discrete and mutually exclusive spatial division of a target area, based on soil, vegetation and topography). It is recognised, however, that, within the broader Environmental Impact Assessment (EIA) literature/guidance, the former term is used more or less synonymously to indicate the latter (e.g.' habitat assessment' used by EPA 2020). Further discussion is provided in Appendix 3.

For the current assessment, VSAs were identified based largely on previous vegetation mapping in the area by GHD (2020). Observations made during the field investigations warranted some adjustment of vegetation (i.e. VSA) boundaries in some parts of the site, and these amendments have been included in the results/analysis here.

2.3 Desktop methods

2.3.1 Nomenclature and taxonomy

As per the recommendations of the EPA (2020), the nomenclature and taxonomic order presented in this report are generally based on the Western Australian Museum's (WAM) Checklist of the Fauna of Western Australia 2019. The authorities used for each vertebrate group were: fish (Morgan *et al.* 2014), frogs (Doughty *et al.* 2019a), reptiles (Doughty *et al.* 2019b), birds (BirdLife Australia 2019; Gill and Donsker 2020), and mammals (Travouillon 2019). In some cases, more widely-recognised names and naming conventions have been followed, particularly for birds where there are national and international naming conventions in place (e.g. the BirdLife Australia working list of names for

Australian Birds, and the International Ornithological Congress' 'World Bird List'). This includes the use of black-cockatoo for all three species to ensure clarity and precision. English common names of species, where available, are used throughout the text; Latin names are presented with corresponding English names in tables in the appendices. The use of subspecies is limited to situations where there is an important (and relevant) geographically distinct population, or where the taxonomic distinction has direct relevance to the conservation status or listing of a taxon.

2.3.2 Conservation significance

Species listed in the report have been assessed for conservation significance as detailed in Appendix 3. Three broad levels of conservation significance are used in this report:

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

See Appendix 3 for an expanded discussion of these categories and Appendix 1 for a description of the categories used in the legislation (EPBC and BC Acts) and by the DBCA.

2.4 Field investigations

2.4.1 Overview

Field investigations were focussed on black-cockatoo habitat analysis (comprising breeding, foraging and roosting assessments), with the major focus on identification of trees suited to black-cockatoo nesting. Methods are detailed below.

2.4.2 Dates

Nine days of field investigations were conducted: 12/01/2021, 13/01/2021, 15/01/2021 to 17/01/2021, 22/02/2021, 23/02/2021, 09/03/2021 and 10/03/2021. From two to four personnel were present on each occasion.

2.4.3 Black-cockatoo habitat analysis

2.4.3.1 Guidelines

The Commonwealth Department of Agriculture, Water and the Environment (DAWE) provide guidelines for the referral of actions that may result in impact to black-cockatoos (for assessment under the EPBC Act). While this project is not investigating impacts, *per se*, the survey and analysis reported here have been conducted with strong reference to both the existing guidelines (DSEWPaC 2012) as well as the recently revised draft guidelines (DEE 2017). This includes application of the foraging habitat scoring tool in DEE (2017). In addition, survey methodology followed the recommendations listed on the DAWE's Species Profile and Threats Database (DAWE 2021a, b, c).

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

2.4.3.2 Breeding

The aim of the breeding surveys was to quantify black-cockatoo nesting trees with METRONET offset allocation areas and provide a statistical basis for extrapolating the number of potential nest-trees across the site, based on VSAs. A number of 'survey areas' were positioned throughout the site in order to sample all VSAs and also to achieve a reasonable spatial spread. Some administrative considerations (from the PTA) were also taken into account when choosing the sampling locations. These survey areas are mapped in Figure 4. Potential nest-tree surveys have been completed in c. 523 ha (46%) of the site. Surveying for trees involved personnel walking c. 50 m apart in a transect and recoding all trees in a measured area, thus ensuring tree densities could be calculated. Survey track logs (that indicate survey coverage) are presented in Appendix 4.

Within the survey areas, the following information was recorded for every suitable tree [1] (predominantly Jarrah, *Eucalyptus marginata*; Flooded Gum, *E. rudis*; Marri, *Corymbia calophylla*; and Sheoak, *Allocasuarina fraseriana*) with a diameter at breast height (DBH) equal to or greater than 500 mm:

- tree location;
- tree species;
- life status;
- DBH; and
- nest-tree rank: trees were assessed (from the ground) for the potential presence/quality of nest-hollows and allocated a nesting rank (developed by BCE) as described in Table 2.

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

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

Table 2. Ranking system for the assessment of potential nest-trees for black-cockatoos (revised 08/01/2021).

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

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

2.4.3.3 Foraging

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

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

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

Black-cockatoo foraging signs were also recorded in conjunction with the breeding tree surveys (see Section 2.4.3.2). When observed, the location, tree species and approximate age of the foraging evidence were recorded. Black-cockatoo foraging evidence may persist for some months or years after the foraging event. There is currently no published evidence documenting the deterioration process of forage. Factors that help to establish the time since foraging include: the colour of nuts/foliage, the degree of weathering or decay of debris, the presence of small fragments of nut debris, the position/compression of the foraging debris relative to surrounding vegetation and leaf litter, and the strength of the eucalypt smell emitted. Despite the absence of empirical data, four categories of foraging activity were recognised, based on the time since foraging:

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

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

2.4.3.4 Roosting

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

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

2.4.4 Opportunistic observations

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

2.5 Mapping and geographic data

Low resolution maps have been provided within the body this report. Higher resolution maps and GIS files can be supplied if required. As per the recommendation of EPA (2020), maps use the GDA94 datum and are projected into the appropriate Map Grid of Australia (MGA94) zone.

Geographic data are also provided as electronic shapefiles, to Index of Biodiversity Surveys for Assessments (IBSA) standards, as per the PTA spatial data procedure.

3 Results and Discussion

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

Four broad *fauna* habitat types were identified by GHD (2020) but for the purposes of this black-cockatoo assessment (to allow a more nuanced analysis) BCE has instead chosen to use the eleven major vegetation types of GHD (2020) as surrogates for VSAs. These are listed below (taken directly from GHD 2020):

VSA 1. Eucalyptus Banksia woodland (EBw). *Eucalyptus marginata* and *Allocasuarina fraseriana* isolated trees over *Banksia menziesii*, *B. attenuata* and *Xylomelum occidentale* low woodland over *Kunzea glabrescens* tall sparse shrubland over *Stirlingia latifolia*, *Dasypogon bromeliifolius* and *Desmocladus flexuosus* herbland. This is the most dominant vegetation type within the survey area.

VSA 2. Allocasuarina Banksia woodland (ABw). *Allocasuarina fraseriana* and/or *Melaleuca preissiana* mid open woodland over *Banksia menziesii* and *B. attenuata* low woodland over *Kunzea glabrescens* tall shrubland over *Dasypogon bromeliifolius* and *Desmocladus flexuosus* herbland. Higher densities of *A. fraseriana* were recorded within this vegetation type along with occasional stands of *M. preissiana*, when compared to EBw.

VSA 3. Banksia ilicifolia woodland (Biw). *Banksia ilicifolia* low woodland over *Xanthorrhoea preissii* low open shrubland over *Dasypogon bromeliifolius* and *Patersonia occidentalis* herbland. This type was recorded from a small pocket located in the north western extent of the survey area.

VSA 4. Corymbia calophylla open woodland (Cw). *Corymbia calophylla* tall open woodland over *Melaleuca preissiana* and/ or *Eucalyptus rudis* isolated trees over *Kunzea glabrescens* tall shrubland over weeds. Located within the south eastern extent and part of the southern tributary of the Serpentine River.

VSA 5. Banksia Kunzea woodland (BKw). *Banksia attenuata* and *B. ilicifolia* woodland over *Kunzea glabrescens* tall shrubland over *Calytrix angulata* low open shrubland over Patersonia occidentalis and *Desmocladus flexuosus* open herbland.

VSA 6. Eucalyptus Melaleuca woodland (EMw). *Eucalyptus rudis* tall woodland over *Melaleuca preissiana* and *M. rhaphiophylla* low woodland over *Dielsia stenostachya* and Juncus pallidus closed sedgeland. Mapped within the north and south western extents of the survey area.

VSA 7. Eucalyptus rudis forest (Ef). *Eucalyptus rudis* tall closed forest over *Astartea* sp. tall sparse shrubland over *Pteridium esculentum* closed fernland and *Lepidosperma longitudinale* open sedgeland. This vegetation type follows the Serpentine River. The density of *E. rudis* decreases with increasing distance from the river.

VSA 8. Melaleuca woodland (Mw). *Melaleuca preissiana* with occasional *M. rhaphiophylla* low open woodland over tall open shrubland *Kunzea glabrescens* tall open shrubland over *Astartea* sp. isolated shrubs over *Lyginia imberbis* and *Dasypogon bromeliifolius* open herbland. Mapped in areas of poor drainage within the survey area.

VSA 9. Tuart woodland (Tw). *Eucalyptus gomphocephala* open forest over *Kunzea glabrescens* tall isolated shrubs over Pteridium esculentum sparse fernland and *Desmocladus flexuosus* open sedgeland. Restricted to one small patch on the northern side of the River.

VSA 10. Scattered natives over weeds (Sn). *Eucalyptus marginata*, *Corymbia calophylla*, *Melaleuca preissiana* and /or *Banksia* spp. other weedy grasses and herbs. Characterised as highly modified areas of vegetation where weedy species dominate.

VSA 11. Track. Gravel and/ or dirt vehicle tracks.

These VSAs (as vegetation types) were mapped by GHD (2020) but, during the present site inspection, it was considered that some alteration of this mapping (in the south-western corner) would be prudent. The adjusted VSA mapping is presented in Figure 2.

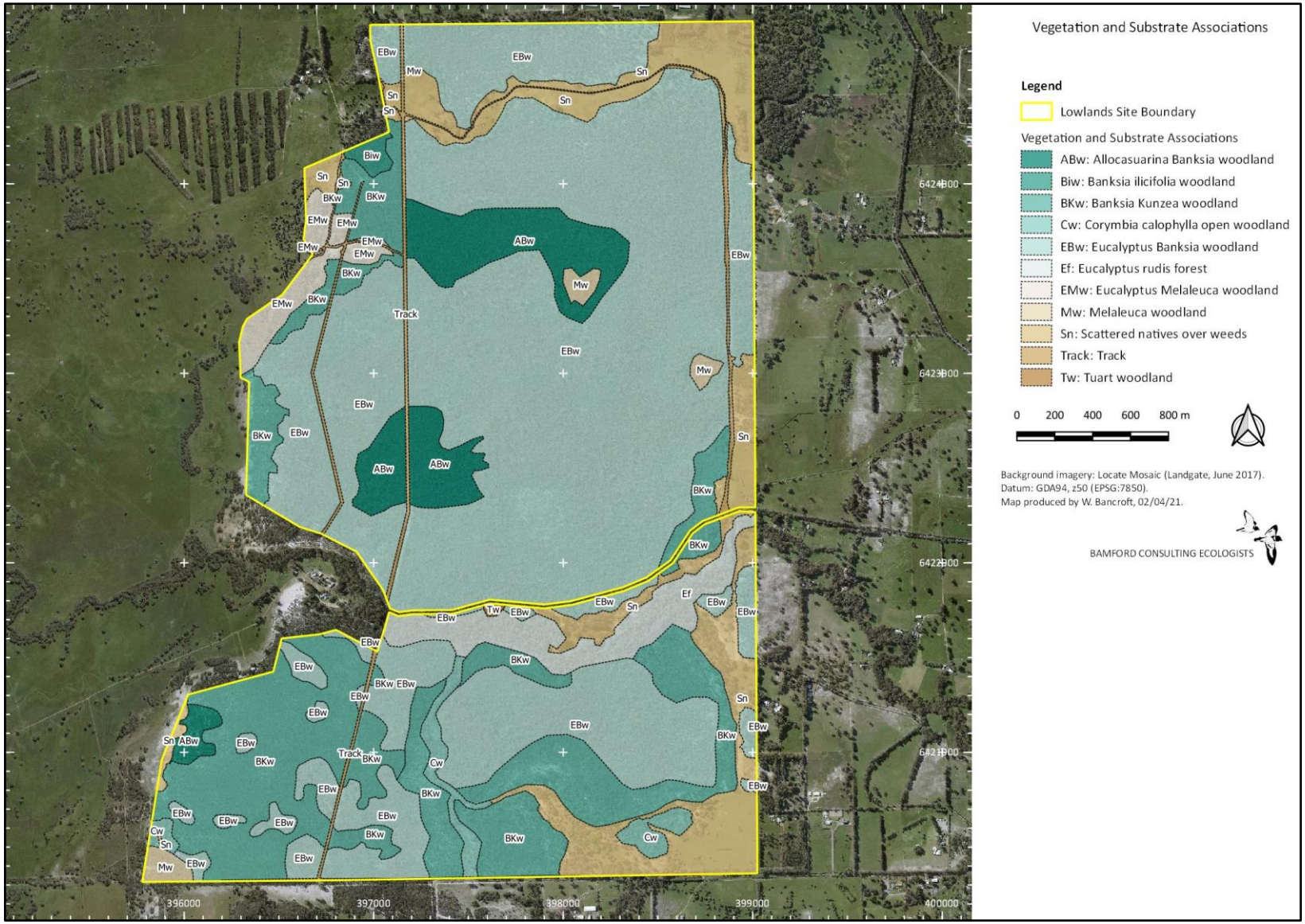

Figure 2. The distribution of VSAs at the site.

3.2 Black-cockatoo habitat analysis

3.2.1 Black-cockatoo presence

Only one of the three species of black-cockatoo known to occur in the vicinity of Lowlands was directly recorded on the site during the January to March 2021 surveys: Forest Red-tailed Black-Cockatoo. The locations of the five observations made (and number of birds recorded at each) are mapped in Figure 3. These were all in the south-western quarter of the site.

GHD (2020) observed Carnaby's Black-Cockatoos passing over the Lowlands site and recorded Forest Red-tailed Black-Cockatoo directly on the site. Baudin's Black-Cockatoo was not observed in the January to March 2021 surveys (this study) or by GHD (2020). Baudin's Black-Cockatoos arrive in the northern Darling Range (from their deep-south breeding areas) in February or March, with some flocks foraging on the Swan Coastal Plain between April and September (Johnstone and Kirkby 2008). Johnstone and Kirkby (2008) noted that there is a "definite shift westward onto the southern Swan Coastal Plain" (including Mundijong and Serpentine areas) in mid-August, ahead of their departure south to breeding areas in mid-October. It is therefore possible that the surveys here (and by GHD 2020) have not been undertaken at a time when Baudin's Black-Cockatoo is most likely to be present. With that said, there was no foraging evidence (which can persist for months or years after feed events) recorded within the Lowlands site. Neighbours to the Lowlands property report seeing only Forest Red-tailed Black-Cockatoo and that white-tailed species (probably Carnaby's Black-Cockatoo) are seen regularly nearby (to the east and thus nearer the escarpment). The scarcity of records of Carnaby's Black-Cockatoo may be a reflection of the isolation of Lowlands from other areas of foraging habitat on the nearby Coastal Plain (see Figure 10).

Given these direct observations, indirect (foraging) records (see Section 3.2.3 below) and roosting data (see Section 3.2.4 below), it is considered that, currently:

- Carnaby's Black-Cockatoo is likely to be an occasional non-breeding visitor/migrant to the site in low numbers.
- Forest Red-tailed Black-Cockatoo is likely to a resident at the site, and may breed at the site or in the vicinity (although no breeding evidence has yet been located).
- Baudin's Black-Cockatoo is unlikely to use the site as it is outside their normal range (see above), although it is possible this will change in the future.

3.2.2 Black-cockatoo breeding habitat

A total of 3609 trees that met the potential nest-tree criteria of DAWE (2021a, b, c) and DEE (2017) was recorded from the c. 523 ha of survey areas sampled within the Lowlands site boundary (see Table 3 and Figure 4). An additional 46 potential nest-trees were recorded outside the survey areas (but within the site boundary). These trees were not used in density estimates. Also, a further 59 potential nest-trees that fell outside the site boundary were inadvertently surveyed. Note that, hereafter, the analysis and discussion refer only to those 3609 trees recorded systematically within the study area.

At least nine species of potential nest-trees were recorded, as listed in Table 3. Four species accounted for almost 98% of trees: Jarrah, Flooded Gum, Sheoak and Marri (c. 49%, 19%, 18% and 12% of all potential nest-trees within the survey areas, respectively). The assessment data (species, life status, DBH and nest-tree rank) for all trees are provided in separate electronic GIS files (shapefile format).

The numbers of potential nest-trees of each species recorded in each ranking category are shown in Table 4. The majority (c. 81.6%) of potential nest-trees surveyed did not have hollow entrances suited to black-cockatoos that were observable from ground level. No active nests were located and no trees had evidence of hollow-entrance chewing by black-cockatoos. A total of 661 trees (c. 18.3%, see Table 4) had potential black-cockatoo nesting hollows (but no sign of recent use).

The DBH profile of the potential nest-trees within the study area is presented in Figure 5. While more than 60% of the trees that were measured had a DBH between 500 and 700 mm, this probably reflects a typical profile in the remnant woodlands of the area (i.e. given considerable clearing, logging and intensive land use). Relatively few very large trees remain.

Of the 3609 potential nest-trees within the survey areas, 2570 (71.2%) were live trees.

The number of potential nest-trees within each VSA within the survey areas is shown for each species in Table 5. Also shown is the area of each VSA that was surveyed, and this enabled calculation of tree density (stems per hectare) for each VSA (presented in Table 5). These densities were then multiplied by the total area of each VSA within the Lowlands site (see Table 5) to provide an estimate of the total number of trees (of each species) for the entire site. It is estimated that there is a grand total of c. 9700 trees (all species combined) that meet the hollow-bearing criteria of DAWE (2021a, b, c) and DEE (2017) within Lowlands (see Table 5). It should be noted, however, that some species are very unlikely to form hollows that could be used by black-cockatoos (e.g. Christmas Tree, Holly-leaved Banksia, Sheoak and Stout Paperbark) and, therefore, a second estimate, of "likely hollow-bearing species" is also provided (by excluding the aforementioned species); a total of c. 7800 trees of the likely hollow-forming species is expected within the whole site (Table 5). Given that c. 46% of the site has now been surveyed (c. 523 ha out of c. 1138 ha), these are likely to represent robust estimates.

The BirdLife Australia database of black-cockatoo breeding surveys search indicated that there were four known breeding sites for Carnaby's Black-Cockatoo (all in artificial hollows) within 12 km of the Lowlands site. The location of these sites was not provided but they were listed as "Baldivis Children's Forest".

Table 3. Species and number of potential black-cockatoo nest-trees recorded.

Tree Species		Survey Areas	Outside Survey Areas	Outside Site Boundary
Allocasuarina fraseriana	Sheoak	636	4	15
Banksia ilicifolia	Holly-leaved Banksia	2	0	0
Corymbia calophylla	Marri	442	11	8
Eucalyptus gomphocephala	Tuart	1	0	2
Eucalyptus marginata	Jarrah	1766	29	27
Eucalyptus rudis	Flooded Gum	689	2	6
Eucalyptus sp.	Unidentified	8	0	0
Melaleuca preissiana	Stout Paperbark	51	0	0
Nuytsia floribunda	Christmas Tree	14	0	0
Pinus sp.	Pine sp.	0	0	1
TOTAL		3609	46	59

Figure 3. Location of direct black-cockatoo records (from January to March 2021 surveys) at the Lowlands site.

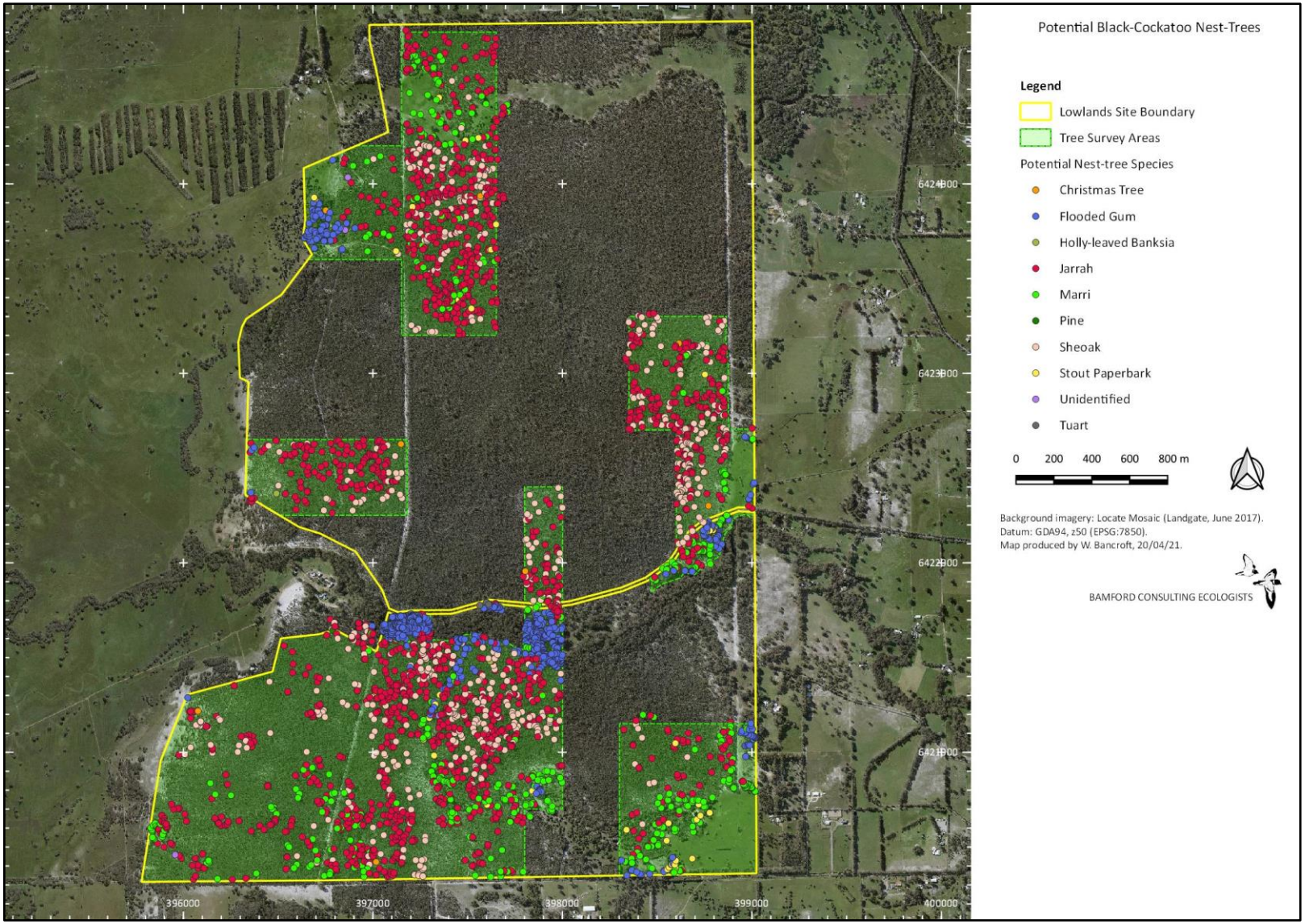

Figure 4. Location of potential nest-trees within the Lowlands site, as classified by tree species.

Table 4. The number of potential nest-trees of each species in each nest-tree rank category in the survey areas.

See Section 2.4.3.2 for full explanation of tree categories.

† 'Other' tree species: *Banksia ilicifolia*, *Eucalyptus gomphocephala*, *Eucalyptus* sp., *Melaleuca preissiana*, and *Nuytsia floribunda*.

Rank		Number of Trees					TOTAL	Percentage (of Grand Total)
		Jarrah	Flooded Gum	Sheoak	Marri	Other†		
1	Active nest.	-	-	-	-	-	0	0.00
2	Potential hollow with chew-marks.	-	-	-	-	-	0	0.00
3	Potential hollow, no chew marks.	556	13	3	83	6	661	18.32
4	Potential hollow, unsuitable orientation.	338	15	4	49	2	408	11.31
5	Sufficient DBH, no observable hollows.	872	661	629	310	68	2540	70.38
	TOTAL:	1766	689	636	442	76	3609	100.00
	Percentage (of Grand Total)	48.93	19.09	17.62	12.25	2.11	100.00	

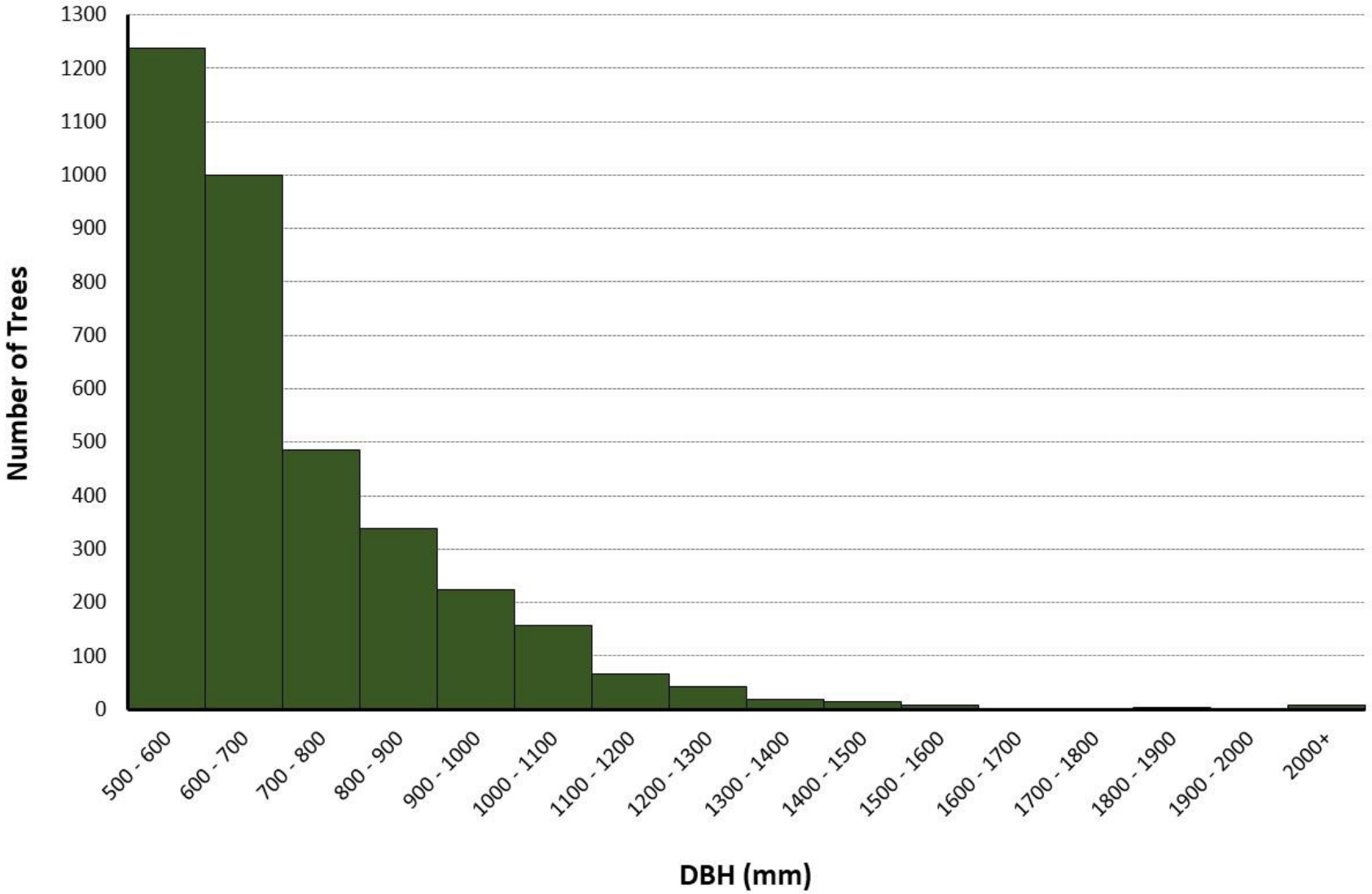

Figure 5. DBH profile of the potential black-cockatoo nest-trees within the survey areas.

Table 5. The number of potential nest-trees of each species in each vegetation and substrate association within the survey areas.

† indicates trees that are unlikely to bear hollows suitable for black-cockatoos.
ABw = Allocasuarina Banksia woodland; Biw = Banksia ilicifolia woodland; BKw = Banksia Kunzea woodland; Cw = Corymbia calophylla open woodland; EBw = Eucalyptus Banksia woodland; Ef = Eucalyptus rudis forest; EMw = Eucalyptus Melaleuca woodland; Mw = Melaleuca woodland; Sn = Scattered natives over weeds; Track = Track; Tw = Tuart woodland.

	Vegetation and Substrate Association											
	ABw	**Biw**	**BKw**	**Cw**	**EBw**	**EMw**	**Ef**	**Mw**	**Sn**	**Track**	**Tw**	***Total***
STEM COUNT												
Christmas Tree†	2		2	1	7	1			1			*14*
Flooded Gum			58	21	23	70	443		53	2	19	*689*
Holly-leaved Banksia†			1		1							*2*
Jarrah	188		211	59	1264	2	20	2	20			*1766*
Marri	13	2	130	68	158	1	6		63	1		*442*
Sheoak†	76	1	75	1	480		2	1				*636*
Stout Paperbark†	4		11	9	6	3		1	16	1		*51*
Tuart											1	*1*
Unidentified			1	1	2	3	1					*8*
Total	*283*	*3*	*489*	*160*	*1941*	*80*	*472*	*4*	*153*	*4*	*20*	*3609*
SURVEYED AREA (ha)												
	30.1	2.7	170.5	16.2	219.4	8.3	10.1	5.9	50.9	8.9	0.3	*523.3*

TREE DENSITY (stems per hectare)

Christmas Tree†	0.07	0	0.01	0.06	0.03	0.12	0	0	0.02	0	0	
Flooded Gum	0	0	0.34	1.3	0.1	8.39	44.01	0	1.04	0.22	61.68	
Holly-leaved Banksia†	0	0	0.01	0	0	0	0	0	0	0	0	
Jarrah	6.24	0	1.24	3.65	5.76	0.24	1.99	0.34	0.39	0	0	
Marri	0.43	0.75	0.76	4.21	0.72	0.12	0.6	0	1.24	0.11	0	
Sheoak†	2.52	0.37	0.44	0.06	2.19	0	0.2	0.17	0	0	0	
Stout Paperbark†	0.13	0	0.06	0.56	0.03	0.36	0	0.17	0.31	0.11	0	
Tuart	0	0	0	0	0	0	0	0	0	0	3.25	
Unidentified	0	0	0.01	0.06	0.01	0.36	0.1	0	0	0	0	
Total	*9.39*	*1.12*	*2.87*	*9.90*	*8.85*	*9.59*	*46.89*	*0.68*	*3*	*0.45*	*64.92*	*6.9*

TOTAL AREA WITHIN SITE (ha)

	63.18	3.27	146.83	14.36	712.17	19.68	36.02	4.82	120.58	16.89	0.57	*1138.37*

ESTIMATED NUMBER OF POTENTIAL BLACK-COCKATOO NEST-TREES WITHIN SITE (stem count: ALL tree species)

Christmas Tree†	4.19	0	1.72	0.89	22.72	2.36	0	0	2.37	0	0	
Flooded Gum	0	0	49.94	18.66	74.65	165.17	1585.16	0	125.5	3.79	35.09	
Holly-leaved Banksia†	0	0	0.86	0	3.25	0	0	0	0	0	0	
Jarrah	394.19	0	181.69	52.43	4102.31	4.72	71.56	1.64	47.36	0	0	
Marri	27.26	2.44	111.94	60.42	512.79	2.36	21.47	0	149.18	1.9	0	

Sheoak[†]	159.35	1.22	64.58	0.89	1557.84	0	7.16	0.82	0	0	0	
Stout Paperbark[†]	8.39	0	9.47	8	19.47	7.08	0	0.82	37.89	1.9	0	
Tuart	0	0	0	0	0	0	0	0	0	0	1.85	
Unidentified	0	0	0.86	0.89	6.49	7.08	3.58	0	0	0	0	
Total	*593*	*4*	*421*	*142*	*6300*	*189*	*1689*	*3*	*362*	*8*	*37*	*9748*

ESTIMATED NUMBER OF POTENTIAL BLACK-COCKATOO NEST-TREES WITHIN SITE (stem count: LIKELY hollow-bearing species only)

Total	*421*	*2*	*344*	*132*	*4696*	*179*	*1682*	*2*	*322*	*6*	*37*	*7823*

3.2.3 Black-cockatoo foraging habitat

3.2.3.1 Carnaby's Black-Cockatoo

Foraging habitat for Carnaby's Black-Cockatoo was present throughout the Lowlands site. This is predominantly due to the presence of four tree species known to be mainstays of the Carnaby's Black-Cockatoo diet: *Banksia attenuata*, *B. ilicifolia*, *B. menziesii* and *Corymbia calophylla* (Groom 2011); see also Appendix 2. These trees were present in variable densities (from absent to high) across the site. Other potential food sources were also present (e.g. Jarrah, Tuart, *Hakea* spp., Grass Trees).

A map of vegetation scores of the Lowlands site for Carnaby's Black-Cockatoo foraging is presented in Figure 6. Vegetation, context, density and combined (foraging) scores for Carnaby's Black-Cockatoo in each VSA present at Lowlands are presented in Table 6. The total areas (and proportions) of each foraging score at Lowlands, for Carnaby's Black-Cockatoo, are presented in Table 7. The vegetation component of the foraging score was assigned as per Appendix 5. Context scores recognised that Lowlands is a large area of foraging habitat in a largely cleared landscape; Lowlands represents about 11% of regional native vegetation. The maximum score of 3 out of 3 for context was assigned to vegetation types with a high vegetation score and that were large in area (such as Allocasuarina/Banksia Woodland), but was moderated to a context of 2 for vegetation types with at least a moderate vegetation score but that were small in area (such as *Banksia ilicifolia* Woodland). A species presence score of zero was used as there was very limited evidence of the species visiting the site, which was unexpected. It is possible this will change in the future as there are recent anecdotal observations of all three black-cockatoos moving around more widely on the coastal plain than in the past.

A limited amount of evidence of foraging by Carnaby's Black-Cockatoos was noted at the site during the 2021 nest-tree surveys. There were seven records of two feed species (five of Candlestick Banksia, *Banksia attenuata*, and two of Firewood Banksia, *B. menziesii*) located in the south-west of the site. This evidence was old (probably well over a year). The locations of these records is shown in Figure 7. GHD (2020) observed Carnaby's Black-Cockatoos passing over the Lowlands site and also noted foraging evidence (on Candlestick Banksia and Holly-leaved Banksia, *B. ilicifolia*).

3.2.3.2 Baudin's Black-Cockatoo

Foraging habitat for Baudin's Black-Cockatoo was present throughout the Lowlands site. This is due to the occurrence of Marri and Jarrah, known to be mainstays of the Baudin's Black-Cockatoo diet (Johnstone and Johnstone 2001; DEC 2008); see also Appendix 2. These trees were present in variable densities (from absent to high) across the site. However, no evidence of foraging by Baudin's Black-Cockatoos was noted at the site during the 2021 nest-tree surveys. GHD (2020) also did not record any foraging by Baudin's Black-Cockatoo.

A map of vegetation scores of the Lowlands site for Baudin's Black-Cockatoo foraging is presented in Figure 8. Vegetation, context, density and combined (foraging) scores for Baudin's Black-Cockatoo in each VSA present at Lowlands is presented in Table 6. The total areas (and proportions) of each foraging score at Lowlands, for Baudin's Black-Cockatoo, are presented in Table 7. The vegetation component of the foraging score was assigned as per Appendix 5. The maximum score of 3 out of 3 for context was assigned to vegetation types with either a high vegetation score (*Corymbia calophylla*

Open Woodland) or a moderate vegetation score but a very large area (Eucalyptus Banksia Woodland). The context score was further moderated for vegetation types with a low vegetation score. A species presence score of zero was used as there was no evidence of the species visiting the site. It is possible this will change in the future as there are recent anecdotal observations of all three black-cockatoos moving around more widely on the coastal plain than in the past.

3.2.3.3 Forest Red-tailed Black-Cockatoo

Foraging habitat for Forest Red-tailed Black-Cockatoo was present throughout the Lowlands site. This is due to the occurrence of Marri, Jarrah and Sheoak, known to be mainstays of the Forest Red-tailed Black-Cockatoo diet (Johnstone and Kirkby 1999); see also Appendix 2. These trees were present in variable densities (from absent to high) across the site.

A map of vegetation scores of the Lowlands site for Forest Red-tailed Black-Cockatoo foraging is presented in Figure 9. Vegetation, context, density and combined (foraging) scores for Forest Red-tailed Black-Cockatoo in each VSA present at Lowlands is presented in Table 6. The total areas (and proportions) of each foraging score at Lowlands, for Forest Red-tailed Black-Cockatoo, are presented in Table 7.

There was extensive but localised evidence of foraging by Forest Red-tailed Black-Cockatoos noted at the site during the 2021 nest-tree surveys. There were 112 records of three feed species (108 of Marri, three of Jarrah and one of Sheoak) predominantly located south of the Serpentine River. The locations of these records are shown in Figure 7. Most of the Marri patches in that southern region were littered with foraging evidence, including some recent signs (at 32 of the 108 locations). No birds were observed actively foraging within the Lowlands site boundary but, given birds were seen or heard on most days, this was almost certainly occurring. GHD (2020) also noted that there was extensive foraging evidence by Forest Red-tailed Black-Cockatoos (Marri, Jarrah and Sheoak) at the Lowlands site and recorded active feeding in two locations (along the mid-southern and mid-eastern boundaries). The vegetation component of the foraging score was assigned as per Appendix 5. The maximum score of 3 out of 3 for context was assigned to vegetation types with either a high vegetation score (*Corymbia calophylla* Open Woodland) or a moderate vegetation score but a very large area (Eucalyptus Banksia Woodland). The context score was further moderated for vegetation types with a low vegetation score. A species presence score of one was used as there was abundant evidence of the species visiting the site. Note that this may be a recent phenomenon as the species was an infrequent visitor to coastal plain sites around Perth until about 2010.

Figure 6. Distribution of Carnaby's Black-Cockatoo foraging habitat at the Lowlands site.

Table 6. Vegetation, context, density and combined (foraging) scores in each VSA present at Lowlands for the three black-cockatoo species present in south-western Australia.

ABw = Allocasuarina Banksia woodland; Biw = Banksia ilicifolia woodland; BKw = Banksia Kunzea woodland; Cw = Corymbia calophylla open woodland; EBw = Eucalyptus Banksia woodland; Ef = Eucalyptus rudis forest; EMw = Eucalyptus Melaleuca woodland; Mw = Melaleuca woodland; Sn = Scattered natives over weeds; Track = Track; Tw = Tuart woodland.

VSA	Area (ha)	Carnaby's Black-Cockatoo				Baudin's Black-Cockatoo				Forest Red-tailed Black-Cockatoo			
		Vegetation	Context	Density	*Total*	Vegetation	Context	Density	*Total*	Vegetation	Context	Density	*Total*
ABw	68.1	4	3	0	*7*	2	1	0	*3*	4	3	1	*8*
Biw	3.3	3	2	0	*5*	2	1	0	*3*	2	1	0	*3*
BKw	214.1	4	3	0	*7*	2	1	0	*3*	2	1	0	*3*
Cw	16.2	3	2	0	*5*	5	3	0	*8*	5	3	1	*9*
EBw	639.7	4	3	0	*7*	3	3	0	*6*	3	3	1	*7*
Ef	36	2	1	0	*3*	2	1	0	*3*	2	1	0	*3*
EMw	18	3	2	0	*5*	3	2	0	*5*	3	2	1	*6*
Mw	8.6	1	0	0	*1*	1	0	0	*1*	1	0	0	*1*
Sn	116.9	2	1	0	*3*	1	0	0	*1*	1	0	0	*1*
Track	16.9	0	0	0	*0*	0	0	0	*0*	0	0	0	*0*
Tw	0.6	2	1	0	*3*	2	1	0	*3*	2	1	0	*3*
Total	*1138.4*												

Table 7. Total areas (ha) and proportions (%) of each (combined) foraging score at Lowlands for the three black-cockatoo species present in south-western Australia.

Foraging Score	Carnaby's Black-Cockatoo		Baudin's Black-Cockatoo		Forest Red-tailed Black-Cockatoo	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
0	16.9	1.5	16.9	1.5	16.9	1.5
1	8.6	0.8	125.5	11.0	125.5	11.0
2	-	-	-	-	-	-
3	153.5	13.5	322.1	28.3	254.0	22.3
4	-	-	-	-	-	-
5	37.5	3.3	18.0	1.6	-	-
6	-	-	639.7	56.2	18.0	1.6
7	921.9	81.0	-	-	639.7	56.2
8	-	-	16.2	1.4	68.1	6.0
9	-	-	-	-	16.2	1.4
10	-	-	-	-	-	-
Total	*1138.4*	*100.0*	*1138.4*	*100.0*	*1138.4*	*100.0*

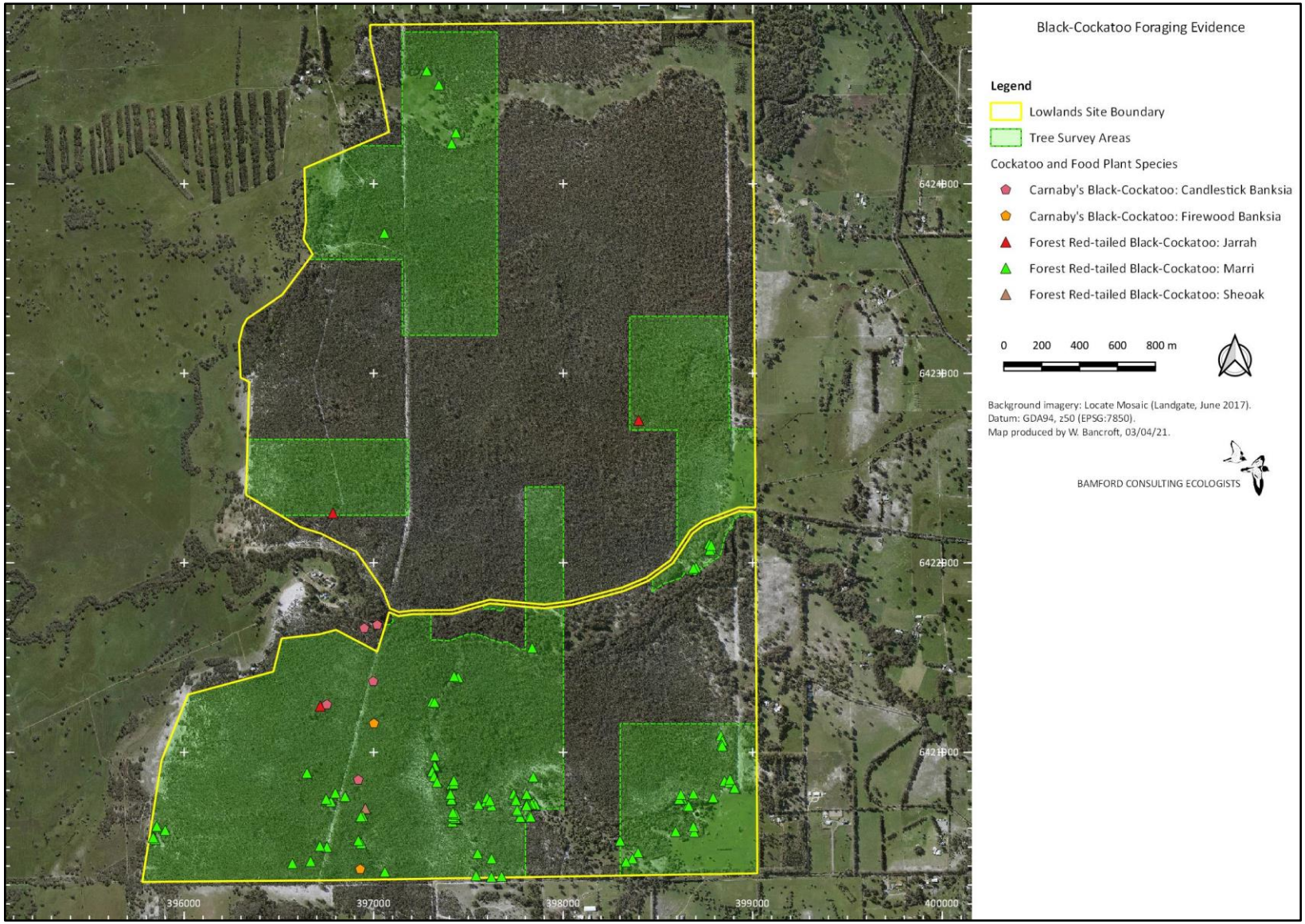

Figure 7. Location of black-cockatoo foraging records (from January to March 2021 surveys) at the Lowlands site.

Figure 8. Distribution of Baudin's Black-Cockatoo foraging habitat at the Lowlands site.

Figure 9. Distribution of Forest Red-tailed Black-Cockatoo foraging habitat at the Lowlands site.

3.2.4 Black-cockatoo roosting habitat

The area around Lowlands site is known to support black-cockatoo roosting, however there are no records of roost sites within the Lowlands site boundary itself. Previously known roost locations from BirdLife Australia's Great Cocky Count database that are within 12 km of Lowlands are mapped in Figure 10, with the count data presented in Appendix 7. The nearest of these known roosts are c. 6 km from the Lowlands boundary. The distribution of roosts may explain the scarcity of Carnaby's Black-Cockatoo records, and the abundance of the Forest-Red-tailed Black-Cockatoo. The nearest Carnaby's roosts are to the north (the nearest is c. 6.2 km from the Lowlands boundary), separated from Lowlands by cleared paddocks. In contrast, the nearest Red-tailed Black-Cockatoo roosts are to the east (the nearest is c. 5.9 km from the Lowlands boundary), along the Serpentine River. Vegetation along the river may provide a corridor for movement of the birds. The absence of a roost within Lowlands was unexpected but is probably real, as the site is in an area that is well-surveyed as part of the Great Cocky Count. Two locations within Lowlands (see Figure 10) were checked for roosting activity in 2017 as part of the Great Cocky Count of that year, following reports of groups of birds seen in these areas, but no roosting activity was observed. However, no subsequent roost surveys have been undertaken, and were not carried out as part of the current studies.

The Lowlands site, however, has extensive areas that would be considered as highly desirable for black-cockatoo roosting (sensu DAWE 2021a, b, c). Areas of tall eucalypts, well suited to roosting, are present along the entire length of the Serpentine River (the *Eucalyptus rudis* forest [Ef] VSA), and the patches of Eucalyptus Melaleuca woodland [EMw] are also typical of black-cockatoo roost sites (see Figure 2). In addition, the majority of the *Corymbia calophylla* open woodland [Cw] patches would likely be suitable roosts (see Figure 2). Some regions within the Eucalyptus Banksia woodland [EBw], where there are stands of tall eucalypts, could also be used for black-cockatoo roosting (see Figure 2). Given the level of activity of the Forest Red-tailed Black-Cockatoo in Lowlands, particularly in the south, it is very likely that there is a roost in this area.

3.2.5 Conclusion

Based upon location and vegetation, the Lowlands property would appear to be highly suitable for foraging by both Carnaby's and the Forest Red-tailed Black-Cockatoo, but unlikely for Baudin's Black-cockatoo. Breeding by both the former species could also be expected as some breeding is known from within 12 km, and there are abundant large Jarrah, and some large Marri, with suitable hollows. Despite this, there is little evidence of usage by Carnaby's with only the Forest Red-tailed present regularly. Although hollows of suitable size and angle were found, no hollows with signs of breeding activity were recorded. It must be stressed, however, that black-cockatoos are dynamic and are displaying ecological plasticity in recent years, with both Carnaby's and the Forest Red-tailed Black-Cockatoos expanding their foraging and breeding range onto the coastal plain, and both exploiting new food sources. It is therefore likely that their level of activity at Lowlands will increase in coming years, and this could be accelerated through creation of corridors across surrounding landscapes. Baudin's Black-Cockatoo is also known to make some use of the eastern Coastal Plain, but its distinctive foraging signs were not found at Lowlands so it is presumably not currently present, possibly because the property is so isolated. There are some observations (M. Bamford) of Baudin's foraging around Perth Airport and at Whiteman Park, on the eastern Coastal Plain, where it had not previously been observed, it may also be moving out onto the Coastal Plain.

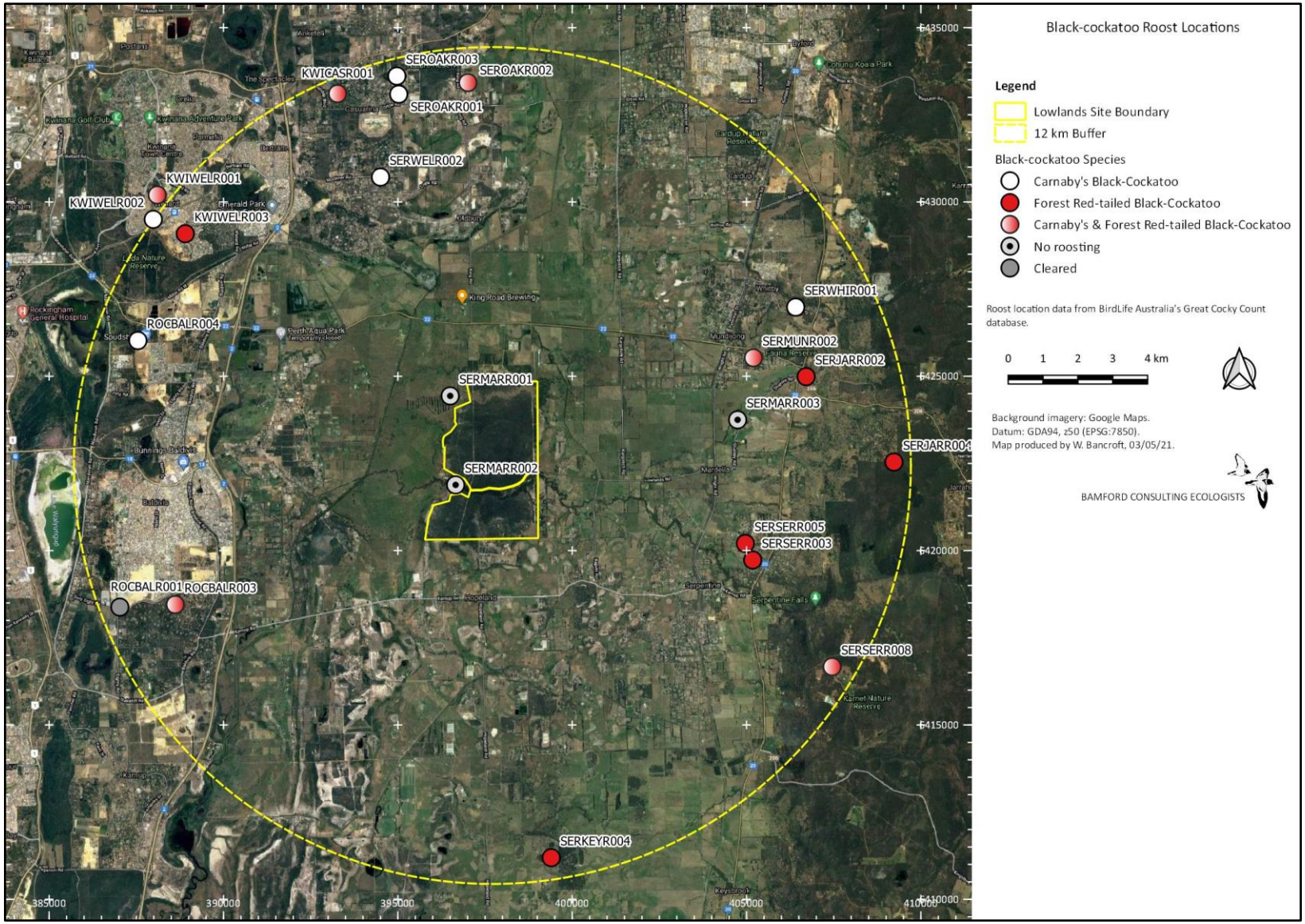

Figure 10. Known black-cockatoo roost locations within 12 km of the Lowlands site.

3.3 Other observations

3.3.1 Vertebrate species

Vertebrate species recorded opportunistically during the field investigations (from January to March 2021) at Lowlands are listed in Table 8. Some comments on these species (and others not recorded) are presented below:

- Ground-dwelling skinks – there was very little sign of ground dwelling skinks (e.g. *Ctenotus*, *Lerista*, *Morethia* species) that would generally be expected to be seen in the area, given the high level of survey time.
- Painted Button-quail (*Turnix varius*) – no evidence of this species, despite considerable survey time. This may reflect pressure from introduced predators (cats, foxes).
- Birds of prey – very few birds of prey noted for a remnant of this site. Only one sighting each of a single Wedge-tailed Eagle and Brown Goshawk.
- Honeyeaters – generally very low numbers of honeyeaters throughout the site. This may reflect the seasonal (summer) absence of food resources but may also be driven by the vegetation, generally, appearing to be 'under strain'. Gilbert's Honeyeater confined to the riparian zone along the Serpentine River.
- Red-capped Robin – unusual on the Swan Coastal Plain. A single (juvenile) bird was observed along the southern boundary.
- Scarlet Robin and Grey Shrike-thrush – a single record of each of these species which was an unexpectedly low recording rate.
- Western Thornbill – not recorded despite large area and apparently suitable environment for the species.
- Brush-tailed Phascogale – one seen on a tree-trunk during the nest-tree surveys; once disturbed it took shelter within a tree hollow. A partial skull of a phascogale was also found.
- Chuditch – this species was recorded in Lowlands Nature Reserve by DBCA (2017) but no evidence (e.g. scats, denning logs) of Chuditch were noted in the present survey.
- Quenda – diggings throughout the site but most numerous in wetland areas.
- Brushtail Possum – no individuals seen but a number of trees had scratch marks on their trunks, indicating possum use.
- Western Grey Kangaroo – in high density throughout the reserve and probably putting extensive grazing pressure on the ground cover and understorey vegetation.
- Brush Wallaby (*Notamacropus irma*) – not recorded from the site, despite considerable survey time.
- Introduced ungulates (sheep, goat, deer) – a single (goat), pair (deer) and small flock (up to six, sheep with several years' growth) of these animals were recorded throughout the reserve, likely putting additional grazing pressure on the ground cover and understorey vegetation.

While not the main part of field investigations, the opportunistic fauna records suggest that a number of species are absent or less abundant than was expected. This is particularly the case for a suite of mostly sedentary, insectivorous birds, and the scarcity of observations of ground-dwelling skinks was also notable. This suggest that the fauna assemblage has been adversely impacted by isolation and a long history of degradation (altered fire regime, logging and grazing).

Table 8. Vertebrate species recorded during the field investigations (from January to March 2021 surveys) at the Lowlands site.

Status codes:

CS1, CS2, CS3 = (summary) levels of conservation significance. See Appendix 3 for full explanation.

EPBC Act listings: E = Endangered, V = Vulnerable, M = Migratory (see Appendix 1).

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

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

LS = considered to be of local significance by Bamford Consulting Ecologists (see Appendix 3). All CS3 species are locally significant due to declines across the coastal plain.

Int = introduced species.

Species		Status
Scincidae (Skinks)		
Cryptoblepharus buchananii	Fence Skink	
Tiliqua rugosa rugosa	Bobtail	
Varanidae (Monitors and goannas)		
Varanus gouldii	Bungarra or Sand Goanna	
Elapidae (Venomous land snakes)		
Pseudonaja affinis affinis	Dugite	
Anatidae (Ducks, Geese and Swans)		
Anas superciliosa	Pacific Black Duck	
Columbidae (Pigeons and Doves)		
Phaps chalcoptera	Common Bronzewing	CS3
Ocyphaps lophotes	Crested Pigeon	
Accipitridae (Eagles, Kites, Goshawks)		
Aquila audax	Wedge-tailed Eagle	
Accipiter fasciatus	Brown Goshawk	
Strigidae (Hawk-Owls)		
Ninox novaeseelandiae	Southern Boobook	
Meropidae (Bee-eaters)		
Merops ornatus	Rainbow Bee-eater	
Alcedinidae (Kingfishers)		
Dacelo novaeguineae	Laughing Kookaburra	Int
Cacatuidae (Cockatoos and Corellas)		
Calyptorhynchus banksii naso	Forest Red-tailed Black-Cockatoo	CS1 (V,S3)
Eolophus roseicapilla	Galah	
Psittaculidae (Parrots, Lorikeets and Rosellas)		
Polytelis anthopeplus	Regent Parrot	
Purpureicephalus spurius	Red-capped Parrot	
Barnardius zonarius	Australian Ringneck	

Species		Status
Maluridae (Fairy-wrens, Emu-wrens and Grasswrens)		
Malurus splendens	Splendid Fairy-wren	CS3
Meliphagidae (Honeyeaters and Chats)		
Lichmera indistincta	Brown Honeyeater	
Phylidonyris novaehollandiae	New Holland Honeyeater	CS3
Phylidonyris niger	White-cheeked Honeyeater	CS3
Melithreptus chloropsis	Gilbert's Honeyeater	CS3
Acanthorhynchus superciliosus	Western Spinebill	CS3
Anthochaera lunulata	Western Wattlebird	
Anthochaera carunculata	Red Wattlebird	
Pardalotidae (Pardalotes)		
Pardalotus striatus	Striated Pardalote	
Acanthizidae (Thornbills and Gerygones)		
Gerygone fusca	Western Gerygone	
Smicrornis brevirostris	Weebill	CS3
Sericornis frontalis	White-browed Scrubwren	CS3
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	CS3
Acanthiza apicalis	Inland Thornbill	CS3
Neosittidae (Sittellas)		
Daphoenositta chrysoptera	Varied Sittella	CS3
Campephagidae (Cuckoo-shrikes and Trillers)		
Coracina novaehollandiae	Black-faced Cuckoo-shrike	
Pachycephalidae (Whistlers, Shrike-thrushes and allies)		
Colluricincla harmonica	Grey Shrike-thrush	CS3
Pachycephala rufiventris	Rufous Whistler	
Pachycephala pectoralis occidentalis	Western Whistler	CS3
Artamidae (Woodswallows, Currawongs, Butcherbirds and Magpie)		
Gymnorhina tibicen	Australian Magpie	
Cracticus torquatus	Grey Butcherbird	
Artamus cyanopterus	Dusky Woodswallow	CS3
Rhipiduridae (Fantails)		
Rhipidura leucophrys	Willie Wagtail	
Rhipidura albiscapa	Grey Fantail	
Corvidae (Crows and Ravens)		
Corvus coronoides	Australian Raven	
Monarchidae (Monarch and Flycatchers)		
Grallina cyanoleuca	Magpie-lark	

Species		Status
Petroicidae (Australian Robins)		
Petroica boodang	Scarlet Robin	CS3
Petroica goodenovii	Red-capped Robin	CS3
Hirundinidae (Swallows and Martins)		
Petrochelidon nigricans	Tree Martin	
Zosteropidae (White-eyes)		
Zosterops lateralis	Silvereye	
Tachyglossidae (Echidnas)		
Tachyglossus aculeatus acanthion	Short-beaked Echidna	
Dasyuridae (Dasyurids)		
Phascogale tapoatafa wambenger	Brush-tailed Phascogale, Wambenger	CS1 (S6)
Peramelidae (Bandicoots)		
Isoodon fusciventer	Quenda	CS2 (P4)
Phalangeridae (Brushtail possums)		
Trichosurus vulpecula hypoleucus	Brushtail Possum	
Macropodidae (Kangaroos)		
Macropus fuliginosus melanops	Western Grey Kangaroo	
Leporidae (Rabbits and hares)		
Oryctolagus cuniculus	Rabbit	Int
Canidae (Dogs)		
Vulpes vulpes	Red Fox	Int
Felidae (Cats)		
Felis catus	Cat	Int
Bovidae (Horned ruminants)		
Capra hircus	Goat	Int
Ovis aries	Sheep	Int
Cervidae (Deer)		
Cervus elaphus	Red Deer	Int

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5 Appendices

Appendix 1. Categories used in the assessment of conservation status.

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

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

Schedules used in the WA *Biodiversity Conservation Act 2016*

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

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

Priority 1 (P1)	Taxa with few, poorly known populations on threatened lands.
Priority 2 (P2)	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3 (P3)	Taxa with several, poorly known populations, some on conservation lands.
Priority 4. (P4)	Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.
Priority 5 (P5)	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years (IUCN Conservation Dependent).

Appendix 2. Plants known to be used for foraging, roosting and nesting by black-cockatoos in south-western Western Australia.

Data compiled from the literature (Davies 1966; Saunders 1974, 1979a, b, 1980; Saunders *et al.* 1982; Saunders 1986; Johnstone and Storr 1998; Higgins 1999; Johnstone and Kirkby 1999, 2008; Groom 2011; Johnstone *et al.* 2011; DotE 2017a, b, c).

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

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

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

Plant Species	Plant Status	FRTBC	CBC	BBC
Acacia baileyana (Cootamundra Wattle)	AN		F	
Acacia pentadenia (Karri Wattle)			F	
Acacia saligna (Orange Wattle)			F	
Agonis flexuosa (Peppermint Tree)			F	
Allocasuarina fraseriana (Sheoak)		F		F
Anigozanthos flavidus (Tall Kangaroo Paw)				F
Araucaria heterophylla (Norfolk Island Pine)	E		F	
Banksia ashbyi (Ashby's Banksia)			F	
Banksia attenuata (Slender Banksia)			F	
Banksia baxteri (Baxter's Banksia)			F	
Banksia carlinoides (Pink Dryandra)			F	
Banksia coccinea (Scarlet Banksia)			F	
Banksia dallanneyi (Couch Honeypot Dryandra)			F	
Banksia ericifolia (Heath-leaved Banksia)	AN		F	
Banksia fraseri (Dryandra)			F	
Banksia gardneri (Prostrate Banksia)			F	
Banksia grandis (Bull Banksia)			F	F
Banksia hookeriana (Hooker's Banksia)			F	
Banksia ilicifolia (Holly Banksia)			F	F
Banksia kippistiana (Dryandra)			F	
Banksia leptophylla			F	
Banksia lindleyana (Porcupine Banksia)				F
Banksia littoralis (Swamp Banksia)			F	F
Banksia menziesii (Firewood or Menzie's Banksia)			F	
Banksia mucronulata (Swordfish Dryandra)			F	
Banksia nivea (Honeypot Dryandra)			F	
Banksia nobilis (Golden Dryandra)			F	
Banksia praemorsa (Cut-leaf Banksia)			F	F
Banksia prionotes (Acorn Banksia)			F	
Banksia quercifolia (Oak-leaved Banksia)			F	F
Banksia sessilis (Parrot Bush)			F	F
Banksia speciosa (Showy Banksia)			F	
Banksia squarrosa (Pingle)			F	F

Plant Species	Plant Status	FRTBC	CBC	BBC
Banksia tricuspis (Lesueur Banskia or Pine Banksia)			F	
Banksia undata (Urchin or Cut-leaf Dryandra)			F	
Banksia verticillata (Granite Banksia)			F	
Brassica campestris (Canola, Rape)	E		F	
Callistemon spp.				F
Callistemon viminalis (Captain Cook Bottlebrush)	AN		F	
Callitris sp.			F	
Carya illnoinensis (Pecan)	E		F	F
Casuarina cunninghamiana (River Sheoak)	AN		F	
Citrullus lanatus (Pie or Afghan Melon)	E		F	
Corymbia calophylla (Marri)		F,N	F,n,R	F,n
Corymbia ficifolia (Red Flowering Gum)			F	
Corymbia haematoxylon (Mountain Marri)			F	
Corymbia maculata (Spotted Gum)			R	
Darwinia citriodora (Lemon-scented Darwinia)	AN		F	F
Diospryros sp. (Sweet Persimmon)	E		F	F
Eremophila glabra (Tarbush)			F	
Erodium aureum (Corkscrew Grass or Storksbill)	E		F	
Erodium botrys (Corkscrew Grass or Storksbill)	E		F	F
Eucalyptus caesia (Silver Princess)			F	
Eucalyptus camaldulensis (River Red Gum)	AN		R	
Eucalyptus citriodora (Lemon Scented Gum)	AN	F	F,R	F
Eucalyptus diversicolor (Karri)		n	n	N
Eucalyptus globulus (Tasmaniam Blue Gum)	AN		R	
Eucalyptus gomphocephala (Tuart)		n	F,n,R	
Eucalyptus grandis (Flooded Gum, Rose Gum)	AN		R	
Eucalyptus longicornis (Red Morrell)			n	
Eucalyptus loxophleba (York Gum)			F,n	
Eucalyptus marginata (Jarrah)		F,N	F,n,R	F
Eucalyptus megacapa (Bullich)		n		n
Eucalyptus occidentalis (Swamp Yate)			n	
Eucalyptus patens (Blackbutt)		F	F,R	
Eucalyptus pleurocarpa (Tallerack)			F	
Eucalyptus preissiana (Bell-fruited Mallee)			F	
Eucalyptus robusta (Swamp Mahogany)			F,R	
Eucalyptus rudis (Flooded Gum)			R	
Eucalyptus salmonophloia (Salmon Gum)			F,N	
Eucalyptus salubris (Gimlet)			n	
Eucalyptus todtiana (Coastal Blackbutt or Prickley Bark)			F	
Eucalyptus wandoo (Wandoo)			F,N,R	F,n
Ficus sp. (Fig)			F	
Grevillea armigera (Prickly Toothbrushes)			F	
Grevillea bipinnatifida (Fuschia Grevillea)			F	
Grevillea hookeriana (Red Toothbrushes)			F	

Plant Species	Plant Status	FRTBC	CBC	BBC
Grevillea hookeriana subsp. *apiciloba* (Black Toothbrushes)			F	
Grevillea paniculata (Kerosene Bush)			F	
Grevillea paradoxa (Bottlebrush Grevillea)			F	
Grevillea petrophiloides (Pink Poker)			F	
Grevillea robusta (Silky Oak)			F	
Grevillea wilsonii (Native Fuchsia)				F
Hakea auriculata			F	
Hakea candolleana			F	
Hakea circumalata (Coastal Hakea)			F	
Hakea commutata			F	
Hakea conchifolia			F	
Hakea costata (Ribbed Hakea)			F	
Hakea cristata (Snail Hakea)			F	F
Hakea cucullata (Snail Hakea)			F	
Hakea cyclocarpa (Ramshorn)			F	
Hakea eneabba			F	
Hakea erinacea (Hedgehog Hakea)			F	F
Hakea falcata (Sickle Hakea)			F	
Hakea flabellifolia (Fan-leaved Hakea)			F	
Hakea gilbertii			F	
Hakea incrassata (Golfball or Marble Hakea)			F	
Hakea lasiantha (Woolly Flowered Hakea)			F	
Hakea lasianthoides			F	F
Hakea laurina (Pin-cushion hakea)			F	
Hakea lissocarpha (Honeybush)			F	F
Hakea marginata				F
Hakea megalosperma (Lesueur Hakea)			F	
Hakea multilineata (Grass Leaf Hakea)			F	
Hakea obliqua (Needles and Corks)			F	
Hakea oleifolia (Dungyn or Olive-leaved Hakea)			F	
Hakea pandanicarpa subsp. *crassifolia* (Thick-leaved Hakea)			F	
Hakea petiolaris (Sea Urchin Hakea)			F	
Hakea polyanthema			F	
Hakea preissii (Needle Tree)			F	
Hakea prostrata (Harsh Hakea)			F	F
Hakea psilorrhyncha			F	
Hakea ruscifolia (Candle Hakea)			F	F
Hakea scoparia (Kangaroo Bush)			F	
Hakea smilacifolia			F	
Hakea spathulata			F	
Hakea stenocarpa (Narrow-fruited Hakea)			F	F
Hakea sulcata (Furrowed Hakea)			F	

Plant Species	Plant Status	FRTBC	CBC	BBC
Hakea trifurcata (Two-leaved Hakea)			F	F
Hakea undulata (Wavy-leaved Hakea)			F	
Hakea varia (Variable-leaved Hakea)			F	F
Helianthus annuus (Sunflower)	E		F	
Hibiscus sp. (Hibiscus)	E		F	
Isopogon scabriusculus			F	
Jacaranda mimosifolia (Jacaranda)	E		F	F
Jacksonia furcellata (Grey Stinkwood)			F	
Kingia australis (Kingia)				F
Lambertia inermis (Chittick)			F	
Lambertia multiflora (Many-flowered Honeysuckle)			F	
Liquidamber styraciflua (Liquid Amber)	E		F	
Lupinus sp. (Lupin)	E		F	
Macadamia integrifolia (Macadamia)	E		F	F
Malus domestica (Apple)	E		F	F
Melaleuca leuropoma			F	
Melia azedarach (Cape Lilac or White Cedar)	E	F	F	
Mesomeleana sp.			F	
Persoonia longifolia (Snottygobble)		F		
Pinus canariensis (Canary Island Pine)	E		F	
Pinus caribea (Caribbean Pine)	E		F	
Pinus pinaster (Pinaster or Maritime Pine)	E		F,R	
Pinus radiata (Radiata Pine)	E		F,R	F
Protea 'Pink Ice'	E		F	
Protea repens	E		F	
Prunus amygdalus (Almond Tree)	E		F	
Pyrus communis (European Pear)	E			F
Quercus spp. (Oak spp.)	E			F
Raphanus raphanistrum (Wild Radish)	E		F	
Reedia spathacea				F
Tipuana tipu (Tipu or Rosewood Tree)	E		F	
Xanthorrhoea preissii (Grass Tree)			F	F

Appendix 3. Explanation of fauna values.

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

Assemblage characteristics

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

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

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

Vegetation and substrate associations (VSAs)

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

Because VSAs provide the habitat for fauna, they are important in determining assemblage characteristics. For the purposes of impact assessment, VSAs can also provide a surrogate for detailed information on the fauna assemblage. For example, rare, relictual or restricted VSAs should automatically be considered a significant fauna value. Impacts may be significant if the VSA is rare, a large proportion of the VSA is affected and/or the VSA supports significant fauna. The disturbance of even small amounts of habitat in a localised area can have significant impacts to fauna if rare or unusual habitats are disturbed.

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

- soil type and characteristics

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

Patterns of biodiversity across the landscape

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

Species of conservation significance

Species of conservation significance are of special importance in impact assessment. The conservation status of fauna species in Australia is assessed under Commonwealth and State Acts such as the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Western Australian *Biodiversity Conservation Act 2016* (BC Act). In addition, the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA) recognises priority levels, while local populations of some species may be significant even if the species as a whole has no formal recognition. Therefore, three broad levels of conservation significance can be recognised and are used for the purposes of this report, and are outlined below. A full description of the conservation significance categories, schedules and priority levels mentioned below is provided in
Appendix 1.

<u>Conservation Significance (CS) 1: Species listed under State or Commonwealth Acts</u>.

Species listed under the EPBC Act are assigned to categories recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN 2012), or are listed as migratory. Migratory species are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA), the Republic of South Korea Australia Migratory Bird Agreement (ROKAMBA), and/or the Convention on the Conservation of Migratory Species of Wild Animals (CMS; also referred to as the Bonn Convention). The *Wildlife Conservation Act 1950* uses a series of seven Schedules to classify conservation status that largely reflect the IUCN categories (IUCN 2012).

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

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

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

This level of significance has no legislative or published recognition and is based on interpretation of distribution information, but is used here as it may have links to preserving biodiversity at the genetic level (EPA 2002). If a population is isolated but a subset of a widespread (common) species, then it may not be recognised as threatened, but may have unique genetic characteristics. Conservation significance is applied to allow for the preservation of genetic richness at a population level, and not just at a species level. Species on the edge of their range, or that are sensitive to impacts such as habitat fragmentation, may also be classed as CS3, as may colonies of waterbirds. The Western Australian Department of Environmental Protection, now DBCA, used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of the Perth Bushplan (DEP 2000).

Marine-listed species

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

Invertebrates

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

Introduced species

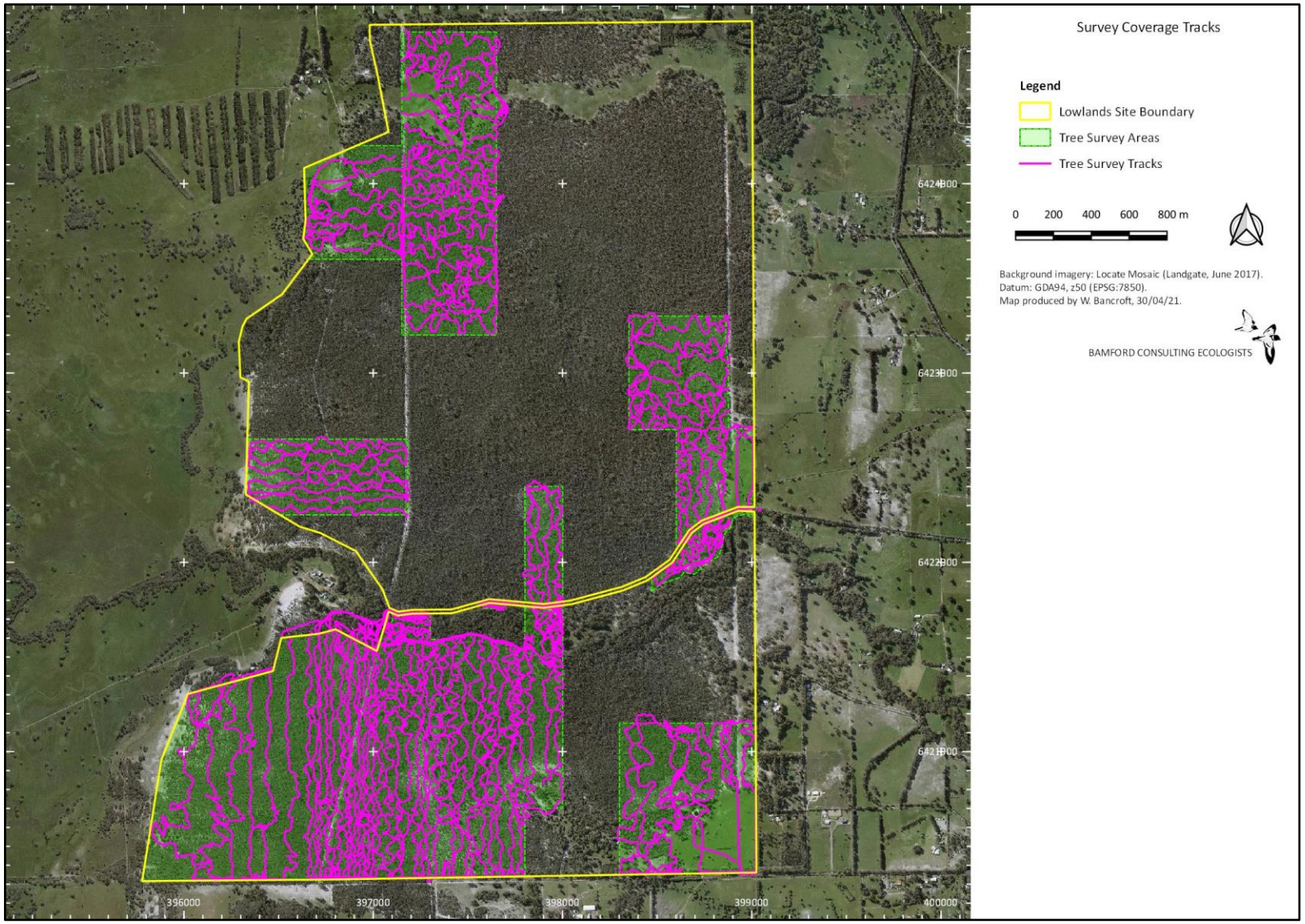
In addition to these conservation levels, species that have been introduced (INT) are indicated throughout the report. Introduced species may be important to the native fauna assemblage through effects by predation and/or competition.

Ecological processes upon which the fauna depend

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

Appendix 7 are effectively the ecological processes that can be altered to result in impacts upon fauna.

Appendix 4. Survey track logs.



Appendix 5. Scoring system for the assessment of foraging value of vegetation for Black-Cockatoos.

Bamford Consulting Ecologists
Revised 4th April 2021

Introduction

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

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

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

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

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

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

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

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

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

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

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
0	No foraging value. No Proteaceae, eucalypts or other potential sources of food. Examples: • Water bodies (e.g. salt lakes, dams, rivers); • Bare ground; • Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits) or with vegetation of no food value, such as some suburban landscapes. • Mown grass	No foraging value. No eucalypts or other potential sources of food. Examples: • Water bodies (e.g. dams, rivers); • Bare ground; • Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits).	No foraging value. No eucalypts or other potential sources of food. Examples: • Water bodies (e.g. dams, rivers); • Bare ground; • Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits).
1	Negligible to low foraging value. Examples: • Scattered specimens of known food plants but projected foliage cover of these is < 2%. This could include urban areas with scattered foraging trees; • Paddocks that are lightly vegetated with melons or other known food-source weeds (e.g. *Erodium* spp.) that represent a short-term and/or seasonal food source; • Blue Gum plantations (foraging by Carnaby's Black-Cockatoos has been reported but appears to be unusual).	Negligible to low foraging value. Scattered specimens of known food plants but projected foliage cover of these < 1%. This could include urban areas with scattered foraging trees.	Negligible to low foraging value. Scattered specimens of known food plants but projected foliage cover of these < 1%. Could include urban areas with scattered foraging trees.

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
2	Low foraging value. Examples: • Shrubland in which species of foraging value, such as shrubby banksias, have < 10% projected foliage cover; • Woodland with tree banksias 2-5% projected foliage cover; • Woodland with tree banksias (of key species *B. attenuata* and *B. menziesii*) with <10% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Open eucalypt woodland/mallee of small-fruited species; • Paddocks that are densely vegetated with melons or other known food-source weeds (e.g. *Erodium* spp.) that represent a short-term and/or seasonal food source.	Low foraging value. Examples: • Woodland with scattered specimens of known food plants (e.g. Marri and Jarrah) 1-5% projected foliage cover; • Marri-Jarrah Woodland with <10% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Parkland-cleared Eucalypt Woodland/Forest with known food plants <10% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants <10% projected foliage cover (establishing food sources with good long-term viability); • Urban areas with scattered foraging trees.	Low foraging value. Examples: • Woodland with scattered specimens of known food plants (e.g. Marri, Jarrah) 1-5% projected foliage cover; • Marri-Jarrah Woodland with <10% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Sheoak Woodland with <10% projected foliage cover; • Parkland-cleared Eucalypt Woodland/Forest with known food plants <10% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants <10% projected foliage cover (establishing food sources with good long-term viability); • Urban areas with scattered food plants such as Cape Lilac, *Eucalyptus caesia* and *E. erythrocorys*.

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
3	Low to Moderate foraging value. Examples: • Shrubland in which species of foraging value, such as shrubby banksias, have 10-20% projected foliage cover; • Woodland with tree banksias 5-20% projected foliage cover; • Woodland with tree banksias (of key species *B. attenuata* and *B. menziesii*) with 10-40% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Eucalypt Woodland/Mallee of small-fruited species; • Eucalypt Woodland with Marri < 10% projected foliage cover.	Low to Moderate foraging value. Examples: • Eucalypt Woodland with known food plants (especially Marri) 5-20% projected foliage cover; • Marri-Jarrah Woodland with 10-40% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Parkland-cleared Eucalypt Woodland/Forest with known food plants 10-40% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants 10-40% projected foliage cover (establishing food sources with good long-term viability).	Low to Moderate foraging value. Examples: • Eucalypt Woodland with known food plants (especially Marri and Jarrah) 5-20% projected foliage cover; • Marri-Jarrah Woodland with 10-40% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Sheoak Forest with 10-40% projected foliage cover; • Parkland-cleared Eucalypt Woodland/Forest with known food plants 10-40% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants 10-40% projected foliage cover (establishing food sources with good long-term viability).

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
4	Moderate foraging value. Examples: • Woodland/low forest with tree banksias (of key species *B. attenuata* and *B. menziesii*) 20-40% projected foliage cover; • Woodland/low forest with tree banksias (of key species *B. attenuata* and *B. menziesii*) with 40-60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Kwongan/ Shrubland in which species of foraging value, such as shrubby banksias, have 20-40% projected foliage cover; • Eucalypt Woodland/Forest with Marri 20-40% projected foliage cover.	Moderate foraging value. Examples: • Marri-Jarrah Woodland/Forest with 20-40% projected foliage cover; • Marri-Jarrah Forest with 40-60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Parkland-cleared Eucalypt Woodland/Forest with known food plants 40-60% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants 40-60% projected foliage cover (establishing food sources with good long-term viability); • Orchards with highly desirable food sources (e.g. apples, pears, some stone fruits).	Moderate foraging value. Examples: • Marri-Jarrah Woodland/Forest with 20-40% projected foliage cover; • Marri-Jarrah Forest with 40-60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Sheoak Forest with 40-60% projected foliage cover; • Parkland-cleared Eucalypt Woodland/Forest with known food plants 40-60% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants 40-60% projected foliage cover (establishing food sources with good long-term viability).

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
5	Moderate to High foraging value. Examples: • Banksia Low Forest (of key species *B. attenuata* and *B. menziesii*) with 40-60% projected foliage cover; • Banksia Low Forest (of key species *B. attenuata* and *B. menziesii*) with > 60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Kwongan/ Shrubland in which species of foraging value, such as shrubby banksias, have 40-60% projected foliage cover; • Marri-Jarrah Forest with 40-60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term). • Pine plantations with trees more than 10 years old (but see pine note below in moderation section).	Moderate to High foraging value. Examples: • Marri-Jarrah Forest with 40-60% projected foliage cover; • Marri-Jarrah Forest with > 60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Parkland-cleared Eucalypt Woodland/Forest with known food plants >60% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants >60% projected foliage cover (establishing food sources with good long-term viability).	Moderate to High foraging value. Examples: • Marri-Jarrah Forest with 40-60% projected foliage cover; • Marri-Jarrah Forest with > 60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Sheoak Forest with > 60% projected foliage cover; • Parkland-cleared Eucalypt Woodland/Forest with known food plants >60% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants >60% projected foliage cover (establishing food sources with good long-term viability).

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
6	High foraging value. Example: • Banksia Low Forest (of key species *B. attenuata* and *B. menziesii*) with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term). • Kwongan/ Shrubland in which species of foraging value, such as shrubby banksias, have >60% projected foliage cover; • Marri-Jarrah Forest with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term).	High foraging value. Example: • Marri-Jarrah Forest with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term).	High foraging value. Example: • Marri-Jarrah Forest with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term).

Vegetation structural class terminology follows Keighery (1994).

B. Site context.

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

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

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

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

C. Species density (stocking rate).

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

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

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

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

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

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

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

Pine plantations

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

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

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

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

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

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

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

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

Active/Recent ↔ Intermediate ↔ Old

Jarrah nuts

Jarrah leaves

Marri nuts

Appendix 7. Great Cocky Count (BirdLife Australia) roost locations (and annual count data) within 12 km of the Lowlands site.

Carnaby's Black-Cockatoo

Site	Site category	Latitude (°)	Longitude (°)	N surveys	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
KWICASR001	joint	-32.2336	115.8672	6	2	.	.	0	19	.	.	0	59	0
KWIWELR001	joint	-32.2593	115.8120	8	.	.	15	50	0	62	0	0	4	40
KWIWELR002	confirmed roost	-32.2656	115.8107	2	.	.	.	.	.	.	.	.	4	133
KWIWELR003	FRT	-32.2694	115.8204	2	.	.	.	.	.	.	.	.	0	0
ROCBALR001	CLEARED	-32.3658	115.7992	1	346	.	.	.	.	.	.	.	.	.
ROCBALR003	joint	-32.3653	115.8161	8	.	78	0	4	0	0	0	.	0	0
ROCBALR004	confirmed roost	-32.2969	115.8056	6	.	40	0	0	0	.	0	0	.	.
SERJARR002	FRT	-32.3080	116.0090	3	.	.	.	.	.	.	.	0	0	0
SERJARR004	FRT	-32.3303	116.0355	1	.	.	.	.	.	.	.	.	.	0
SERKEYR004	FRT	-32.4318	115.9299	3	.	.	.	.	.	.	.	0	0	0
SERMUNR002	joint	-32.3030	115.9930	3	.	.	.	.	.	.	10	12	.	0
SEROAKR001	confirmed roost	-32.2339	115.8858	6	0	110	.	0	0	.	.	0	0	.
SEROAKR002	joint	-32.2311	115.9069	7	0	0	0	2	.	.	.	0	0	0
SEROAKR003	confirmed roost	-32.2292	115.8853	8	167	0	0	0	0	0	.	.	0	0
SERSERR003	FRT	-32.3553	115.9922	6	.	.	.	.	0	0	0	0	0	0
SERSERR005	FRT	-32.3510	115.9900	3	.	.	.	.	.	.	0	0	0	.
SERSERR008	joint	-32.3831	116.0161	1	.	.	.	.	.	.	.	.	.	23
SERWELR002	confirmed roost	-32.2553	115.8800	3	.	.	.	.	.	.	.	298	75	0
SERWHIR001	confirmed roost	-32.2900	116.0060	2	.	.	.	.	.	.	34	.	56	.

Forest Red-tailed Black-Cockatoo

Site	Site category	Latitude (°)	Longitude (°)	N surveys	2014	2015	2016	2017	2018	2019
KWICASR001	joint	-32.2336	115.8672	4	0	.	.	75	16	0
KWIWELR001	joint	-32.2593	115.8120	6	0	0	9	0	0	0
KWIWELR002	confirmed roost	-32.2656	115.8107	2	.	.	.	.	0	0
KWIWELR003	FRT	-32.2694	115.8204	2	.	.	.	.	14	0
ROCBALR001	CLEARED	-32.3658	115.7992	0	.	.	.	.	.	.
ROCBALR003	joint	-32.3653	115.8161	5	17	25	24	.	45	65
ROCBALR004	confirmed roost	-32.2969	115.8056	3	0	.	0	0	.	.
SERJARR002	FRT	-32.3080	116.0090	3	.	.	.	7	0	0
SERJARR004	FRT	-32.3303	116.0355	1	.	.	.	.	.	45
SERKEYR004	FRT	-32.4318	115.9299	3	.	.	.	14	26	9
SERMUNR002	joint	-32.3030	115.9930	3	.	.	0	4	.	0
SEROAKR001	confirmed roost	-32.2339	115.8858	3	0	.	.	0	0	.
SEROAKR002	joint	-32.2311	115.9069	3	.	.	.	4	15	0
SEROAKR003	confirmed roost	-32.2292	115.8853	4	0	0	.	.	0	0
SERSERR003	FRT	-32.3553	115.9922	6	0	0	3	0	9	3
SERSERR005	FRT	-32.3510	115.9900	3	.	.	12	0	4	.
SERSERR008	joint	-32.3831	116.0161	1	.	.	.	.	.	41
SERWELR002	confirmed roost	-32.2553	115.8800	3	.	.	.	0	0	0
SERWHIR001	confirmed roost	-32.2900	116.0060	2	.	.	0	.	0	.

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Appendix D – WA Offsets Template

WA Offsets Template - Project Name: METRONET Byford Rail Extension

Existing environment / Impact	Mitigation			Significant Residual Impact	Offset				
	Avoid and minimise	Rehabilitation Type	Likely Rehab Success		Type	Risk	Likely offset success	Time Lag	Offset Quantification
GHD (2021) mapped approximately 16.91 ha of TEC *Corymbia calophylla - Kingia australis* woodlands on heavy soils (SCP3a) within the local area of the Proposal. The existing railway line already intersects the patch of SCP 3a at Lambert Lane Nature Reserve and Fletcher Park. Clearing within the Footprint will be limited to the edges of SCP3a mapped within Fletcher Park and will mostly avoid SCP3a mapped at Lambert Lane Nature Reserve. The Proposal will clear up to 1.91 ha of SCP3a at this location. GHD (2021) mapped a 1.08 ha occurrence of SCP3a within the existing rail corridor south of Thomas Road. SCP3a is limited to vegetation on both sides of the railway line at this location. As this SCP3a occurrence is within the rail corridor direct impact is unavoidable. Proposed clearing will impact on 0.92 ha of SCP3a at this location. During the assessment some impacted vegetation mapped as SCP3a was reclassified as SCP3c.	The PTA has designed the Proposal to avoid areas of SCP Type 3 vegetation where possible and minimise impacts to this community through narrowing the Footprint width as far as practicable. Clearing has been limited to the edges at Fletcher Park and Lambert Lane. The Footprint was designed to avoid clearing SCP3a in Excellent condition. Use already cleared land for access tracks and set-down areas.	On-site rehabilitation of SCP3a or SCP3c is not possible due to location of permanent infrastructure.	NA	Extent 2.26 ha of SCP3a 0.48 ha of SCP3c Quality SCP3a - Good or better condition (2.03 ha, 72%) SCP3c - Good or better condition (0.22 ha, 46%) Conservation Significance High significance - the impacts are to vegetation listed as Endangered under the EPBC Act and assessed as Critically Endangered by the WA Threatened Ecological Communities Advisory Committee. Land Tenure Rail Reserve Reserve (Fletcher Park) Time Scale Permanent As per the significance framework, the residual impact is significant as the impacts are on vegetation listed as Endangered under the EPBC Act and assessed as Critically Endangered by the WA Threatened Ecological Communities Advisory Committee. Data obtained from the DBCA indicates there is approximately 194 ha of SCP3a across its range however GHD (2021) mapped additional extents of 4.01 ha. The Proposal will clear 2.26 ha of SCP3a or 1.16% of the DBCA mapped extents. Data obtained from the DBCA indicates there is approximately 113 ha of SCP3c remaining across its range. The Proposal will clear 0.48 ha of SCP3c or 0.42% of the DBCA mapped extents.	On-ground management. Revegetation.	Low risk. Sites are DBCA or LGA managed land (low risk).	What is the type of vegetation being revegetated? TEC *Corymbia calophylla - Kingia australis* woodlands on heavy soils (SCP3a). TEC *Corymbia calophylla - Xanthorrhoea preissii* woodlands and shrublands (SCP3c). Revegetation will use species that occur within the TEC, however creating to the floristic community type level is not guaranteed. The overall aim of the revegetation will be to provide a buffer to the existing extent of the TEC occurrence. Can the values being offset be defined and measured? Yes - vegetation condition and extent can be measured. Can the environmental values be rehabilitated? Evidence? The LGA undertook successful rehabilitation of SCP3a in Fletcher Park (ENV 2010). The PTA have been advised by consultants and the DBCA that restoration of SCP3a or SCP3c in areas in poor condition is unlikely to be successful. Revegetation of native vegetation within Degraded areas within occurrences of SCP3a or SCP3c will provide good conservation outcomes for the TEC. Operator experience in undertaking action? DBCA/LGAs are experienced land managers. Revegetation or on-ground activities may be undertaken in house, by local land care groups, contractors or consultants. The PTA will ensure a suitable operator is engaged to undertake onground management and revegetation works.	1-5 years for management actions. 1-3 years for revegetation. 1-3 years for changes in tenure.	The PTA will offset 3.3 ha of SCP3a at Lambert Lane Nature Reserve and 6.5 ha of SCP3a at Brickwood Reserve. The PTA will offset 3.0 ha of SCP3c at Roman Road Nature Reserve. Offset extents have been calculated using the Commonwealth Offsets Assessment Guide.
Across the Development Envelope and Footprint there are large amounts of negligible value foraging habitat for all three black cockatoo species. The best foraging value for all three species is within the Eucalypt woodland to forest, which provides 13.5 ha of foraging habitat within the Development Envelope. The loss of 61.1 ha of forest red-tailed black cockatoo foraging habitat overlaps with 19.3 ha of Carnaby's cockatoo foraging habitat and 8.7 ha of Baudin's cockatoo habitat. 336 potential black cockatoo breeding trees have been recorded within the Development Envelope. Of these, 139 (41.4%) may be removed within the Footprint. The 139 potential breeding trees within the Footprint are comprised of 131 (94.4%) potential breeding trees with no hollows, and eight (5.8%) potential breeding trees with hollows.	The Footprint has been selected in order to minimise the extent of clearing of fauna habitats as far as practicable. The PTA will ensure that any landscaping or revegetation undertaken will select species that do not encourage black cockatoos to forage or roost in close proximity to the railway. The Proposal was designed to place the temporary construction areas within existing cleared or Completely Degraded areas adjacent or near the rail corridor wherever practicable.	Areas cleared for the Proposal, that are no longer required for future infrastructure or management access, will be revegetated, with consideration for operational safety requirements.	Rehabilitation will be undertaken using appropriate locally endemic native species. Disturbance following construction will be kept to a minimum and therefore it is considered the rehabilitation will be successful.	Extent 61.1 ha of black cockatoo foraging habitat comprising: 61.1 ha of forest red-tailed black cockatoo foraging habitat, comprised of 8.7 ha of moderate to high value foraging habitat and 52.5 ha of low value foraging habitat 19.3 ha of Carnaby's cockatoo foraging habitat, comprised of 8.7 ha of moderate value foraging habitat and 10.7 ha of low value foraging habitat 8.7 ha of Baudin's cockatoo habitat, classified entirely as moderate value foraging habitat 139 black cockatoo potential breeding trees Quality Low to moderate-high. Conservation Significance High significance - Carnaby's and Baudin's cockatoos are listed as Endangered and forest red-tailed black cockatoos are listed as Vulnerable under the EPBC Act and BC Act. Land Tenure Rail Reserve Time Scale Permanent As per the significance framework, the residual impact is significant as the impacts are on habitat for species listed as Endangered or Vulnerable under the EPBC Act and the BC Act.	On-ground management at the Lowlands Nature Reserve offset site.	Low risk. The site has been acquired by the State as an advanced offset and allocated to the PTA to offset METRONET projects. The site classified as a Class A Reserve, Bush Forever Site. The DBCA are the land managers.	What is the type of vegetation being offset or revegetated? Black cockatoo foraging habitat and potential breeding trees. Can the values being offset be defined and measured? Yes - black cockatoo foraging habitat quality and extent and potential breeding trees can be measured. Operator experience in undertaking action? The DBCA is an experienced land manager. A reserve officer has been appointed to co-ordinate management actions. On-ground activities may be undertaken in house, by local land care groups, contractors or consultants.	No time lag. The site was protected when it was acquired by the State from a private land owner. On-ground management will be funded for 7 years.	The PTA will offset 232.5 ha of forest red-tailed, 78.8 ha of Carnaby's and 70.6 ha of Baudin's cockatoo foraging habitat at the Lowlands Nature Reserve offset site. Offset extents have been calculated using the Commonwealth Offsets Assessment Guide. The PTA will offset 417 black cockatoo potential breeding trees at the Lowlands Nature Reserve offset site. This has been calculated at a 3:1 ratio. Lowlands contains overlapping foraging and breeding tree habitats for black cockatoos so these extents will overlap.

WA Offsets Template - Project Name: METRONET Byford Rail Extension

Existing environment / Impact	Mitigation			Significant Residual Impact	Offset				
	Avoid and minimise	Rehabilitation Type	Likely Rehab Success		Type	Risk	Likely offset success	Time Lag	Offset Quantification
A total of 114 ha of mapped geomorphic wetlands are intersected by the Development Envelope. Wetlands within and adjacent to the Development Envelope have generally been altered through historical clearing and modification of hydrology. The Proposal will require the disturbance of up to 55.4 ha of mapped geomorphic wetlands within the Footprint. This includes the loss of 3.5 ha of CCW including 2.6 ha of CCW retaining conservation values and 0.9 ha of CCW identified as being significantly altered and no longer representative of the CCW management category; and the loss of 51.9 ha of MUW. Of the 51.9 ha of MUW to be disturbed for the Proposal, 11.7 ha contains native vegetation mapped in Good to Completely Degraded Condition. Of the 3.5 ha of CCW to be disturbed for the Proposal, 1.2 ha contains native vegetation in Good to Excellent condition and 1.3 ha in Degraded and Completely Degraded condition.	The Proposal design has been developed in order to avoid clearing of CCW wherever practicable. Investigate opportunities during detailed design and construction planning to reduce impacts on CCWs and MUWs further. Maintain existing vegetation along Wungong Brook and around wetlands in as an undisturbed state as possible to provide a buffer against disturbance of the wetland.	Rehabilitate disturbance associated with the removal of the existing pylon in Wungong Brook.	Rehabilitation will be undertaken using appropriate locally endemic native species. Disturbance following construction will be kept to a minimum and therefore it is considered the rehabilitation will be successful.	Extent 2.6 ha of conservation category wetlands Quality NA Conservation Significance CCWs are wetlands which support a high level of attributes and functions and are considered significant at State level. Due to the disturbance of wetlands in the local areas, wetlands containing intact native vegetation and ecosystems retain wetland values and are of elevated conservation significance. Land Tenure Rail Reserve Time Scale Permanent As per the significance framework, the residual impact is significant as the impacts are on wetlands listed by the State as the highest priority for protection.	On-ground management. Revegetation.	Low risk. Sites are DBCA or LGA managed land (low risk).	What is the type of vegetation being offset or revegetated? Conservation category wetlands. Can the values being offset be defined and measured? Yes - wetland values can be measured. Can the environmental values be rehabilitated? Evidence? NA Operator experience in undertaking action? DBCA/LGAs are experienced land managers. Revegetation or on-ground activities may be undertaken in house, by local land care groups, contractors or consultants. The PTA will ensure a suitable operator is engaged to undertake revegetation works.	1-5 years for management actions. 1-3 years for revegetation. 1-3 years for changes in tenure.	To offset impacts to 2.6 ha of conservation category wetlands the PTA will offset 7.8 ha with the SCP3a offsets. This has been calculated using a 3:1 ratio.
The Proposal will result in clearing of up to 15.99 ha of native vegetation across the Forrestfield and Guildford complexes. The Forrestfield and Guildford complexes have limited remaining extents at all scales. The complexes are already below, or close to the now rescinded 10% target the EPA used as a guide for retention of vegetation complexes within constrained areas of the SCP (EPA 2008). The Proposal would result in further small reductions (1.66 ha or less) in the already limited extents of these complexes, reducing their current extents by 0.18% or less at all scales. The Proposal will result in the permanent loss of 1.59 ha of vegetation associated with Bush Forever sites no. 264 (1.29 ha), 266 (0.21 ha) and 350 (0.04 ha). The Proposal will result in the permanent loss of 0.68 ha of vegetation assocaited with Guildford Complex.	The Proposal was designed to prioritise placement within existing linear infrastructure corridors where practicable, avoiding clearing of native vegetation within the Bush Forever sites. The PTA has designed the Proposal to avoid vegetation within Bush Forever where possible. Construction and operational access tracks will be designed to coincide with existing tracks or aligned along cleared areas where practicable.	Areas cleared for the Proposal will be revegetated where not required for permanent infrastructure or management access with consideration for operational safety requirements.	Rehabilitation will be undertaken using appropriate locally endemic native species. Disturbance following construction will be kept to a minimum and therefore it is considered the rehabilitation will be successful.	Extent 1.54 ha of Bush Forever 0.68 ha of Guildford Complex Quality Bush Forever - Excellent to Degraded Guildford Complex - Degraded Conservation Significance High significance - the impacts are to vegetation listed by the State as Bush Forever, which is considered to be regionally significant bushland. Guildford Complex has less than 10% of its pre-European extent remaining on the SCP. Land Tenure Rail Reserve Time Scale Permanent As per the significance framework, the residual impact is significant as the impacts are on Bush Forever, listed by the State as regionally significant bushland.	On-ground management. Revegetation.	Low risk. Sites are DBCA or LGA managed land (low risk).	What is the type of vegetation being offset or revegetated? Native vegetation. Can the values being offset be defined and measured? Yes - vegetation condition and extent can be measured. Can the environmental values be rehabilitated? Evidence? NA Operator experience in undertaking action? DBCA/LGAs are experienced land managers. Revegetation or on-ground activities may be undertaken in house, by local land care groups, contractors or consultants. The PTA will ensure a suitable operator is engaged to undertake on-ground management and revegetation works.	1-5 years for management actions. 1-3 years for revegetation. 1-3 years for changes in tenure.	To offset impacts to 1.54 ha Bush Forever the PTA will offset 3.08 ha with the SCP3a and/or SCP3c offsets. To offset impacts to 0.68 ha of Guildford Complex the PTA will offset 1.36 ha. This has been calculated using a 2:1 ratio based on SPP 2.8.