

s. 22(1)(a)(ii)

From: s. 22(1)(a)(ii)
Sent: Monday, 20 April 2020 9:26 AM
To: s. 47F(1) s. 22(1)(a)(ii) s. 47F(1)
Cc: s. 47F(1)
Subject: RE: Malaga to Ellenbrook Rail Works Proposal - Schedule Update Meeting Actions [SEC=UNOFFICIAL]

Hello **s. 47F(1)**

A few adjustments to your notes below.

Regards

s. 22(1)(a)(ii)

From: s. 47F(1) @metronet.wa.gov.au>
Sent: Friday, 17 April 2020 4:39 PM
To: s. 47F(1) @metronet.wa.gov.au>; s. 47F(1) @pta.wa.gov.au>;
s. 22(1)(a)(ii) @awe.gov.au; s. 22(1)(a)(ii) @awe.gov.au>; s. 47F(1) @mainroads.wa.gov.au>; s. 47F(1) @mainroads.wa.gov.au>
Cc: s. 47F(1) @metronet.wa.gov.au>; s. 47F(1) @pta.wa.gov.au>
Subject: Malaga to Ellenbrook Rail Works Proposal - Schedule Update Meeting Actions

Hello

Thank you for attending the Tuesday 14 April 2020 meeting 10:30-11:00 am to discuss the accelerated schedule for the METRONET Malaga to Ellenbrook Rail Works Proposal. I have summarised the meeting actions below, noting that some of these actions are subject to discussions with EPA Services, Ministers and the Delegate.

Actions

Commonwealth to discuss with EPA Services an accelerated process where the PTA emails assessment documents directly to the Commonwealth and EPA Services to enable parallel processing and early and efficient provision of Commonwealth comments to the State and PTA .
PTA to provide detailed and complete information in relation to MNES in assessment documentation. The PTA can seek additional advice from s. 22(1)(a)(ii) and s. 47F(1) on what is required for assessment under the EPBC Act.
Commonwealth to discuss the Proposal with the post assessment branch and confirm the approach to condition the development of an Offsets Strategy to enable offsets to meet the needs of both the State and the Commonwealth . Please note that PTA will need to consult the State about their offset requirements.
PTA to organise a workshop with Commonwealth/State (DAWE/DBCA/DWER) to discuss offsets. This workshop will need to be focused and targeted to very specific issues that can not be dealt with outside of the normal assessment process.
Regular meetings with DAWE/PTA/MR will be held – these should be on a needs basis and must be focused with specific topics to discuss that can not be managed through normal email exchanges.
Continue regular fortnightly emails between PTA and DAWE.
DAWE to provide recent examples of similar Proposals with similar MNES to PTA. DAWE has some examples for some of the more novel species (eg Carter's mussel) being assessed for this proposal, however it was not meant that DAWE has proposals that are similar to the Morley Ellenbrook proposal. The closest are the PTA's own Yanchep and the Thornley Coburn proposals.
PTA to provide final Development Envelope to DAWE for discussion on approach to variation.

If you have any changes/additional actions please let me know by Monday COB and I will recirculate the final actions list.

Kind regards

s. 47F(1)

Senior Environmental Officer



one40 William Street, Perth WA 6000

Tel: s. 47F(1) | Web: www.metronet.wa.gov.au

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s. 22(1)(a)(ii)

From: s. 47F(1) @pta.wa.gov.au>
Sent: Thursday, 23 April 2020 4:55 PM
To: s. 22(1)(a)(ii)
Cc: s. 47F(1)
Subject: Advanced Offset Proposal Black Cockatoo Research
Attachments: Advanced Offset Proposal Black Cockatoo Research - s. 22(1)(a)(ii).pdf

Good afternoon

Please find attached a letter seeking the Departments in principle endorsement to the PTA's proposal to pursue a Murdoch University Black Cockatoo research project as an proportional indirect advanced offset for the PTA's Malaga to Ellenbrook rail works.

If you have any queries regarding the letter please do not hesitate to contact me.

Best Regards

s. 47F(1)

Environmental Officer | Infrastructure Planning and Land Services

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Government of Western Australia
Public Transport Authority

Your ref 2019/8546

Our ref A5202560

Enquiries [s. 47F\(1\)@pta.wa.gov.au](mailto:s.47F(1)@pta.wa.gov.au)

23 April 2020

s. 22(1)(a)(ii)

Assistant Director
Department of the Environment Water, Heritage & Arts
GPO Box 787
CANBERRA ACT 2601

Dear **s. 22(1)(a)(ii)**

Advanced Offset Proposal: Black Cockatoo Research Proposal

The Public Transport Authority (PTA) referred Part 2 of the Morley-Ellenbrook rail line (MEL) proposal, between Malaga and Ellenbrook, Western Australia (the Proposal) to the Department of Agriculture, Water and the Environment (DAWE) in 2019. In March 2020, the DAWE agreed the Proposal will be assessed by an accredited assessment under the *Environment Protection & Biodiversity Conservation Act 1999*.

As a strategic advanced indirect environmental offset for the Proposal, the PTA is proposing to contribute funding to a Murdoch University Black Cockatoo research proposal (Warren et. al. 2019) (the research proposal) to be undertaken in Western Australia.

A summary of the proposed advanced offset is as follows:

Proponent	Public Transport Authority (PTA), Perth, Western Australia
Contact Details	s. 47F(1) s. 47F(1) @pta.wa.gov.au
ABN	61 850 109 576
Location of advanced offset	Western Australia
Matters of National Environmental Significance that the advanced offset aims to benefit	Carnaby's Black Cockatoo (endangered) Baudin's Black Cockatoo (endangered) Forest Red-tailed Cockatoo (vulnerable)
The start date for the proposed advanced offset	The research is anticipated to commence in May 2020; <i>however due to the Coronavirus pandemic the anticipated start date may be postponed.</i>

The purpose of this letter is to request the Departments in principle endorsement of the PTA pursuing the research proposal (Warren et. al., 2019) as an advanced indirect offset. The advanced offset will be in the form of an advanced payment to Murdoch University in 2020 to partially fund the Black Cockatoo research proposal (Warren et. al., 2019).

The research proposal titled "*Conservation Management for the long-term survivorship of black cockatoos endemic to the south-west of Western Australia: the application of telemetry to determine spatial ecology on the Perth-Peel Coastal Plain, south-west forest region and key breeding sites in response to a changing environment*" (Warren et. al, 2019) aims to provide further understanding of black cockatoo movement, breeding and habitat use across the Perth-Peel Coastal Plain and in the south-west forest region of Greenbushes for all three black cockatoo species. A copy of the research proposal (Warren et. al, 2019) is provided in Attachment A.

The PTA have also proposed to provide funding to Murdoch University to implement their research proposal (Warren et. al., 2019) as an indirect offset for two other METRONET proposals, the Thornlie-Cockburn Link (EPBC 2018/8188) and the Part 2 : Eglinton Station to Yanchep Rail Extension (EPBC 2018/8262).

The PTA's contribution will be less than or equal to 10% of its final fiduciary black cockatoo offset requirements. The exact value of the financial contribution to be provided by the PTA to Murdoch University will be determined in accordance with the DAWE supplied formula once the final significant residual environmental impacts of the Proposal to black cockatoo foraging has been assessed.

The research proposal (Warren et al, 2019) is compliant with the advanced offset criteria as follows:

- It is undertaken for the explicit purpose of protecting or managing a matter of national environmental significance;
- There will be sufficient information to enable a clear assessment of the conservation benefit that has been realised as a result of the offset; and
- There will be sufficient information to demonstrate that this conservation benefit is additional to existing obligations under other planning regimes, legislation, schemes or duty of care.

The indirect advanced black cockatoo offset details and alignment with Commonwealth environmental offset policy and guidelines will be provided to DAWE in the Draft Malaga to Ellenbrook Rail Works offsets strategy, which will be submitted with the Proposal's Public Environmental Review Document.

Please direct all enquiries to **s. 47F(1)** or
s. 47F(1) [@pta.wa.gov.au](mailto:s.47F(1)@pta.wa.gov.au).

Yours Sincerely,

s. 47F(1)

ENVIRONMENTAL MANAGER, INFRASTRUCTURE PLANNING & LAND SERVICES

cc: **s. 47F(1)**

Attachments

Attachment A – Murdoch University Black Cockatoo Research Proposal (Warren et. al, 2019).

References

Warren, K., Shephard, J., Yeap, L., Jackson, B., Vaughan-Higgins, R., Donaldson, R., Mitchell, D., Barrett, G., Dawson, R., Mawson, P., Saunders, D. & Bouten, W. (2019). *Conservation management for the long-term survivorship of black cockatoos endemic to the south-west of Western Australia: the application of telemetry to determine spatial ecology on the Perth-Peel Coastal Plain, south-west forest region and key breeding sites in response to a changing environment.*

Conservation management for the long-term survivorship of black cockatoos endemic to the south-west of Western Australia: the application of telemetry to determine spatial ecology on the Perth-Peel Coastal Plain, south-west forest region and key breeding sites in response to a changing environment

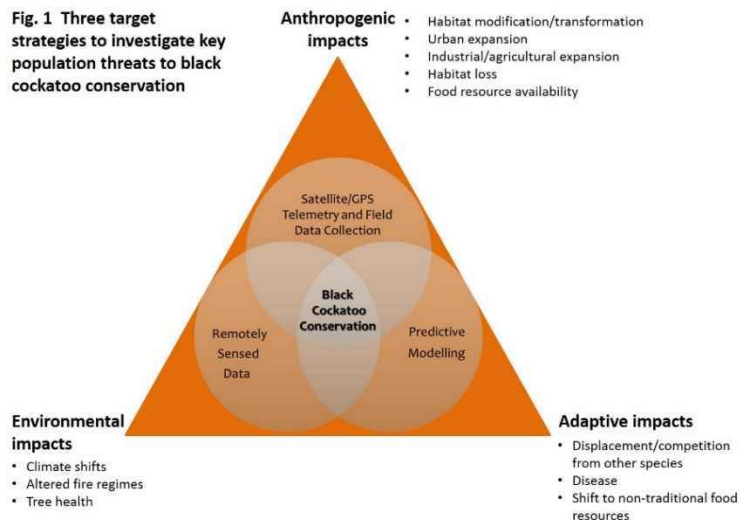
A/Professor Kristin Warren¹, Dr Jill Shephard¹, Dr Lian Yeap¹, Dr Bethany Jackson¹, Dr Rebecca Vaughan-Higgins¹, Rebecca Donaldson¹, Dr David Mitchell², Dr Geoff Barrett², Rick Dawson², Dr Peter Mawson², Dr Denis Saunders³, Professor Willem Bouten⁴

¹Harry Butler Institute, Murdoch University, ² Department of Biodiversity, Conservation and Attractions, ³ CSIRO, ⁴ University of Amsterdam.

Summary

Western Australia's three endemic black cockatoo species, Carnaby's cockatoos (*Calyptorhynchus latirostris*), Baudin's cockatoos (*Calyptorhynchus baudinii*) and forest red-tailed black cockatoos (*Calyptorhynchus banksii naso*) are threatened and receive special protection as Matters of National Environmental Significance (MNES) under the Environment Protection and Biodiversity Conservation Act (1999)¹⁻⁷. Threats to species survivorship for these black cockatoos are well documented, and include habitat loss and modification, urban and industrial expansion, disease, displacement by competing species, and climate shifts¹⁻² (Figure 1). Despite significant research to date⁸⁻¹³, key information required to address the National Recovery Plan remains outstanding¹⁴.

Fig. 1 Three target strategies to investigate key population threats to black cockatoo conservation



Background and Significance

Black cockatoos are iconic species in the Western Australian landscape. People hold strong cultural associations with them, and they are well placed to function as flagship species for habitat conservation. All three species occupy a large area of habitat in the south-west of Western Australia, including populations that inhabit the Perth-Peel Coastal Plain; with Carnaby's cockatoos typically migrating from inland breeding areas to coastal habitat during the non-breeding season, Baudin's cockatoos migrating from wintering sites in the Darling Ranges to southern breeding sites, and forest red-tailed black cockatoos moving between the Perth-Peel Coastal Plain and the Darling Ranges. All three species also have populations that inhabit the south-west forests in the southern part of their distribution range, which do not migrate to the Perth-Peel Coastal Plain.

Carnaby's cockatoos are listed as Endangered under Australian Federal law (*Environment Protection and Biodiversity Conservation Act 1999*) and internationally by the IUCN^{1,4}. At the state level they are listed as Endangered under the Western Australia *Biodiversity Conservation Act 2016*⁵. The species has undergone an estimated 50% decline over the last 5 decades¹, including an estimated average decline of 5% per annum across the Perth-Peel Coastal Plain over the last nine years¹³. Overall this has contributed to a suggested 30% range contraction¹, and significant loss of breeding populations^{1,13}.

Forest red-tailed black cockatoos have declined in range by 30% as a result of habitat loss and have suffered a marked decline in population numbers since the 1950s^{2,9,10}. The species is listed as Vulnerable under Australian Federal law (*Environment Protection and Biodiversity Conservation Act 1999*) and under the Western Australia *Biodiversity Conservation Act 2016*⁵. The forest red-tailed black cockatoo fits the IUCN Red List Criteria for Vulnerable due to a projected or suspected decline in the population of more than 30% within the next 10 years or three generations².

Baudin's cockatoos are listed as Endangered at the Federal Level (*Environment Protection and Biodiversity Conservation Act 1999*), and at the State Level (*Biodiversity Conservation Act 2016*)⁵. The population has been in decline over the last 50 years, however in the last eleven years there has been a dramatic decline (over 90%) in the numbers recorded at traditional autumn-winter roost sites in the northern Darling Range¹⁵. Additionally, in 2017 there were unexpectedly few records of large flocks of this species in the south-west¹⁵.

The Carnaby's Cockatoo Recovery Plan¹ lists six priority Actions that must be undertaken to meet the Plan's objectives; and the Forest Black Cockatoo Recovery Plan² lists 13 Actions. The Actions listed in both these Recovery Plans have remained largely out of reach, as they have required information about the species' ecology, movement patterns and habitat use/selection which can only be obtained by large-scale tracking of wild flocks. Our team has developed and tested an approach enabling us to track wild flocks using satellite and GPS tags at both local population and landscape scales; allowing us to collect a suite of hitherto unknown ecological information. Accordingly, this proposed project will address and inform all six priority Actions from the Carnaby's Cockatoo Recovery Plan, and seven of the priority Actions in the Forest Black Cockatoo Recovery Plan.

Threatening processes for Western Australia's black cockatoos are exacerbated by the rapidly increasing urban and industrial development in the Perth-Peel region and the south-west of Western Australia³. Perth's human population is projected to nearly double to 3.5 million by 2050³, emphasising the need to understand flock movements and habitat use, and identify critical feeding and breeding sites; which still remain largely unknown despite early attempts using direct observation^{8-13,16-20}. There is an apparent mismatch between legislative intent and management action as insufficient knowledge exists about basic behavioural ecology across spatial scales, and which habitats are integral to long-term retention of black cockatoos.

Development and biodiversity conservation are not mutually exclusive. Perth is undergoing rapid and extensive development, and could be a strong model for how development and conservation can be managed synergistically. A large part of what makes Perth special is its unique and endemic biodiversity, which we are fortunate to have in our urban areas; including endangered and iconic black cockatoos. As Perth develops, it will be important to implement effective efforts to ensure the conservation management of our threatened species. For black cockatoos, this will mean identifying and protecting important habitat on the Perth-Peel Coastal Plain, alongside creation of replacement habitat, to ensure no net habitat loss across their distribution range.

Our tracking research, which identifies habitat use and flock movements through the landscape, can assist with identifying key habitats and areas for conservation/revegetation. Our research team is in a strong position to work alongside government to identify areas of habitat that are high-use, and to inform decisions regarding which areas are most appropriate to conserve and manage to halt black cockatoo population declines.

Our research team at Murdoch University has developed a novel tracking methodology for black cockatoos using GPS and satellite telemetry²¹⁻²². Together this will enable researchers to obtain movement, behavioural and ecological data at both the extent and spatial scale (local population and landscape scales) required to inform conservation and land management planning.

Funding Partnerships

Three industry partners have proposed funding for this project in relation to their offset packages – Main Roads Western Australia, the Public Transport Authority of Western Australia (PTA) and Talison Lithium.

Main Roads WA are responsible for the building and provision of road infrastructure and operations in relation to improvement in road efficiency, as well as maintenance of the State's major government roads, bridges and road verges. *It is proposed that Main Roads WA would provide funding for Year 1 of this research project.*

The Government of Western Australia has embarked on the delivery of METRONET, considered to be Perth's most ambitious public transport program, which aims to address sustainability issues in the city through the optimisation of existing rail capacity and building new rail systems. *The funding component from the PTA is for Years 2-5 and is linked to proposed METRONET projects.*

Talison Lithium Australia Pty Ltd has been operating the Greenbushes Lithium mine, in the Greenbushes region in south-west WA, for over 30 years. Talison Lithium is proposing to expand its operations at this mine site to increase the production of spodumene ore and lithium mineral concentrate. *The funding component from Talison Lithium in Year 2-5 is linked to the proposed expansion of the Greenbushes Lithium mine.*

These industry partners have indicated that they are committed to sustainable development; they aim to minimise and manage potential environmental impacts and work with the Western Australian Environmental Protection Authority and Department of Water and Environmental Regulations, and the Federal Department of Environment and Energy in relation to environmental approval and offset requirements.

Proposed Research

This project aims to utilise innovative tracking methodologies to undertake a movement ecology study of Carnaby's cockatoos, Baudin's cockatoos and forest red-tailed black cockatoos, to determine habitat use and threatening processes in modified landscapes. We will track the three species of black cockatoos on the Perth-Peel Coastal Plain and in the south-west

forest region of Greenbushes, and additionally – given the importance of the Perth-Peel Coastal Plain for Carnaby’s cockatoos during the non-breeding season – we will track Carnaby’s cockatoos at key breeding sites to better understand migratory movement dynamics of this species across its distribution range. We will also undertake health research on Carnaby’s cockatoos at key breeding sites, to better understand the potential role of disease as a threatening process for this species. Several potential pathogens associated with avian disease have been found in wild Carnaby’s cockatoo nestlings in south-western Australia, including: (1) psittacine beak and feather disease (a listed Key Threatening Process for endangered parrots, Commonwealth EPBC Act 1999); (2) polyoma virus; and, (3) *Chlamydia* sp. The clinical significance of these diseases for species survival remains unknown²³. The Murdoch team has also been involved in the investigation of Carnaby’s cockatoo Hindlimb Paralysis Syndrome (ChiPs) in adult Carnaby’s cockatoos, likely associated with toxicity events involving birds exposed to agricultural chemicals at breeding sites. Each year a number of Carnaby’s cockatoos that have migrated back to the Perth-Peel Coastal Plain following the breeding season, are observed with clinical symptoms suggestive of delayed organophosphate neuropathy. This disease is also suspected to have caused two mass mortality events at a key Wheatbelt breeding site (2009, 2012), resulting in a population crash at this site of > 90% of breeding birds, and functional extirpation of this important breeding population²⁴.

This research will use remote sensing to produce predictive modelling of black cockatoo population movements and habitat use, in association with existing and emerging threats across key range areas. The project offers a novel approach: it combines (a) satellite/GPS derived movement data from our innovative tracking system; (b) other remotely sensed landscape data (e.g. vegetation, water); and (c) existing fire and climate models, to identify crucial habitat characteristics and regions most resilient to impacts of threatening processes (fire, climate shifts, habitat modification, tree health, disease, urban expansion). The data and information they generate will allow collaborators to develop policies and take action to manage land changes, and build resilience into modified landscapes to address black cockatoo declines.

Objectives of the Study

In this study we adopt a multidisciplinary approach (Fig. 1) to meet the following five objectives: **1)** Characterise black cockatoo movement and habitat use across the Perth-Peel Coastal Plain and in the south-west forest region of Greenbushes for all three black cockatoo species; **2)** Study known Carnaby’s cockatoo breeding sites, focussing on characterising habitat suitability, food resource availability and selection, nestling health, specific threatening processes and fledgling dispersal routes; **3)** Identify new breeding sites in inland or southern areas for all three species based on migratory movement of birds to breeding grounds; **4)** Apply new ecotoxicology methods to investigate ChiPs toxicity cases, particularly in the agricultural zone; and **5)** predictively model survivorship scenarios for all three species of black cockatoo using movement, habitat use and threats.

Methods and Analytical Framework to meet Objectives

Obj 1 and Obj 3 – Flock Movements and Habitat Use across the PPCP; south-west forest region of Greenbushes; New Breeding Sites (Carnaby’s cockatoo, Baudin’s cockatoo and forest red-tailed black cockatoo)

- Double mounted Satellite and GPS tracking – 16 black cockatoos tracked on the Perth-Peel Coastal Plain per annum for four years - 8 Carnaby’s cockatoos (4 individuals released into two different resident flocks), 4 Baudin’s cockatoos and 4 forest red-tailed black cockatoos released into resident wild flocks on the Perth-Peel Coastal Plain and in south-west forest region of Greenbushes* – use of Switching State-Space Models²⁵, First-Passage Time Analysis²⁶ and GIS to model movement behaviour, habitat selection and foraging strategies. *The number of releases of black cockatoos equates to a total of 10 releases on the Perth-Peel Coastal Plain i.e. 6 for Carnaby’s cockatoos, 2 for forest red-tailed black cockatoos, 2 for Baudin’s cockatoos) and 6 releases in the south-west forest region of Greenbushes i.e. 2 for Carnaby’s cockatoos, 2 for forest red-tailed black cockatoos, 2 for Baudin’s cockatoos; fewer Baudin’s cockatoos present for rehabilitation and whilst it is likely there will be birds from this species undergoing rehabilitation that will enable a number of release groups, in the event that there are insufficient Baudin’s cockatoos to have four release groups over the duration of the project, additional Carnaby’s cockatoos or forest red-tailed black cockatoos will be released instead based on discussion with the industry partners and DBCA.

Obj 2 – Known Breeding Sites and Dispersal Routes (Carnaby’s cockatoo)

- GPS tracking and Satellite tracking – 9 breeding sites across the distribution range – 3 sites per annum for three years, with each site monitored in the subsequent year through field observations by research staff. Numbers of birds tracked: 4 adult breeding birds per site per year (i.e. 12 birds per year), each double mounted (UVA-BITS and Telonics tags). This will include sites currently monitored by DBCA and Birdlife Australia (e.g. Coomallo Creek, Borden, Lake King, Stennetts Lake), and new sites (e.g. Kojonup and 4 additional sites identified by the tracking work) – Use of Switching State-Space Models, Calculation of Utilisation Distributions and associated Home Range estimators to identify and quantify high use habitat for feeding and watering; Examination of ecological linkages across identified habitat parameters using spatially explicit models (e.g. GLMs, GAMs, Maxent, Random Forests) to assess linkages between bird movement and specific habitat features (including travel distances to foraging and watering sites). These data will also be used in comparative studies between sites/regions and to inform predictive modeling.
- Energetics – combined analysis using GPS accelerometer derived activity budgets and caloric benefit of identified food species determined by Bomb Calorimetry.

- Nestling health - 20 nestlings per site - 60 nestlings per year. Screening for: i) psittacine beak and feather disease (key threatening process), ii) polyoma virus, iii) *Chlamydia* sp. (present in nestlings in south-western Australia).
- Ground surveys – identification of new nest hollows, assessment of hollow condition, inventory of current and potential future threats at each site.

Obj 3 – Identify new breeding sites – see Obj 1 above

Obj 4 – CHiPs toxicity (Carnaby's cockatoo)

- Application of new ecotoxicology methods to investigate CHiPs toxicity – catastrophic mass mortality events in 2009 and 2012 led to functional extirpation of a key breeding site in the Wheatbelt²⁴. Separation Science (e.g. GC-MS) targeting agricultural pesticides undertaken. Samples will include environmental samples, eggshells and cadavers (in the event of further mortality events; CHiPs clinical cases).

Obj 5 – Predictive modelling of perturbation scenarios (Carnaby's cockatoo, forest red-tailed black cockatoo and Baudin's cockatoo)

- Realised movement, habitat use, food and water resources will be modelled in a predictive framework (e.g. using Ensemble Species Distribution Modelling²⁷ against various perturbation scenarios including: habitat loss, habitat modification due to climate shifts, fire impacts, and forecast land-use transformation through urban and industrial expansion to identify landscape critical for supporting species survivorship in the long-term [modelled in 10yr increments for 50-100yrs]). Existing fire and climate models exist. Ensemble modelling allows the prioritisation of habitat according to competing ecological hypotheses and is an excellent tool for guiding conservation management under large-scale disturbance scenarios.

Projected Conservation Management Outcomes

This project will deliver major new flock movement and habitat use information and conservation outcomes. Since 2015, our research team has successfully deployed 84 tags and generated over 140,000 GPS location fixes, 33,000 km of track movement and over 2.8M accelerometer records. The methodology is proven, and facilitates black cockatoo flock movement characterisation at spatial and temporal scales previously unattainable. The proposed research builds on this existing success, with a clear focus on conservation and management of all three black cockatoo species on the Perth-Peel Coastal Plain and the south-west forest region of Greenbushes, as well as at key Carnaby's cockatoo breeding sites across the species distribution range.

We envisage the following direct conservation management outcomes:

1. Identification and prioritisation of key habitat resources, including food, water and vegetation corridors, to maximise the retention of critical conservation value habitat for the long-term retention of Carnaby's cockatoos, Baudin's cockatoos and forest red-tailed black cockatoos across their distribution range.
2. Characterisation of appropriate roosting habitat for all three species of black cockatoo, particularly on the Perth-Peel Coastal Plain – this is important as it is not necessarily synonymous with appropriate feeding or nesting habitat.
3. Characterisation of optimal provisioning distances based on energetics work to inform future offset purchases.
4. Identification of new breeding sites (and nest hollow identification) for all three species of black cockatoo, facilitating additional long-term monitoring and protection of stronghold populations, and informing the purchase of off-set land.
5. Additional knowledge about key threatening processes (disease, displacement species, pesticide exposure etc) on Perth-Peel Coastal Plain, in the south-west forest region and at breeding sites.
6. Additional knowledge about critical habitat resources and the overall health of breeding populations at key Carnaby's cockatoo breeding sites, which is required to ensure appropriate long-term conservation management of these sites.
7. Correlation of realised species movement ecology with existing PVA models.
8. Facilitation of consultation with local, State and Federal governments to maximise future urban and peri-urban design to retain birds on the Perth-Peel Coastal Plain and maximise conservation management.
9. Continued liaison with stakeholder groups which consult with private landowners and industry, to manage properties and to maximise landscape and habitat integrity suitable to sustain black cockatoo populations over the long-term.

This project has been developed in collaboration with DBCA to meet the requirements of the EPBC Act Referral Guidelines for the three black cockatoo species⁴, as well as priority Actions and recommendations from the national Carnaby's Cockatoo Recovery Plan¹; Forest Black Cockatoo Recovery Plan²; Matters of National Environmental Significance (MNES) Significant Impact Guidelines⁴⁻⁷; and the Consideration of MNES by the WA land use planning system Discussion Paper⁷.

In addition, this project will meet the following recommendations from the MNES Paper:

- Will address the Government of Western Australia's MNES Discussion Paper recommendations⁴⁻⁷ to identify key areas within a region to sustain threatened populations, including collecting sufficient spatial information to inform assessments and provide clarification on aspects of MNES guidelines with respect to Carnaby's cockatoo, Baudin's cockatoo and forest red-tailed black cockatoo conservation.

- Will contribute substantially towards the Government of Western Australia's preferred option for addressing Carnaby's cockatoo, Baudin's Cockatoo and forest red-tailed black cockatoo conservation in line with the EPBC Act, through identification of critical habitat, areas under threat and areas for potential offsets⁴.

References

- 1 Department of Environment and Conservation (2012) Carnaby's Cockatoo (*Calyptorhynchus latirostris*) Recovery Plan. (Perth, Western Australia).
- 2 Department of Environment and Conservation (2007) Forest Black Cockatoo (Baudin's Cockatoos *Calyptorhynchus baudinii* and Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso*) Recovery Plan 2007-2016, Perth, Western Australia.
- 3 Western Australian Planning Commission (2010) Directions 2031 and Beyond - Metropolitan Planning Beyond the Horizon. (Department of Planning, Perth, Western Australia).
- 4 SEWPaC (2012) EPBC Act referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo (endangered) *Calyptorhynchus latirostris*; Baudin's cockatoo (vulnerable) *Calyptorhynchus baudinii*; Forest red-tailed black cockatoo (vulnerable) *Calyptorhynchus banksii naso*. Department of Sustainability, Environment, Water, Population and Communities, Australian Government.
- 5 DBCA (2019) Black Cockatoos, - Available from: <https://www.dpaw.wa.gov.au/plants-and-animals/animals/208-saving-carnaby-s-cockatoo>, Government of Western Australia. Accessed 7 February 2019.
- 6 Department of Environment, Water, Heritage and the Arts (DEWHA) (2009). Matters of National Environmental Significance: Significant impact guidelines 1.1. Commonwealth of Australia 2009.
- 7 Department of Planning (2010). Consideration of Matters of National Environmental Significance by the WA land use planning system. Discussion Paper. Prepared for the Department of Planning by Essential Environmental Services, December 2010.
- 8 Johnstone, R. and Kirkby, T. (2008) Distribution, status, social organisation, movements and conservation of Baudin's Cockatoo (*Calyptorhynchus baudinii*) in South-west Western Australia. *Rec. West. Aust. Mus.* 25, 107-118.
- 9 Johnstone, R., Kirkby, T. and Sarti, K. (2013) The breeding biology of the Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso* (Gould) in south-western Australia. II. Breeding behaviour and diet. *Pac. Conserv. Biol.* 19, 143-155.
- 10 Johnstone, R., Kirkby, T. and Sarti, K. (2013) The breeding biology of the Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso* (Gould) in south-western Australia. I. Characteristics of nest trees and nest hollows. *Pac. Conserv. Biol.* 19, 143-155.
- 11 Saunders, D. A. and Ingram, J. A. (1998) Twenty-eight years of monitoring a breeding population of Carnaby's Cockatoo. *Pac. Conserv. Biol.* 4, 261.
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s. 22(1)(a)(ii)

From: s. 22(1)(a)(ii)
Sent: Friday, 24 April 2020 6:45 AM
To: s. 47F(1)
Cc: Angela Gillman; s. 47F(1)
 Owen Carr
Subject: RE: Advanced Offset Proposal Black Cockatoo Research [SEC=UNOFFICIAL]

Thanks s. 47F(1)

We will consider this as part of the assessment of the proposal.

Can you please include s. 22(1)(a)(ii) in future emails as he is the assessing officer for this proposal. I have included s. 22(1)(a)(ii) in the Cc line of this reply.

Regards
 s. 22(1)(a)(ii)

From: s. 47F(1) @pta.wa.gov.au>
Sent: Thursday, 23 April 2020 4:55 PM
To: s. 22(1)(a)(ii) @environment.gov.au>
Cc: s. 22(1)(a)(ii) @environment.gov.au>; s. 47F(1) @pta.wa.gov.au>; s. 47F(1) @metronet.wa.gov.au>; s. 47F(1) @pta.wa.gov.au>
Subject: Advanced Offset Proposal Black Cockatoo Research

Good afternoon

Please find attached a letter seeking the Departments in principle endorsement to the PTA's proposal to pursue a Murdoch University Black Cockatoo research project as an proportional indirect advanced offset for the PTA's Malaga to Ellenbrook rail works.

If you have any queries regarding the letter please do not hesitate to contact me.

Best Regards

s. 47F(1)

Environmental Officer | Infrastructure Planning and Land Services

Public Transport Authority of Western Australia

Public Transport Centre, West Parade, Perth, 6000

PO Box 8125, Perth Business Centre, WA, 6849

Tel: s. 47F(1) Fax: s. 47F(1) Mob: s. 47F(1)

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s. 22(1)(a)(ii)

From: s. 47F(1) @pta.wa.gov.au>
Sent: Friday, 8 May 2020 10:53 AM
To: s. 22(1)(a)(ii) s. 47F(1)
s. 22(1)(a)(ii)
Cc: s. 22(1)(a)(ii)
Subject: RE: Malaga to Ellenbrook Rail Works Proposal - Offsets Strategy meeting
Attachments: Malaga to Ellenbrook Draft Offset Strategy Summary Table - for discussion.docx

Hi All

Please find attached the Malaga to Ellenbrook Rail Works Proposal Draft Offset Strategy summary table to support discussion during this morning's meeting.

Agenda:

1. The PTA to present the information within the table. We welcome discussion and questions as each offset is presented.
2. Other business.

Thanks

s. 47F(1)

Note: I work Tuesday to Friday.

s. 47F(1)

Environmental Planner | METRONET | Infrastructure Planning & Land Services

Public Transport Authority of Western Australia

Public Transport Centre, West Parade, Perth, 6000

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-----Original Appointment-----

From: s. 47F(1)

Sent: Wednesday, 29 April 2020 11:40 AM

To: s. 47F(1) ; s. 22(1)(a)(ii) ; s. 47F(1)

s. 22(1)(a)(ii)@environment.gov.au

Cc: s. 22(1)(a)(ii)

Subject: Malaga to Ellenbrook Rail Works Proposal - Offsets Strategy meeting

When: Friday, 8 May 2020 9:30 AM-11:00 AM (UTC+08:00) Perth.

Where: WebEx meeting

Hi all

This meeting has been scheduled to discuss the proposed draft offset strategy for the Malaga to Ellenbrook Rail Works Proposal.

An agenda for this meeting will be provided closer to the date. I have allowed 1.5 hours for the meeting.

Please contact me if you have any questions.

Thanks

s. 47F(1)

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Table 1: Indicative significant residual environmental impacts and indicative proposed offsets for the Malaga to Ellenbrook Rail Works Proposal

Environmental value/MNES	Listing	Indicative Footprint -estimated impact	Indicative Footprint -estimated required offset	Offset strategy
Banksia Woodlands of the Swan Coastal Plain (SCP) Threatened Ecological Community (TEC)	MNES	Approx. 10 ha	59 ha	Direct land acquisition site: Lowlands site
Carnaby's Black Cockatoo foraging habitat	State & Commonwealth MNES	Approx. 71* ha	98* ha	Direct land acquisition site: Lowlands site (90%)
Forest red-tailed and Baudin's Black Cockatoos foraging habitat		TBA	TBA	Advanced indirect Black Cockatoo research proposal (10%)
Potential Carnaby's and Forest red-tailed Black Cockatoo potential breeding trees	State & Commonwealth MNES	Approx. 387 trees, 29 with hollows	1161 trees	Direct land acquisition site: Lowlands site
Conservation Category Wetlands	State	Approx. 2 ha	6 ha	Direct land acquisition site: Keysbrook site
Bush Forever site 304 (Whiteman Park)	State	Approx. 65 ha	130 ha	Direct land acquisition site: Keysbrook site

* Values represent significant residual impact and proposed offset for all Black Cockatoo species. Actual values to be provided within the Draft Offsets Strategy and ERD.

Note: The information within this table is correct at the time of writing, however is subject to change. Estimated offset numbers have been conservatively rounded for discussion purposes. Final values will be presented within the Draft Offsets Strategy and ERD.

s. 22(1)(a)(ii)

From: s. 47F(1) @pta.wa.gov.au>
Sent: Monday, 15 June 2020 7:09 PM
To: s. 22(1)(a)(ii)
Cc: s. 47F(1) s. 22(1)(a)(ii)
Subject: s. 47F(1)
Attachments: Re: Morley Ellenbrook (EPBC2019/8546) - Variation Request
s156A EPBC Act Application Malaga to Ellenbrook Final 15 June 2020.pdf

Hello s. 22(1)(a)(ii)

Please see attached a formal variation request under s156A for the Morley Ellenbrook Part 2 Proposal.

If you or s. 22(1)(a)(ii) have any questions please let us know,

Kind regards

s. 47F(1)

Senior Environmental Officer

METRONET

Public Transport Authority of Western Australia
Public Transport Centre, West Parade, Perth, 6000
PO Box 8125, Perth Business Centre, WA, 6849

Tel: s. 47F(1)

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From: s. 47F(1)
Sent: Thursday, 11 June 2020 11:42 AM
To: s. 22(1)(a)(ii)@awe.gov.au' s. 22(1)(a)(ii)@awe.gov.au>
Cc: s. 47F(1) @pta.wa.gov.auv' s. 47F(1) @pta.wa.gov.auv>; s. 47F(1) @metronet.wa.gov.au>; s. 47F(1) @pta.wa.gov.au>; s. 22(1)(a)(ii) @environment.gov.aus. 22(1)(a)(ii) @environment.gov.au>s. 47F(1) @metronet.wa.gov.au>; s. 47F(1) @metronet.wa.gov.au>; s. 47F(1) @pta.wa.gov.au>
Subject: Re: Morley Ellenbrook (EPBC2019/8546) - Variation Request [SEC=OFFICIAL]

Hello s. 22(1)(a)(ii)

Thank you for the below email with your advice in regards to submitting a variation for EPBC2019/8546.

As discussed this morning, we will prepare and submit a formal variation request as soon as possible. We appreciate that you have applied an exemption in this case and that you will continue any assessment work that arises.

We will send you a copy of the Environmental Review Document when we submit it on Monday,

Thank you

s. 47F(1)

**Senior Environmental Officer
METRONET**

Public Transport Authority of Western Australia
Public Transport Centre, West Parade, Perth, 6000
PO Box 8125, Perth Business Centre, WA, 6849

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From: **s. 22(1)(a)(ii)** @awe.gov.au>
Sent: Thursday, 11 June 2020 10:05 AM
To: **s. 47F(1)** @pta.wa.gov.au>
Cc: **s. 22(1)(a)(ii)** @environment.gov.au>
Subject: Morley Ellenbrook (EPBC2019/8546) - Variation Request [SEC=OFFICIAL]

Dear **s. 47F(1)**

After reviewing the variation request sent to the WA EPA for the Morley Ellenbrook proposal (EPBC2019/8546) I am requesting that the Perth Transport Authority submit a section '156A Request to vary proposal to take an action' under the EPBC Act.

Because there has been a change in the development footprint we will require a formal variation request. This will also mean our records will match up with WA EPA records under the accredited assessment approach. Under the EPBC regulations 2000, we require the following information to be included in the variation request.

5.07 Manner of request to vary a proposal to take an action

For paragraph 156A(3)(a) of the Act, a request under subsection 156A(1) of the Act must be:

- (a) made in writing or electronically; and*
- (b) given or sent to the Department.*

5.08 Information for a request to vary a proposal to take an action

For paragraph 156A(3)(b) of the Act, a request under subsection 156A(1) of the Act must contain the following information:

- (a) details of the proposed variation to the action;*
- (b) the reasons for the proposed variation;*
- (c) how the impacts of the proposed variation on matters of national environmental significance compare with those of the original proposal;*
- (d) if applicable, the impacts of the proposed variation on matters of national environmental significance not considered in the referral or assessment of the original proposal;*

(e) if applicable, alternatives, mitigation measures and offsets to compensate for additional impacts on matters of national environmental significance.

Please note that submitting a variation request does incur a cost recovery fee of \$1,353 which will be invoiced upon the variation request being accepted. Ordinarily no work would occur on the project until the variation request has been accepted and the cost recovery fee has been paid, however, noting this is a priority project the Department will make an exemption for this case and continue any assessment work as it arises.

If you have any questions about this process please get in touch with me. Happy to have a chat on the phone if this is more convenient.

Kind regards,

s. 22(1)(a)(ii)

Administration and Assessment Officer
Assessments (WA, SA, NT), Post Approvals and Policy Branch
Environment Approvals Division

Department of Agriculture, Water and the Environment | awe.gov.au

John Gorton Building, King Edward Terrace, Parkes, ACT
PO Box 858, CANBERRA CITY ACT 2601

Ts. 22(1)(a)(ii) | E: [s.22\(1\)\(a\)\(ii\)@awe.gov.au](mailto:s.22(1)(a)(ii)@awe.gov.au)

The Department acknowledges the traditional owners of country throughout Australia and their continuing connection to land, sea and community. We pay our respects to them and their cultures and to their elders both past and present





Government of Western Australia
Public Transport Authority

Your ref : EPBC 2019/8546

Our ref : A4415666

Enquiries : [s. 47F\(1\)@pta.wa.gov.au](mailto:s.47F(1)@pta.wa.gov.au)

15 June 2020

s. 22(1)(a)(ii)

Assistant Director
Department of the Environment Water, Heritage & Arts
GPO Box 787
CANBERRA ACT 2601

Dear **s. 22(1)(a)(ii)**

Request to vary a proposal under s156A of the EPBC Act 1999 – Malaga to Ellenbrook Line Part 2: Morley to Ellenbrook (EPBC 2019/8546)

In September 2019, the Public Transport Authority of Western Australia (PTA) submitted a referral under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) for the Morley to Ellenbrook proposal (the Proposal). The Proposal received a decision on assessment as a controlled action on 24 December 2020, as the proposed action is likely to have a significant impact on the following matters of national environmental significance:

Listed threatened species and communities (sections 18 & 18A), including but not limited to:

- *Banksia woodlands of the Swan Coastal Plain* Threatened Ecological Community– Endangered;
- Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) – Endangered;
- Forest red-tailed Black Cockatoo (*Calyptorhynchus banksia naso*) – Vulnerable;
- Baudin's Black Cockatoo (*Calyptorhynchus baudinii*) – Endangered; and
- Grand spider-orchid (*Caladenia huegelii*) – Endangered.

The proposal has been under assessment by the WA Environmental Protection Authority (EPA) under the *Environmental Protection Act 1986* (WA) as an accredited assessment.

Through this process, the PTA identified the opportunity to further minimise native vegetation clearing impacts by modifying the proposal's development envelope from 501 ha to 463.8 ha, and applying a disturbance Footprint of 249 ha to further minimise native vegetation clearing.

This was achieved through:

- reducing the size of the Development Envelope at the Proposed Malaga Station and at the proposed Whiteman Park Station.
- application of a Proposal Footprint of 249 ha to minimise the potential impacts to MNES through the implementation of the Proposal.

With the above changes, the PTA reduced the area of the disturbance footprint to 249 ha (disturbance footprint). The PTA has submitted a s43A request to the EPA under s43A of the *WA Environmental Protection Act 1986*.

The PTA requests to vary the Morley to Ellenbrook Proposal under s156A of the EPBC Act in accordance with the above changes. As no other changes to the proposal are requested, the PTA considers that this varied proposal is substantially the same as the character of the original proposal.

Please see Attachment 1 for information to support this request for Variation to Assessment.

If you have any questions please contact **s. 47F(1)** on **s. 47F(1)** or **s. 47F(1)** @pta.wa.gov.au.

Yours sincerely

s. 47F(1)

Executive Director
Infrastructure Planning & Land Services

Attachment 1 Request to vary the Part 2: Morley to Ellenbrook rail line, Malaga to Ellenbrook Rail Works Proposal

(a) Details of the proposed variation to the action

The Public Transport Authority of Western Australia (PTA) is proposing to vary the Malaga to Ellenbrook Rail Works Proposal (the Proposal) (Figure 1), reducing impacts to native vegetation by modifying the proposal's Development Envelope from 500.8 ha to 463.8 ha, and applying a disturbance footprint (the Footprint) of 249 ha (Table 1). The Footprint represents a disturbance of 49.7% of the referred Development Envelope. See Figures 1 to 3 for details of the proposed variation to the action.

This variation corresponds with a decrease in the extent of native vegetation clearing from the referred 312.0 ha to the current 152.1 ha, a reduction of 159.9ha.

Of the 249 ha Footprint, the 152.1 ha of native vegetation to be cleared is comprised of 59.9ha (24.1% of the Footprint) of native vegetation in Good - degraded condition and 92.2 ha (37% of the Footprint) of native vegetation in Completely degraded condition.

There is also 96.9ha (38.9% of the Footprint) that is not native vegetation, being either completely cleared or planted vegetation.

Table 1: Proposed variation to the action

Item	Referred action	Proposed variation to the action
Development envelope	500.8 ha	463.8 ha (Development Envelope)
Development footprint or work area including disturbance footprint	500.8 ha ¹	249 ha (Proposal Footprint)

1

(b) The reasons for the proposed variation

The rationale for the reduction in the size of the Development Envelope and the application of a Footprint was to avoid and minimise the Proposal's environmental impacts.

The resulting avoidance and minimisation of impacts to environmental values was achieved because of a 7% reduction in the size of the Development Envelope and the application of the Footprint representing a 50.3% reduction in the Proposal's area of disturbance compared to the original Development Envelope.

¹ The Proposal was referred with a Development Envelope of 500.8 ha. At the time of referral, the actual extent of the disturbance footprint was not known.

The PTA will continue to work on the final rail engineering design within the Development Envelope, to further avoid, mitigate and where practicable manage the Proposal's potential direct and indirect impacts.

During the environmental impact assessment of this project, the PTA has undertaken considerable design work to avoid and minimise potential environmental impacts in the Footprint and Development Envelope where practicable. Native Vegetation Retention Areas (NVRAs) have been allocated within the Development Envelope to protect areas of native vegetation from the Proposal's direct and indirect impacts.

In addition to the overall reduction to the size of the Development Envelope and the application of Footprint to designate the area of disturbance, the PTA identified the opportunity to further minimise impacts to MNES by the following specific changes:

- Banksia TEC/PEC at the proposed Malaga Station –reduced impacts by changing the Development Envelope and the Proposal's Footprint and applied a NVRA to a portion of the remaining TEC this remains within the Development Envelope.
- Whiteman Park Station – reduced impacts to Bush Forever site 304 Whiteman Park, including potential Carnaby's Cockatoo potential breeding trees by reducing the western edge of the Development Envelope.
- Avoided 44.9 ha of native vegetation by including NVRAs to protect native vegetation within the Development Envelope, including up to 25.6 ha of Black Cockatoo foraging habitat. The NVRAs will also retain 201 (30%) of the Black Cockatoo potential breeding trees within these NVRAs.

These changes were also submitted to the Western Australian EPA under s43A of the *WA Environmental Protection Act 1986* on the 8th June 2020.

(c) How the impacts of the proposed variation on matters of national environmental significance compare with those of the original proposal

An assessment of the impacts of the proposed variation on matters of national environmental significance, as compared with those of the original proposal is outlined below and in Table 2. Overall, the changes to the Development Envelope were undertaken to avoid or minimise impacts to environmental values.

Table 2: MNES impacts

MNES	Referred impact	Proposed variation to the impact
Banksia woodlands of the Swan Coastal Plain TEC ²	23.1 ha.	9.35 ha.

MNES	Referred impact	Proposed variation to the impact
<i>Calyptorhynchus latirostris</i> (Carnaby's Black Cockatoo) <i>Calyptorhynchus banksia</i> subsp. naso (Forest red-tailed Black Cockatoo) <i>Calyptorhynchus baudinii</i> (Baudin's Black Cockatoo)	30.1 ha ³ of foraging habitat. 206 potential habitat trees.	81.4 ha of foraging habitat suitable for Carnaby's and Baudin's Black Cockatoo, including. 68.1 ha of foraging habitat for Forest Red-tailed Black Cockatoo. 423 potential nesting trees, including 33 with unsuitable hollows.
<i>Caladenia huegellii</i> (Grand Spider Orchid)	Not recorded in the survey area, but known to occur in areas adjacent to the Development Envelope.	Not recorded in the survey area but known to occur at a location two km from the Development Envelope. The Footprint contains 12.3 ha of inferred suitable habitat at two distinct locations. Two targeted surveys have been undertaken and no <i>Caladenia huegellii</i> individuals were detected.

Impacts to Banksia Woodlands of the Swan Coastal Plain TEC

As indicated in Table 2 the Proposal results in the loss of 9.35 ha of the Banksia woodlands of the Swan Coastal Plain TEC. This represents a decrease of 13.71 ha from the original referral which was 23.06 ha, a decrease of 13.71 ha.

The area extent of this TEC has recently been revised due to more accurate mapping and floristic community mapping to include additional areas previously not mapped as TEC.

Changes to the Proposal to avoid or minimise direct clearing impacts to the TEC included a reduction in the Development Envelope area and the implementation of Native Vegetation Retention Areas (NVRAs) where native vegetation will not be cleared. This has reduced clearing of the Banksia Woodlands of the Swan Coastal Plain TEC by 14.7 ha comprising:

- 7.74 ha of Banksia TEC/PEC avoided to the north of the Development Envelope near the proposed Malaga Station.
- 6.95 ha of Banksia TEC/PEC protected by a NVRA within the Development Envelope.

Impacts to Black Cockatoo species

The potential impacts to Black Cockatoo foraging habitat and potential impacts to Black Cockatoo potential breeding trees impacted (Table 2) is attributable to the completion of an additional comprehensive Black Cockatoo on-ground survey and habitat assessment undertaken by ELA in November 2019 and February 2020 (ELA 2020), incorporating all known information from

previous surveys. This detailed study found that there is more Black Cockatoo habitat within the Development Envelope than known at original referral. Table 2 addresses the original referral amount of 30.1 ha of Black Cockatoo foraging habitat and 206 potential habitat trees, based on preliminary surveys undertaken for the referral.

Using the updated Black Cockatoo data available from ELA 2020 a re-assessment of the referral of the original referred Development Envelope included 137.3 ha of Black Cockatoo foraging habitat and 710 Black Cockatoo potential breeding trees. The modified Proposal Footprint impacts up to 81.4 ha of Black Cockatoo foraging habitat and 423 Black Cockatoo potential breeding trees including 33 with hollows >10 cm within the Footprint.

The PTA has also applied NVRAs which protect 25.6 ha of Black Cockatoo Foraging Habitat and 201 Black Cockatoo potential breeding trees, including four with hollows >10 cm within the Footprint. Based on advice from Tony Kirkby that the Proposal is outside the modelled breeding range for Baudin's Cockatoo, potential breeding trees are only considered to be suitable for Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo.

None of the 40 hollows within the Development Envelope were found to be suitable for Black Cockatoo breeding purposes. All hollows present were either too small, incorrect angle, too close to the ground, too shallow or a combination of these factors (Kirkby 2020).

Table 3: Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo potential breeding trees (ELA 2020, Kirkby 2020)

Item	Development Envelope	Footprint	NVRA
Black Cockatoo potential breeding trees	680	423	201
Black Cockatoo potential breeding trees with hollows	40	33	4
Tree hollows suitable for breeding use	0	0	0

Changes to the Proposal have reduced the potential impacts to Black Cockatoo species compared to those that would otherwise have occurred without the reductions in the Development Envelope area, the designation of a Proposal Footprint (Table. 1) and the implementation of NVRAs.

The implementation of NVRAs has protected:

- 25.6 ha of Black Cockatoo foraging habitat.
- 201 Black Cockatoo potential breeding trees.

Impacts to *Caladenia huegelii* inferred suitable habitat

The Proposal will not directly impact any known occurrences of *Caladenia huegelii*. The Footprint includes 12.3 ha of inferred suitable habitat at two distinct areas (Area A and Area D), 11.1 ha at Site A and 1.2 ha at Site D. Two targeted surveys have been undertaken and no *Caladenia huegelii* individuals were detected.

A NVRA protects 8.05 ha of inferred suitable habitat within Area A.

- (d) If applicable, the impacts of the proposed variation on matters of national environmental significance not considered in the referral or assessment of the original proposal.**

Not applicable to this proposed variation.

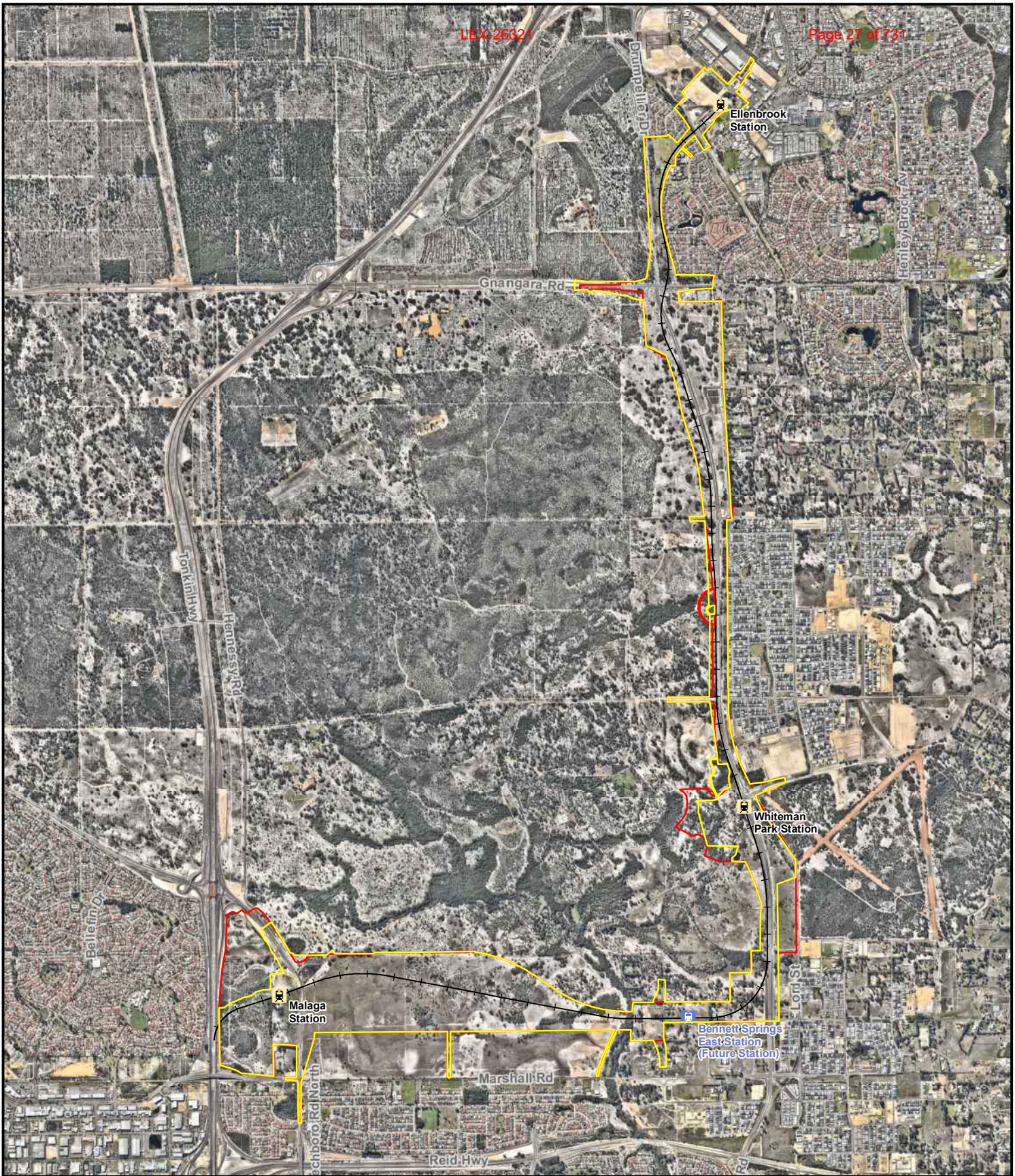
- (e) If applicable, alternatives, mitigation measures and offsets to compensate for additional impacts on matters of national environmental significance.**

During the environmental impact assessment of this project, the PTA has undertaken considerable design work to avoid, minimise and mitigate potential impacts in the final footprint and proposed development envelope where practicable.

Through this process, the PTA identified the opportunity to further minimise impacts to the environment, by reducing impacts to native vegetation as described above. Overall, the changes to the development envelope were undertaken to avoid or minimise impacts to environmental values.

Additionally, the PTA proposes to undertake offsets with the objective of counterbalancing the significant residual impact to the environmental values of:

- 9.35 ha of Banksia Woodlands of the Swan Coastal Plain TEC;
- 81.4 ha of potential Carnaby's and Baudin's Black Cockatoo foraging habitat, which includes 68.1 ha of Forest Red-tailed Black Cockatoo foraging habitat; and
- 423 Black Cockatoo potential breeding trees.



METRONET | Malaga to Ellenbrook s156A
 Figure 1 Modifications to Development Envelope

- Legend**
- Development Envelope
 - Referred Development Envelope
 - Proposed Railway Station
 - Proposed Railway Station (Future)
 - Indicative Railway Alignment



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 Approved by: C. Baxter

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METRONET | Malaga to Ellenbrook s156A
 Figure 2A Modifications to Development Envelope

Legend

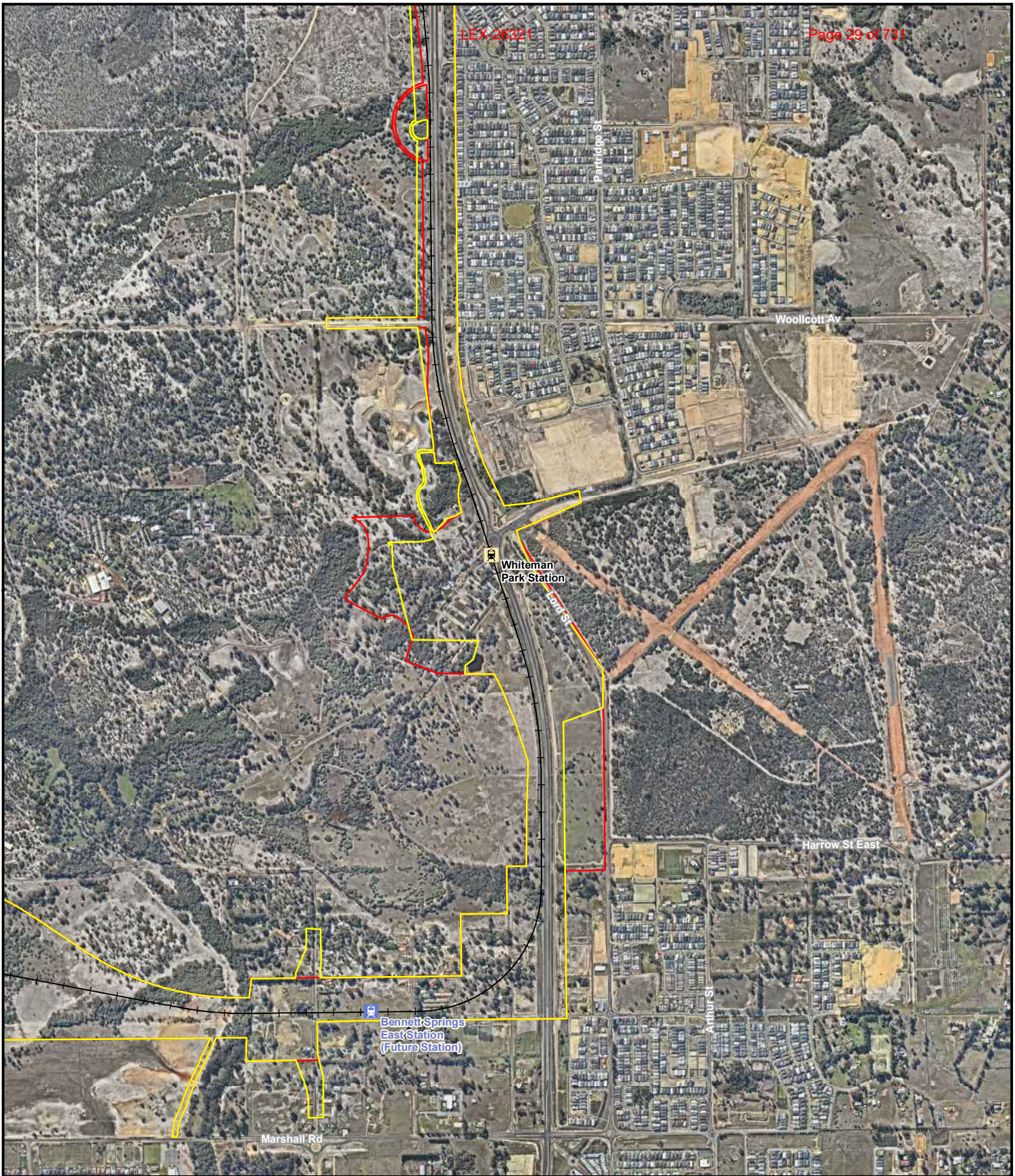
- Development Envelope
- Referred Development Envelope
- Proposed Railway Station
- Indicative Railway Alignment



Date Printed: 15/06/2020
 Created By: D.Whiteley
 Approved by: C.Baxter

Scale: 1:20,000 @ A4
 Coordinate System: GDA 1994 MGA Zone 50

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METRONET | Malaga to Ellenbrook s156A
 Figure 2B Modifications to Development Envelope



Public Transport Authority

- Legend**
- Development Envelope
 - Referred Development Envelope
 - Proposed Railway Station
 - Proposed Railway Station (Future)
 - Indicative Railway Alignment



Date Printed: 15/06/2020
 Created By: D.Whiteley
 Approved by: C.Baxter

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METRONET | Malaga to Ellenbrook s156A
Figure 2C Modifications to Development Envelope



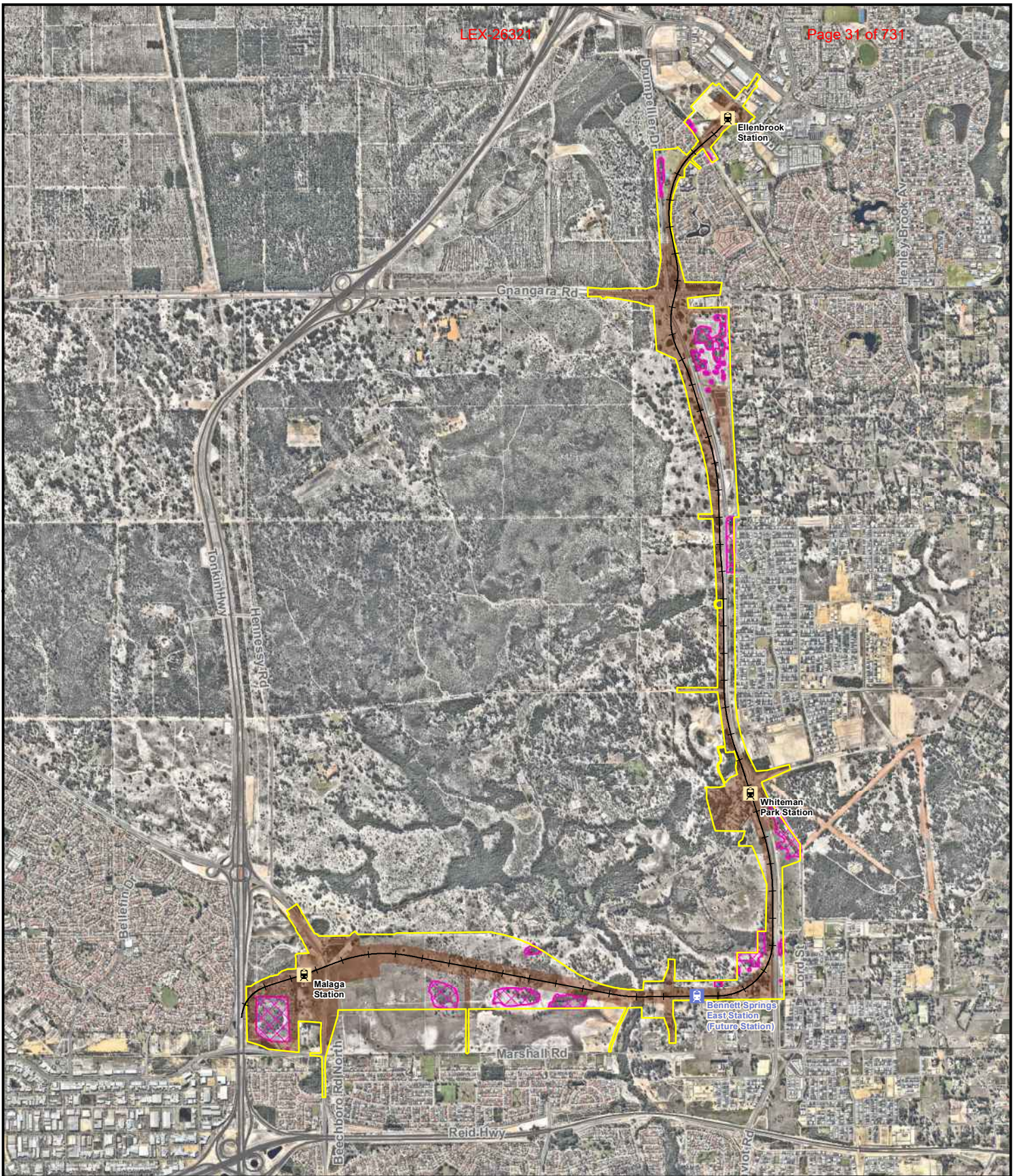
- Legend**
- Development Envelope
 - Referred Development Envelope
 - Proposed Railway Station
 - Indicative Railway Alignment



Date Printed: 15/06/2020
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 Approved by: C.Baxter

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METRONET | Malaga to Ellenbrook s156A
 Figure 3 The Proposal



- Legend**
- Development Envelope
 - Indicative Disturbance Footprint
 - Native Vegetation Retention Area
 - Proposed Railway Station
 - Proposed Railway Station (Future)
 - Indicative Railway Alignment



Date Printed: 15/06/2020
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 Approved by: C. Baxter

Scale: 1:45,000 @ A4
 Coordinate System: GDA 1994 MGA Zone 50



EPBC Ref: 2019/8546

s. 47F(1)

Executive Director Infrastructure Planning and Land Services
MetroNet
one40 William Street,
PERTH WA 6000

Dear s. 47F(1)

**Decision on request to vary proposed action
Morley Ellenbrook Rail Line Part 2, WA**

I refer to your letter dated 15 June 2020 requesting a variation of the proposed action to construct the Morley Ellenbrook Rail Line Part 2.

After examination of all relevant information, I have considered the request under section 156A of the EPBC Act. As a delegate of the Minister for the Environment, I have decided to accept the variation to the proposal.

A copy of the notice recording this decision is enclosed. This document will be published on the website of the Department of Agriculture, Water and the Environment.

I note that all provisions under the EPBC Act have ceased to apply to the original proposal and now apply to the varied proposal, and that for the purpose of the application of those provisions, anything done in relation to the original proposal is taken to have been done in relation to the varied proposal. I also note that the varied proposal will be consistent with the proposed action being assessed by the Western Australian Department of Water and Environmental Regulation and therefore consider that the proposed action can continue to be assessed by accredited assessment with the Western Australian Government.

If you have any questions about the assessment process or this decision, please contact the project manager, s. 22(1)(a)(ii) by email to s. 22(1)(a)(ii)@awe.gov.au, or telephone s. 22(1)(a)(ii) and quote the EPBC reference number shown at the beginning of this letter.

Yours sincerely

s. 47F(1)

Denis Snowdon
Acting Assistant Secretary
Environment Approvals Division

15 July 2020

Appendix T Offsets Strategy – Malaga to Ellenbrook Rail Works Proposal



Public Transport
Authority



Draft Offsets Strategy

Malaga to Ellenbrook Rail Works Proposal

July 2020

Document Information

Version	Prepared by	Description/Changes made	Reviewed by	Authorised for release by	Provided to	Version Date
A	B. Lockley	First Draft	S. Brown	M. Ludlow	DWER DAWE	June 2020
B	B. Lockley	Second Draft	S. Brown	J. Morrell	DWER DAWE	July 2020
C						

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Telephone: (08) 9326 2000

Email: enquiries@pta.wa.gov.au

www.pta.wa.gov.au

Executive Summary

The Public Transport Authority of Western Australia (PTA) is proposing to develop the Malaga to Ellenbrook Rail Works (the Proposal) as part of the Western Australian Government's METRONET vision. The Proposal is located between 12 to 22 kilometres (km) north-east of the Perth Central Business District (CBD), within the City of Swan. The Proposal connects to the proposed Bayswater to Malaga railway line at the eastern edge of the Tonkin Highway road reserve.

The Proposal forms an integral component of Perth's long term public transport network, providing essential transportation services to the rapidly expanding northern coastal suburbs and delivering the better sustainability outcomes envisioned by the Western Australian Government's Perth and Peel@3.5million plan (Department of Lands and Heritage and Western Australian Planning Commission 2018).

A summary of the Proposal is provided in Table ES1 and Figure 1.

Table ES1 - Summary of the Proposal

Item	Details
Proposal title	Malaga to Ellenbrook Rail Works
Proponent name	Public Transport Authority of Western Australia
Short description	The Proposal is to construct and operate a 13km new dual railway track, which connects to the Bayswater to Malaga Rail Works proposal. The Proposal includes the construction and operation of three new stations at Malaga, Whiteman Park and Ellenbrook, with provision for a future Bennett Springs East Station. Provision will also be made for a potential future Rail Stabling Facility at Henley Brook within Whiteman Park.

The Proposal's 464 ha Development Envelope extends east from the Tonkin Highway, north of Marshall Road to Bennett Springs where the railway alignment turns to the north to run adjacent to Drumpellier Drive (formerly Lord Street), passing under Gnangara Road and turning to the northeast to terminate south of The Parkway in Ellenbrook (see Figure 1).

Significant residual environmental impacts of the Proposal are constrained to the Indicative Footprint and are proposed to be managed in accordance with this Draft Offsets Strategy.

The objectives of this Draft Offsets Strategy are to:

1. Provide the Department of Water and Environmental Regulation (DWER) and Department of Agriculture, Water and the Environment (DAWE) with evidence of the PTA's ability to meet its offset requirements.
2. Outline the PTA's proposed Draft Offsets Strategy to counterbalance anticipated significant residual environmental impacts of the Proposal, in accordance with relevant State and Commonwealth policy and guidance.

The scope of this Draft Offsets Strategy is as follows:

- Outline the Proposals' significant residual environmental impacts to State listed environmental values and Matters of National Environmental Significance (MNES).

- Apply the *WA Environmental Offsets Template* (Government of Western Australia 2014b) and/or the *Commonwealth Offsets Assessment Guides* (Australian Government 2012b) (referred to throughout as the 'Commonwealth offset calculator') to the Proposal's significant residual environmental impacts to estimate the total quantity of offsets that may be required to meet regulatory guidelines.
- Identify the proposed offsets strategy to counterbalance the Proposal's significant residual environmental impacts in accordance with State and Commonwealth environmental offsets policy and guidance.
- Demonstrate that available offsets presented within this Draft Offsets Strategy will counterbalance the Proposal's significant residual impacts.

The process of identifying significant residual environmental impacts and determining appropriate offsets has been conducted in accordance with the framework provided in the following documents:

- *Environmental Protection Act 1986* (EP Act) (Government of Western Australia 2019a);
- *WA Environmental Offsets Policy* (Government of Western Australia 2011);
- *WA Environmental Offsets Guidelines* (Government of Western Australia 2014a);
- *WA Environmental Offsets Template* (Government of Western Australia 2014b);
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Australian Government 2019);
- *State Planning Policy 2.8* (SPP 2.8) (Western Australian Planning Commission 2010);
- EPBC Act *Environmental Offsets Policy* (Australian Government 2012a); and
- *Commonwealth Offsets Assessment Guide* (Australian Government 2012b).

The Draft Offsets Strategy for the Proposal is summarised within Table ES2. The Lowlands and Keysbrook offset sites are within the PTA's METRONET offset site portfolio. The Keysbrook site has previously been used to offset significant residual environmental impacts from the Thornlie-Cockburn Link (TCL) Proposal. Environmental values assessments suggest there is sufficient quantity of commensurate environmental factors available at the offset sites for the implementation of this Proposal.

After considering all the information provided in the DWER and DAWE guidance documents and tools, the holistic environmental value of an impacted factor, including information specific to the Proposal, the PTA has undertaken an environmental impact assessment and has calculated the significant residual environmental impacts of the implementation of the Proposal. This Draft Offsets Strategy identifies the most suitable and appropriate available offsets that meets both State and Commonwealth requirements. Through the implementation of the proposed Offsets Strategy, the PTA consider that the significant residual environmental impacts of the Proposal will be counterbalanced.

The Draft Offsets Strategy will be finalised following comments from regulators and to meet the approval conditions imposed by the DWER and DAWE.

Table ES2: Summary of the Proposal's Draft Offsets Strategy

Environmental value/MNES	Listing	Significant residual impacts to Footprint ^A	Total quantum of impact	Minimum area to offset	Offsets Strategy	Comparable environmental values of the offset site	Figure reference
Banksia Woodlands of the Swan Coastal Plain (SCP) Threatened Ecological Community (TEC) including Banksia dominated woodlands of the SCP IBRA region Priority Ecological Community (PEC)	State & Commonwealth MNES	Impacts to 10.05 ha comprised of: <ul style="list-style-type: none"> 7.01 ha in Very Good condition; 2.31 ha in Good condition; and 0.73 ha in Degraded condition. 	8.04 ha ^B	62.34 ha ^B	Direct land acquisition and management of the Lowlands site (100%)	926 ha of Banksia Woodlands of the SCP TEC comprised: <ul style="list-style-type: none"> 354.88 ha in Excellent condition; 403.99 ha in Very Good condition; and 165.75 ha in Good condition. 	Lowlands site Figures 2-4
Carnaby's Cockatoo foraging habitat	State & Commonwealth MNES	Impacts to 81.4 ha comprised of: <ul style="list-style-type: none"> 42.8 ha High value habitat; 11.3 ha Moderate value habitat; and 27.3 ha Low value habitat. 	48.8 ha ^B	340.9 ha ^B	Direct land acquisition and management of the Lowlands site (90%) Funding to Murdoch University for the advanced indirect Black Cockatoo research proposal (10%)	1,122 ha - Carnaby's Cockatoo foraging habitat comprised: <ul style="list-style-type: none"> 939.8 ha High Value habitat; and 181.7 ha Low/Moderate Value habitat. 	Lowlands site Figures 2-4
Forest Red-tailed Black Cockatoo foraging habitat		Impacts to 68.1 ha comprised of: <ul style="list-style-type: none"> 33.6 ha High value habitat; 4.3 ha Moderate value habitat; and 30.2 ha Low value habitat. 	40.7 ha ^B	260.1 ha ^B		1,122 ha - Forest Red-tailed Black Cockatoo foraging habitat comprised: <ul style="list-style-type: none"> 939.8 ha of High Value habitat; and 181.7 ha of Low/Moderate Value habitat. 	Lowlands site Figures 2-4

Environmental value/MNES	Listing	Significant residual impacts to Footprint ^A	Total quantum of impact	Minimum area to offset	Offsets Strategy	Comparable environmental values of the offset site	Figure reference
Baudin's Cockatoo foraging habitat		Impacts to 81.4 ha comprised of: <ul style="list-style-type: none"> • 42.8 ha Moderate value habitat; and • 38.6 ha Low value habitat. 	40.7 ha ^B	284.1 ha ^B		1,122 ha - Baudin's Cockatoo foraging habitat comprised: <ul style="list-style-type: none"> • 939.8 ha of High Value habitat; and • 181.7 ha of Low/Moderate Value habitat. 	Lowlands site Figures 2-4
Black Cockatoo potential breeding trees	State & Commonwealth MNES	Clearing of 423 Black Cockatoo potential breeding trees	423 trees	1,269 trees ^C	Direct land acquisition and management of the Lowlands site (100%)	8,096 Black Cockatoo potential breeding trees.	N/A
Conservation Category Wetlands (CCWs)	State	Impacts to 1.9 ha of CCWs comprised: <ul style="list-style-type: none"> • 0.5 ha Good condition; • 1.2 ha Degraded condition; and • 0.2 ha Completely Degraded condition. 	1.9 ha	5.7 ha ^C	Direct land acquisition and management of the Keysbrook site (100%)	43.1 ha of CCWs in predominantly Good condition.	Keysbrook site figures 5-7
Resource Enhancement Wetlands (REWs)	State	Impacts to 0.5 ha as a portion of one REW comprised: <ul style="list-style-type: none"> • 0.3 Excellent condition; • 0.1 Good condition; and 	0.5 ha	1.5 ha ^C	Direct land acquisition and management of the Keysbrook site (100%)	15.18 ha of REWs in predominantly Completely Degraded condition.	Keysbrook site figures 5-7

Environmental value/MNES	Listing	Significant residual impacts to Footprint ^A	Total quantum of impact	Minimum area to offset	Offsets Strategy	Comparable environmental values of the offset site	Figure reference
		<ul style="list-style-type: none"> 0.1 Degraded condition. 					
Bush Forever site 304 (Whiteman Park)	State	Impacts to 17.2 ha of Bush Forever comprised of: <ul style="list-style-type: none"> 0.3 ha of Very Good condition; 0.3 ha of Very Good - Good condition; 3.9 ha of Good condition; 2.1 ha of Good - Degraded condition; and 10.6 ha of Degraded condition. 	17.2 ha	34.4 ha ^C	Direct land acquisition and management of the Keysbrook site (100%)	257.3 ha of Bush Forever in predominantly Degraded condition.	Keysbrook site figures 5-7

A - Calculated based on information provided within the Malaga to Ellenbrook Rail Works Environmental Review Document (ERD) (PTA 2020).

B - Calculated using the Commonwealth Offsets Calculator unless otherwise indicated.

C - Calculated using assigned offset ratios.

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Appendix H - Lowlands Site Management Plan
Appendix I - WA Offset Template

1. Introduction

1.1. Project overview

The Public Transport Authority of Western Australia (PTA) is proposing to develop the Malaga to Ellenbrook Rail Works (the Proposal) as part of the Western Australian Government's METRONET vision. The Proposal is located between 12 to 22 kilometres (km) north-east of the Perth Central Business District (CBD), within the City of Swan. The Proposal connects to the proposed Bayswater to Malaga railway line at the eastern edge of the Tonkin Highway road reserve.

The Proposal includes the installation of 13 km of new dual railway track which spurs off the proposed Bayswater to Malaga Rail Works line, including the construction and operation of three new stations at Malaga, Whiteman Park and Ellenbrook with intermodal rail, bus, carpark, and active mode (cycling and walking) facilities at each station and a potential rail stabling facility. A potential future station is also proposed at Bennett Springs (Figure 1).

The Proposal's 463.8 ha Development Envelope extends east from the Tonkin Highway, north of Marshall Road to Bennett Springs where the railway alignment turns to the north to run adjacent to Drumpellier Drive (formerly Lord Street), passing under Gnangara Road and turning to the northeast to terminate south of The Parkway in Ellenbrook (Figure 1). Predicted direct impacts will be incurred within the 249 ha Indicative Footprint (hereinafter the Footprint) (Figure 1).

The PTA has considered and applied avoidance, minimisation and mitigation measures within the Proposal's Environmental Review Document (PTA 2020). Significant residual environmental impacts of the Proposal are proposed to be managed in accordance with this Draft Offsets Strategy.

1.2. Regulatory context

The significant residual environmental impacts of the Proposal and appropriate offsets to counterbalance these impacts were identified and assessed in accordance with the following legislation, policy and guidelines:

- *Environmental Protection Act 1986* (EP Act) (Government of Western Australia 2019a);
- *WA Environmental Offsets Policy* (Government of Western Australia 2011);
- *WA Environmental Offsets Guidelines* (Government of Western Australia 2014a);
- *WA Environmental Offsets Template* (Government of Western Australia 2014b);
- *State Planning Policy 2.8* (SPP 2.8) (Western Australian Planning Commission 2010);
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Australian Government 2019);
- EPBC Act *Environmental Offsets Policy* (Australian Government 2012a); and
- *Commonwealth Offsets Assessment Guide* (Australian Government 2012b).

1.3. Regulator assessment of the Proposal

The Proposal has been submitted to the Department of Environment and Water Regulation (DWER) and the Commonwealth Department of Water, Agriculture and Environment (DAWE) for assessment.

1.3.1. Western Australia

The PTA referred the Proposal to the Environmental Protection Authority (EPA) on 24 December 2019 under Section 38 of the *Environmental Protection Act 1986* (EP Act). The EPA determined on 18 February 2020 that the Proposal would be formally assessed under the EP Act, with the level of assessment set as Public Environmental Review (PER) with a two week public review period. The PTA prepared the Environmental Scoping Document (ESD) on behalf of the EPA, and the EPA subsequently published the ESD on 1 May 2020 which sets out the matters to be addressed in the Environmental Review Document (ERD).

1.3.2. Commonwealth

The PTA referred the Proposal to the Commonwealth Department of the Environment and Energy (DEE, now the Department of Agriculture, Water and the Environment (DAWE)) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 23 September 2019 and the delegate for the Minister for the Environment determined on 24 December 2019 that the proposal is a Controlled Action under section 75 of the EPBC Act, requiring further assessment and approval. On 16 March 2020, the Commonwealth published the decision on the assessment approach, that the Proposal will undergo an accredited assessment.

1.4. Objectives

The objectives of this Draft Offsets Strategy are to:

1. Provide the Department of Water and Environmental Regulation (DWER) and DAWE evidence of the PTA's ability to meet its offsets requirements.
2. Outline the PTA's proposed Draft Offsets Strategy to counterbalance anticipated significant residual environmental impacts of the Proposal, in accordance with relevant State and Commonwealth policy and guidance (refer to Section 1.2).

1.5. Scope

The scope of this Draft Offsets Strategy is as follows:

- Outline the Proposals' significant residual environmental impacts to State listed environmental values and Matters of National Environmental Significance (MNES).
- Apply the *WA Environmental Offsets Template* (Government of Western Australia 2014b) and/or the *Commonwealth Offsets Assessment Guides* (Australian Government 2012b) (referred to throughout as the 'Commonwealth offset calculator') to the Proposal's significant residual environmental impacts to estimate the total quantity of offsets that may be required to meet regulatory guidelines.
- Identify the proposed offsets strategy to counterbalance the Proposal's significant residual environmental impacts in accordance with State and Commonwealth environmental offsets policy and guidance (refer to Section 1.2).
- Demonstrate that available offsets presented within this Draft Offsets Strategy will counterbalance the Proposal's significant residual impacts.

1.6. Key environmental factors and MNES

This Draft Offsets Strategy relates to the following environmental factors:

- Flora and vegetation;
- Terrestrial fauna; and
- Inland waters.

Construction and operation of the Proposal will result in direct and indirect impacts associated with the clearing of conservation significant vegetation and fauna habitat. Indirect impacts will be managed in accordance with site-specific management plans and therefore will not be offset (PTA 2020).

After application of the mitigation hierarchy, and completion of studies and environmental impact assessment, the Proposal's significant residual impacts are in relation to:

MNES:

- Banksia Woodlands of the Swan Coastal Plain (SCP) Threatened Ecological Community (TEC) - endangered and Priority Ecological Community (PEC) - Priority 3 (P3).
- Carnaby's Cockatoo (*Calyptorhynchus latirostris*) - endangered.
- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) - vulnerable.
- Baudin's Cockatoo (*Calyptorhynchus baudinii*) - endangered.

State matters of environmental significance:

- Bush Forever.
- Conservation Category Wetlands (CCWs).
- Resource Enhancement Wetlands (REWs).

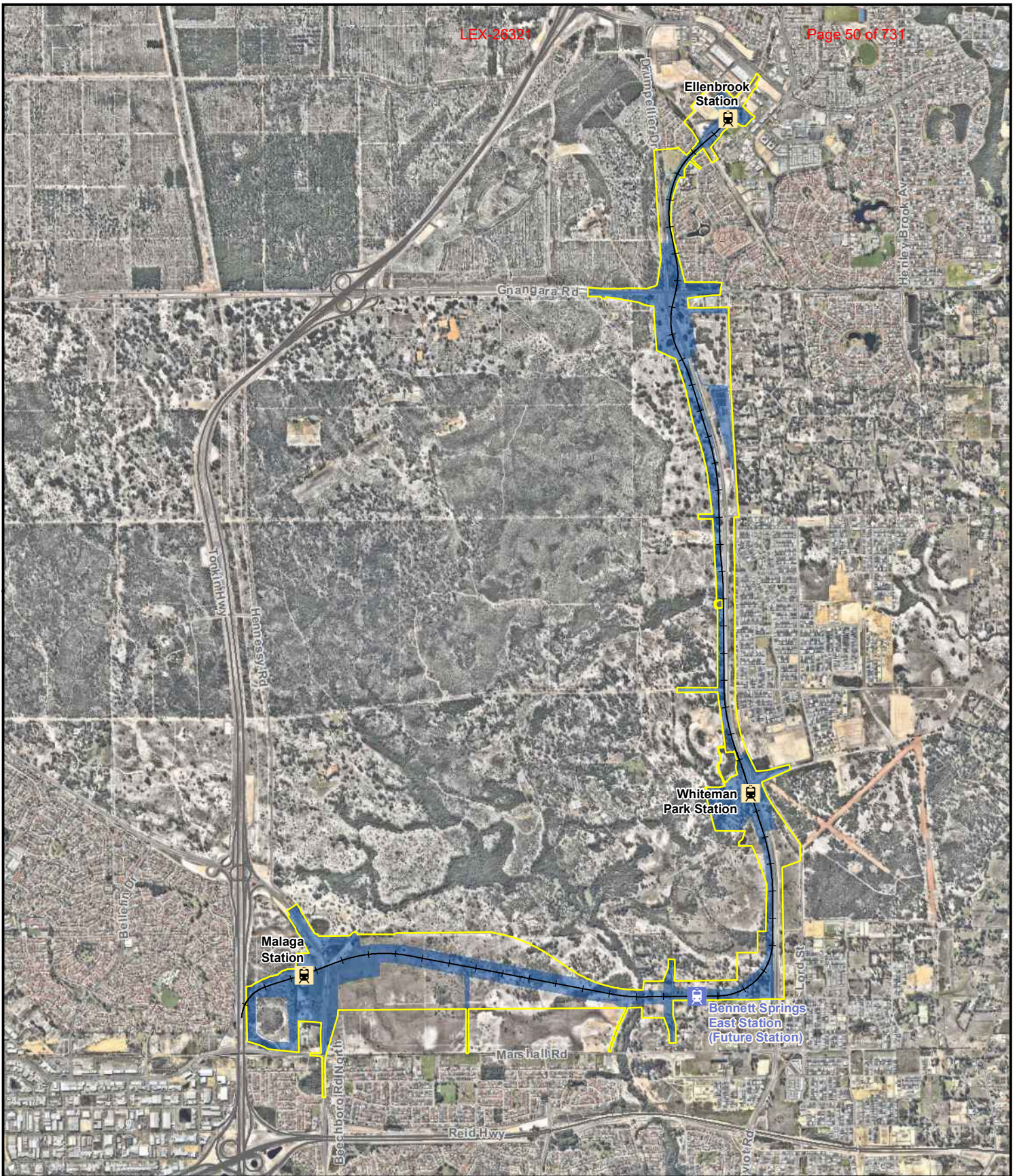
1.7. Assumptions and limitations

The following assumptions have been made in the preparation of this Draft Offsets Strategy:

- The information presented in this version of the Draft Offsets Strategy is accurate at the time of writing.
- Information obtained from publically available government databases and/or datasets was considered to be accurate at the time of writing.
- The PTA understands that the Department of Biodiversity, Conservation and Attractions (DBCA) are currently revising the current Geomorphic Wetlands Swan Coastal Plain (SCP) dataset (DBCA-019). The DBCA have advised that the revised geomorphic wetland mapping is currently in the process of receiving internal DBCA approval and will potentially be released in the second half of 2020. As this information is not currently publically available nor approved, the PTA has utilised the current DBCA Geomorphic Wetlands SCP dataset (DBCA-019) (Department of Biodiversity, Conservation and Attractions 2020).
- Native Vegetation Retention Areas are designated areas within the Development Envelope that will not be directly impacted by this Proposal, and therefore do not require offsetting.
- Data has been rounded to one decimal place for the purposes of this document, with the exception of TEC/PEC data which has been rounded to two decimal places in accordance with DWER advice. As a conservative measure, decimals places were rounded up to ensure proposed offsets areas are compliant with guidelines.
- The PTA have a portfolio of advanced direct land acquisition offset sites available for use to counterbalance significant residual impacts of METRONET proposals. 'Banked' sites will be applied as offset sites in this Draft Offsets Strategy.
- Proposed offsets sites have undergone environmental values assessments (EVAs) to inform this Draft Offsets Strategy.
- The PTA has sought written in-principle DWER and DAWE endorsement for the purchase of advanced indirect offsets to counterbalance a portion of the Proposal's impact to Black Cockatoos. The indirect offset is to provide funding to Murdoch University to conduct their

Black Cockatoo research proposal. At the time of writing, the DWER and DAWE had not provided a response. This Draft Offsets Strategy has included the indirect advanced Black Cockatoo research proposal offset to partially counterbalance the Proposal's significant residual impacts to Black Cockatoos.

- This Draft Offsets Strategy does not include mapping to illustrate the extent of environmental values allocated as offsets at each offset site, but demonstrates that the PTA can provide suitable offset options to counterbalance each of the Proposal's anticipated significant environmental impacts. Offset allocation mapping and an IBSA data package will be included in the final Offsets Strategy.
- This Draft Offsets Strategy will be finalised based on Proposal approval and in accordance with approval conditions issued by the DWER and DAWE. The final Offsets Strategy will take into consideration results of further studies/surveys and associated data, therefore, the final document may contain deviations from information presented within this Draft Offsets Strategy.



METRONET | Malaga to Ellenbrook Rail Works Draft Offsets Strategy
 Figure 1 Indicative Project Footprint

Legend

- Development Envelope
- Indicative Footprint
- Proposed Railway Station
- Proposed Railway Station (Future)
- Indicative Railway Alignment



Date Printed: 3/06/2020
 Created By: K.Du
 Approved by: C.Baxter

Scale: 1:45,000 @ A4
 Coordinate System: GDA 1994 MGA Zone 50

2. Significant Residual Environmental Impacts

2.1. Proposal Significant Residual Environmental Impacts

Following consideration and application of avoidance, minimisation and mitigation measures using the State Residual Impact Significance Model (RISM) (provided in Appendix A), and based on the results of current studies, the Proposal's Development Envelope and Footprint, the following residual environmental impacts outlined in Table 1 are considered significant and the PTA are proposing offsets to counterbalance these impacts.

Table 1: Proposal's Significant Residual Environmental Impacts

Environmental Value/MNES	State/Commonwealth listing	Significant residual environmental impact to be offset	Proposed Offsets Strategy
Banksia Woodlands of the SCP TEC / PEC	State and MNES	10.05 ha	Refer to Section 4.2
Carnaby's Cockatoo foraging habitat	State and MNES	81.4 ha	Refer to Sections 4.2 and 4.4
Forest Red-tailed Black Cockatoo foraging habitat	State and MNES	68.1 ha	Refer to Sections 4.2 and 4.4
Baudin's Cockatoo foraging habitat	State and MNES	81.4 ha	Refer to Sections 4.2 and 4.4
Black Cockatoo potential breeding trees	State and MNES	423 trees, 33 with (unsuitable) hollows	Refer to Sections 4.2 and 4.4
CCWs	State	Clearing of 1.9 ha of CCWs comprising of portions of: UFI 8429 - 0.1 ha UFI 8728 - 1.2 ha UFI 15259 - 0.6 ha	Refer to Section 4.3
REWs	State	Clearing of 0.5 ha as a portion of one REW UFI 8678	Refer to Section 4.3
Bush Forever	State	Clearing of 17.2 ha of vegetation in Bush Forever Site 304 (Whiteman Park) in Degraded or better condition	Refer to Section 4.3

2.2. Banksia Woodlands

2.2.1. Description

The Commonwealth-listed Banksia Woodlands of the SCP (Banksia Woodlands TEC) is restricted to the SCP Interim Biogeographic Regionalisation for Australia (IBRA) bioregion and immediately adjacent areas, including the Dandaragan Plateau, from Jurien Bay in the north, to Dunsborough in the south, and northwest on the Whicher and Darling escarpments. It typically occurs on well-

drained, low nutrient soils on sandplain landforms, particularly deep Bassendean and Spearwood sands and occasionally on Quindalup sands (Commonwealth of Australia, 2016).

The Banksia Woodlands TEC is described in the EPBC Act *Approved Conservation Advice* (TSSC 2016) as:

A Woodland associated with the Swan Coastal Plain of southwest Western Australia. A key diagnostic feature is a prominent tree layer of Banksia, with scattered eucalypts and other tree species often present among or emerging above the Banksia canopy. The understorey is a species rich mix of sclerophyllous shrubs, graminoids and forbs. The ecological community is characterised by a high endemism and considerable localised variation in species composition across its range.

The conservation objective under the *Approved Conservation Advice* (TSSC 2016) is to mitigate the risk of extinction of this ecological community, and help recover its biodiversity and function, through protecting it using the EPBC Act and implementing priority conservation actions.

The three key approaches to achieve the conservation objective under the *Approved Conservation Advice* (TSSC 2016) are:

1. Protect the ecological community to prevent further loss of extent and condition;
2. Restore the ecological community within its original range by active abatement of threats, re-vegetation and other conservation initiatives; and
3. Communicate with and support researchers, land use planners, landholders, land managers, community members, including the Indigenous community, and others to increase understanding of the value and function of the ecological community and encourage their efforts in its protection and recovery.

The *Approved Conservation Advice* (TSSC 2016) indicates high conservation value, unmodified and older growth areas are particularly important for retention and management and areas that form important landscape connections, such as wildlife corridors or other patches of particularly high quality or regional importance should be retained.

While TECs are formally protected under the Western Australian *Biodiversity Conservation Act 2016* (BC Act) and/or the EPBC Act, PECs are defined by the DBCA and include ecological communities of conservation concern not listed under the BC Act.

The Banksia Woodlands TEC impacted by the Proposal is directly synonymous with the Banksia Dominated Woodlands of the SCP PEC (Priority 3) community listed by the DBCA (DBCA technical advice, May 2020). There are no areas of the PEC within the Development Envelope that extend beyond the boundary of the Banksia Woodlands TEC. The discussion below is applicable to both the TEC and the PEC.

2.2.2. Significant residual impact

The Proposal will result in the clearing of no more than 10.05 ha of Banksia Woodlands TEC (including the Banksia Woodlands PEC) in two patches comprising of:

- 7.01 ha of vegetation in Very Good condition;
- 2.31 ha of vegetation in Good condition; and
- 0.73 ha of vegetation in Degraded condition.

Both patches have been assessed as comprising floristic community type (FCT) SCP23a.

2.2.3. Total quantum of impact

An environmental offset for the clearing of 10.05 ha of Banksia Woodlands of the SCP TEC (including the Banksia Woodlands PEC) will be provided. Table 2 calculates the total quantum of impact based on the total area impacted by the Proposal and quality.

The proposed direct offset is discussed in Section 4.2.

Table 2: Banksia Woodlands TEC (including Banksia Woodlands PEC) impact calculations in accordance with the Commonwealth Offset Calculator

Criteria	Value	Explanation
Impact area (ha)	10.05	The Proposal will result in the clearing of no more than 10.05 ha of Banksia Woodland TEC, which includes the Banksia Woodlands PEC within the Footprint.
Quality (scale 0-10)	8	The value of 8 has been applied in the calculator to reflect the majority of the Banksia Woodlands TEC (including the Banksia Woodlands PEC) being in Very Good condition.
Total quantum of impact (ha)	8.04	Adjusted based on assessment of quality.

2.3. Black Cockatoo foraging habitat

2.3.1. Carnaby's Cockatoo habitat

During the breeding season, Carnaby's Cockatoo (*Calyptorhynchus latirostris*) forage in native vegetation that surrounds woodlands used for breeding. During the non-breeding season, Carnaby's Cockatoo forage extensively on:

- Banksia woodlands on the Swan Coastal Plain, including the Perth metropolitan area and Banksia heath on the southern coast;
- Seeding Marri and Jarrah;
- Pine plantations, seasonally, such as that on the Swan Coastal Plain; and
- Native and non-native plants around the Perth metropolitan area, such as liquid amber (Australian Government 2016a).

Breeding habitats (or sites) encompass those areas that contain suitable breeding trees within the range of the species, and associated foraging habitat. Carnaby's Cockatoo's nest in the large hollows of tall living or dead Eucalypts. Formerly breeding activity was typically restricted to Eucalypt woodlands mainly in the Wheatbelt, but recent breeding activity records indicate the species has expanded its breeding range west and southward into the Jarrah-Marri forests of the Darling Scarp and into the Tuart forests of the Swan Coastal Plain, including the Yanchep area, Lake Clifton and near Bunbury (Australian Government 2016a).

2.3.2. Forest Red-tailed Black Cockatoo habitat

Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) are endemic to the humid and sub-humid zones of the south-west of Western Australia, generally inhabiting the Jarrah, Marri and Karri forests within the 600mm average rainfall isohyet. Their current distribution ranges from north of Perth to Augusta and Albany and east to Mount Helena, Christmas Tree Well, North Bannister, Mt Saddleback, Rocky Gully and the upper King River. Family groups and small flocks are now also observed on the Swan Coastal Plain throughout the year. The critical breeding habitat for this

species is within remnant patches of old Marri (*Corymbia calophylla*) trees within the Northern and Southern Jarrah Forest IBRA sub-regions (Government of Western Australia 2017).

Roost sites are in Jarrah-Marri-Blackbutt habitat generally situated within 4 km of potential feeding sites. They are most often observed in small flocks at dawn or dusk as they leave or return to a roost site. Approximately 90% of the Forest Red-tailed Black Cockatoo diet is made up of Marri (*Corymbia calophylla*) seeds and Jarrah (*Eucalyptus marginata*) fruit, but they will also feed on the following:

- Blackbutt (*Eucalyptus patens*);
- Karri (*Eucalyptus diversicolor*);
- Sheoak (*Allocasuarina fraseriana*);
- Snottygobble (*Persoonia longifolia*);
- Hakea species;
- The introduced Spotted Gum (*Eucalyptus maculata*); and
- The exotic Cape Lilac (*Melia azedarach*) on the Swan Coastal Plain (Government of Western Australia 2017).

2.3.3. Baudin's Cockatoo habitat

Baudin's Cockatoo (*Calyptorhynchus baudinii*) mainly occurs in Eucalypt forests, especially Jarrah, Marri and Karri forest and is less frequent in partly cleared farmlands and urban areas, including roadside trees and house gardens (Johnstone and Kirkby 2008).

Baudin's Cockatoo breeds in the Jarrah, Marri and Karri forests of the far south-west in areas averaging more than 750 mm of rainfall annually. Breeding generally occurs in woodland or forest, but may also occur in former woodland or forest now present as isolated trees. Areas of breeding are also known from the southern Swan Coastal Plain, the south coast region and the southern Wheatbelt region around Kojonup. Nesting occurs in hollows in live or dead trees of Karri, Marri, Wandoo and Tuart (*Eucalyptus gomphocephala*) (Australian Government 2016b). During the breeding season feeding primarily occurs in native vegetation, particularly Marri (Australian Government 2016b).

Outside the breeding season, the species feeds on Banksia and Hakea species, and *Erodium botrys* (wild geranium), as well as Dryandra species.

Baudin's Cockatoo sometimes associates with Carnaby's Cockatoo and the Forest Red-tailed Black Cockatoo's at sites where food is abundant (Higgins 1999; Saunders 1974b), most likely in Jarrah-Marri forest on the Darling Plateau. Breeding, foraging and roosting areas also overlap on the southern Swan Coastal Plain.

2.3.4. Significant residual impact

The Proposal will result in the clearing of no more than 81.4 ha of Carnaby's Cockatoo foraging habitat, including 81.4 ha of Baudin's Cockatoo and 68.1 ha of Forest Red-tailed Black Cockatoo foraging habitat, and 423 potential Black Cockatoo breeding trees.

2.3.5. Total quantum of impact

Carnaby's Cockatoo foraging habitat

An environmental offset for the clearing of 81.4 ha of Carnaby's Cockatoo foraging habitat, consisting of 42.8 ha of High quality, 11.3 ha of Moderate quality and 27.3 ha of Low quality habitat, will be provided.

Table 3 calculates the total quantum of impact based on the total area impacted by the Proposal and impacted foraging habitat quality.

The proposed direct offset is discussed in Section 4.2.

Table 3: Carnaby's Cockatoo foraging habitat impact calculations in accordance with the Commonwealth Offset Calculator

Criteria	Value	Explanation
Impact area (ha)	81.4	The Proposal will result in the clearing of 81.4 ha of Carnaby's Cockatoo foraging habitat.
Quality (scale 0-10)	6	Clearing of 81.4 ha of Carnaby's Cockatoo foraging habitat comprised of 42.8 ha of High quality habitat, 11.3 ha of Moderate quality and 27.3 of Low quality habitat within the Footprint. A quality rating of 6 has been applied as approximately 48% of the habitat is of Low-Moderate value, there were confirmed sightings of Carnaby's Cockatoo during the survey (Eco Logical Australia 2020) and the area is mapped by the DBCA as Carnaby's Cockatoo Areas requiring investigation as feeding habitat in the Swan Coastal Plain (SCP) IBRA Region (DBCA-057).
Total quantum of impact (ha)	48.8	Adjusted based on assessment of quality.

Forest Red-tailed Black Cockatoo foraging habitat

The clearing of Carnaby's Cockatoo foraging habitat includes a subset of 68.1 ha of Forest Red-tailed Black Cockatoo foraging habitat, consisting of 33.65 ha of High quality, 4.3 ha of Moderate quality and 30.2 ha of Low quality habitat. An environmental offset will be provided for this impact.

Table 4 calculates the total quantum of impact based on the total area impacted by the Proposal and impacted foraging habitat quality.

The proposed direct offset is discussed in Section 4.2.

Table 4: Forest Red-tailed Black Cockatoo foraging habitat impact calculations in accordance with the Commonwealth Offset Calculator

Criteria	Value	Explanation
Impact area (ha)	68.1	The Proposal will result in the clearing of 68.1 ha of Forest Red-tailed Black Cockatoo foraging habitat.
Quality (scale 0-10)	6	Clearing of 68.1 ha of Forest Red-tailed Black Cockatoo foraging habitat comprised of 33.6 ha of High quality habitat, 4.3 ha of Moderate quality and 30.2 ha of Low quality habitat within the Footprint. A quality rating of 6 has been applied as approximately 50% of the habitat is of Low-Moderate value and there were confirmed sightings of Forest Red-tailed Black Cockatoo during the survey (Eco Logical Australia 2020).
Total quantum of impact (ha)	40.7	Adjusted based on assessment of quality.

Baudin's Cockatoo foraging habitat

The clearing of Carnaby's Cockatoo foraging habitat includes 81.4 ha of Baudin's Cockatoo foraging habitat, consisting of 42.8 ha of Moderate quality and 38.6 ha of Low quality habitat. An environmental offset will be provided for this impact.

Table 5 calculates the total quantum of impact based on the total area impacted by the Proposal and impacted foraging habitat quality.

The proposed direct offset is discussed in Section 4.2.

Table 5: Baudin's Cockatoo foraging habitat impact calculations in accordance with the Commonwealth Offset Calculator

Criteria	Value	Explanation
Impact area (ha)	81.4	The Proposal will result in the clearing of 81.4 ha of Baudin's Cockatoo foraging habitat.
Quality (scale 0-10)	5	Clearing of 81.4 ha of Baudin's Cockatoo foraging habitat comprised of 42.8 ha of Moderate quality and 38.6 ha of Low quality habitat within the Footprint. A quality rating of 5 has been applied as the habitat is of Low-Moderate value. No Baudin's Cockatoo were sighted during the survey (Eco Logical Australia 2020) however it is understood the species may be a vagrant/visitor to the area, and potentially increasing its range due to expanding urban development in its previously mapped range.
Total quantum of impact (ha)	40.7	Adjusted based on assessment of quality.

2.4. Black Cockatoo potential breeding trees**2.4.1. Description**

Black Cockatoos are known to breed in large hollow-bearing trees, generally within woodlands or forests. It is generally accepted that the size of the tree (measured as the diameter at breast height (DBH)) can be a useful indication of the hollow-bearing potential of the tree, in which the Black

Cockatoo is known to nest (Australian Government 2008). To protect the Black Cockatoo breeding habitat it is vital breeding trees are maintained and protected.

A breeding tree is a tree of species known to support Black Cockatoo breeding within the range of the species which either have a suitable nest hollow OR are of a suitable DBH to develop a nest hollow. For most tree species, suitable DBH is 500 mm. For salmon gum and wandoo, suitable DBH is 300 mm (Australian Government 2008).

2.4.2. Significant residual impact

Black Cockatoo Surveys (Eco Logical Australia 2020) undertaken of the Footprint identified that 423 potential breeding trees will be removed as part of the Proposal, of which 33 contained hollows. A Black Cockatoo hollow assessment survey (Kirkby 2020) determined that none of the hollows were considered suitable to be used by Black Cockatoos for breeding.

2.4.3. Required offset

An environmental offset will be provided to counterbalance the clearing of 423 Black Cockatoo potential breeding trees. Calculated on a 3:1 ratio, 1,269 existing Black Cockatoo potential breeding trees on a direct land acquisition site will be provided as an offset. The offset proposal is provided in Section 4.2.

2.5. Wetlands

2.5.1. Description

The Proposal is located on the Swan Coastal Plain where over a quarter of the land between Wedge Island and Dunsborough is identified as wetland. By area, 20 per cent of wetlands across the Swan Coastal Plain retain high ecological values, making them the highest priority for conservation.

The geomorphic wetlands on the SCP have been evaluated, and assigned a management category by the DBCA. The Geomorphic Wetlands SCP dataset (DBCA-019) describes the wetlands of the Swan Coastal Plain representing two main aspects, physical classification and environmental evaluation. As a minimum, mapping identifies the presence of wetlands, but it can also identify the wetland boundary, classification, and values, and assign the wetland to a management category on the basis of its values.

The Geomorphic Wetlands SCP dataset (DBCA-019) divides wetlands into the following categories:

- Conservation;
- Resource enhancement; and
- Multiple use (Department of Parks and Wildlife 2018).

The DBCA has indicated that the Geomorphic Wetlands SCP dataset (DBCA-019) has recently been revised based on recent wetlands surveys and assessments. The PTA understands that the new dataset is currently in the process of receiving internal DBCA approval and will potentially be released in the second half of 2020. For the purpose of this Draft Offsets Strategy the existing, publically available and approved Geomorphic Wetlands, SCP dataset (DBCA-019) will be applied.

The EPA recommends that significant residual impacts to CCWs are required to be offset (Environmental Protection Agency 2019).

2.5.2. Significant residual impact

The current Geomorphic Wetland SCP dataset (DBCA-019) indicates the following wetlands, considered significant, intersect the Footprint and may be directly impacted by the Proposal:

- CCWs:
 - Unique Feature Identifier (UFI) 8429;
 - UFI 8728; and
 - UFI 15259 (Bennett Brook).
- REW:
 - UFI 8678.

Wetland and riparian vegetation condition of the impacted CCWs and REW located within the Footprint, in accordance with DBCA Geomorphic Wetland SCP dataset (DBCA-019) and wetland assessments (Biologic 2020), is summarised in Table 6.

Table 6: Significant residual impacts to CCWs and One REW intersecting the Proposal's Footprint

Wetland UFI & Conservation Status	Total area of wetland (ha) ¹	Impacted within Footprint		
		Wetland extent (ha) & % of total wetland	Vegetation condition	Vegetation extent (ha)
8429 (CCW)	1.5	0.1 (6.5%)	Degraded	0.1
8728 (CCW)	3.8	1.2 (31.9%)	Degraded	1.0
			Completely Degraded	0.2
15259 (CCW)	88.8	0.6 (0.7%)	Degraded/ Completely Degraded	0.1
			Good	0.5
TOTAL CCWs	94.1	1.9	NA	1.9
8678 (REW)	2.3	0.5 (21.7%)	Excellent	0.3
			Good	0.1
			Degraded	0.1
TOTAL REW	2.3	0.5		0.5
TOTAL CCWs & REW	96.4	2.4	NA	2.4

1 - Based on DBCA Geomorphic Wetland SCP dataset (DBCA-019)

2.5.3. Required offset

An environmental offset will be provided to counterbalance impacts to the following wetlands within the Footprint:

- 1.9 ha of CCWs, including 1.4 ha of vegetation in Degraded or better condition; and
- 0.5 ha of REWs, including 0.5 ha of vegetation in Degraded or better condition.

Based on a 3:1 ratio, 5.7 ha of land containing existing CCWs and 1.5 ha of land containing existing REWs will be provided as a direct land acquisition offset. The offset proposal is provided in Section 4.3.

In addition to the required offset, areas directly impacted by clearing for the Proposal within the riparian zone of Bennett Brook, not required for permanent infrastructure or ongoing management of the railway, will be revegetated.

2.6. Bush Forever

2.6.1. Description

The Bush Forever Policy (Government of Western Australia 2000a) was developed by the Western Australian Government in 2000 which aimed to fulfil the Government's commitment to prepare a strategic plan for the conservation of bushland on the SCP portion of the Perth Metropolitan Region. The Bush Forever Policy (Government of Western Australia 2000a) was to be implemented as a whole of government initiative designed to identify, protect and manage regionally significant bushland. Along with the Bush Forever Policy (Government of Western Australia 2000a), the Western Australian Government released a directory of Bush Forever Sites (Government of Western Australia 2000b).

The Proposal will impact up to 64.7 of Bush Forever site 304 (Whiteman Park), a summary of Bush Forever site 304 (Whiteman Park) is provided in Table 7.

Table 7: Summary of Bush Forever site 304 (Whiteman Park)

Site Aspect	Comment
Bush Forever Reference No.	304
Local Authority	City of Swan
Total mapped area	2,801.22 ha
Area within the Footprint	64.7 ha
Vegetation within the Footprint	<ul style="list-style-type: none"> • Marri on low slopes and flats. • Low-lying Banksia woodland. • Banksia woodland on dune slopes and crests. • Melaleuca wetland/dampland. • Eucalyptus rudis wetland / dampland / creekline. • Modified/cleared
Vegetation condition within the Footprint	<ul style="list-style-type: none"> • 0.3 ha - Very Good; • 0.3 ha - Very Good-Good; • 3.9 ha - Good; • 2.1 ha - Good-Degraded; • 10.6 ha - Degraded; • 37.5 ha - Completely Degraded; and • 10.0 ha - Cleared.
Conservation significant flora within the Footprint	None found.
Conservation significant fauna within the Footprint	Fauna habitat for species including: <ul style="list-style-type: none"> • Carnaby's Cockatoo; • Forest Red-tailed Black Cockatoo;

Site Aspect	Comment
	<ul style="list-style-type: none"> • Baudin's Cockatoo; • Quenda/Southern Brown Bandicoot (<i>Isoodon obesulus obesulus</i>); and • Rainbow Bee-eater (<i>Merops ornatus</i>).
Wetlands	The site contains CCWs as well as REWs and multiple use wetlands (MUWs).
Ecological linkage	<p>The Development Envelope intersects two historically mapped ecological linkages:</p> <ul style="list-style-type: none"> • Greenways 13 is a north-south corridor connecting Gngangara-Moore River State Forest, Whiteman Park and remnant vegetation along Bennett Brook. The linkage is relatively unbroken, although southern parts are increasingly surrounded by urbanisation (PTA 2020 ref ELA 2019). The Development Envelope crosses this linkage at Bennett Brook, where a rail bridge is proposed to be constructed across the watercourse, allowing water flow and ecological function to be maintained beneath the infrastructure. • Greenways 32 - An east-west corridor connecting Whiteman Park to vegetation on the eastern side of Lord Street, such as the former Caversham airbase, and ultimately to Ellenbrook. This linkage is being increasingly affected by urban development. The Development Envelope intersects this linkage around Youle-Dean Road. This section is already fragmented by a number of roads including old Lord Street and the new Drumpellier Drive and associated kangaroo exclusion fencing. (PTA 2020 ref ELA 2020).

2.6.2. Significant residual impact

The Proposal will result in the clearing of no more than 17.2 ha of regionally significant bushland from within the Footprint. Regionally significant bushland is considered to be vegetation in Degraded or better condition (PTA 2020).

2.6.3. Required offset

Based on a 2:1 ratio, 34.4 ha of existing Bush Forever will be provided as an offset within a direct land acquisition site. The offset proposal is provided in Section 4.3.

3. Land acquisition sites

3.1. Lowlands site

3.1.1. Background

A land parcel on Lowlands Road in Mardella (referred to as the Lowlands site), comprising a total area of approximately 1,138 ha and contained within Bush Forever Site 368 was purchased by the Western Australian Planning Commission (WAPC) in 2014 as an 'Advanced offset'.

In 2012, the Western Australian Government consulted with the Commonwealth Government advising of their intention to purchase the Lowlands site due to its suitability for offsetting environmental impacts associated with the State's Strategic Assessment of the Perth and Peel Region (SAPPR). The State sought formal Commonwealth acknowledgement that the transfer to public ownership for conservation purposes would represent a significant conservation gain as part of a future environmental offsets package for the SAPPR.

The Commonwealth agreed in principle that the Lowlands site could form part of an overall offsets package in the MNES Plan being developed as part of the SAPPR. The Commonwealth also acknowledged that the Commonwealth Offsets Policy (Australian Government, 2012) allows 'advanced offsets' where the offset is secured before the impact of an action(s) occurs.

Following this advice, the Lowlands Site was purchased by the WAPC in 2014 and a Class 'A' conservation reserve status was applied in 2015. Elevation of conservation status to Class A was conducted in 2015 for urgent management reasons and to honour the agreement made with the former private landowner.

Although the SAPPR is currently on hold, the environmental impacts of the METRONET rail infrastructure proposals were included in the original SAPPR calculations. Therefore in 2019, the Lowlands site (i.e. all 1,138 ha) was allocated by the State to the PTA to offset METRONET Proposals.

Allocation of the Lowlands site to offset significant residual environmental impacts of METRONET rail infrastructure proposals aligns with the:

- Principal State and Commonwealth Lowlands purchase agreement made in 2012.
- The State's original intention to purchase Lowlands as an advanced offset to offset significant residual environmental impacts of proposals included within the SAPPR.
- *WA Environmental Offsets Guidelines* (Government of Western Australia 2014a) "pre-impact" offsets guidelines.
- *Commonwealth Offsets Policy* (Australian Government, 2012) advanced offsets policy.
- Government of Western Australia (2014) and Australian Government (2012) guidance to identify and assess the suitability and appropriateness of proposed direct offsets.

A portion of the Lowlands site has been allocated to this Proposal. The remainder has been used to offset the TCL Proposal and it is also intended to be allocated to other METRONET proposals for offset purposes.

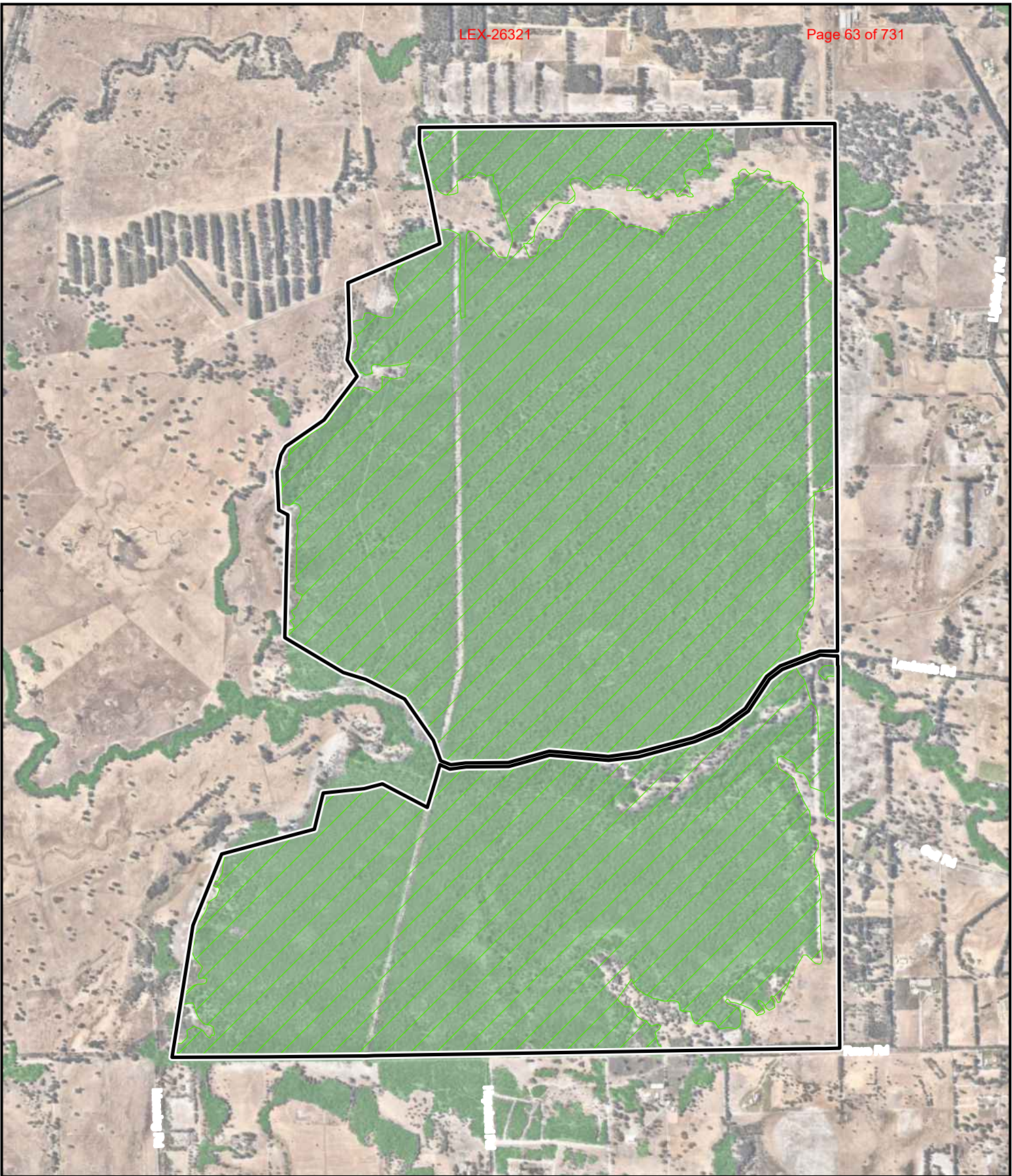
The total area of the site is appropriate and proportionate to the quantum of impact such that there is a net environmental gain for the values arising from the offset in the long-term.

3.1.2. Site description

A description of the Lowlands site is presented in Table 8.

Table 8: Lowlands site description

Site aspect	Description
Name of site	Lowlands
Address	Lot 301 Lowlands Road, Mardella
Lot on Plan	Lot 301 on Deposited Plan 77559
Local Government	Shire of Serpentine Jarrahdale (SSJ)
Local Zoning	Environment Conservation Reserve
Size	1,138 ha
Owner	The site is owned by the State of Western Australia, with the DBCA nominated as the responsible entity (a copy Certificate of Title is provided in Appendix B).
Land manager	The DBCA is the responsible management agency (refer to Certificate of Title, provided in Appendix B).
Allocation	The site was purchased as an Advanced offset in 2014 and entirely allocated to the PTA to offset METRONET Proposals in 2019.
Site plan	Figure 2 - Site plan for Lowlands site
Layout	<p>The site is irregular in shape with Lowlands Road reserve traversing the site in an east-west direction.</p> <p>The site is void of any structures with the vegetation in Good condition. This site has a waterway that travels adjacent to the Lowlands Road reserve and clearing is generally limited to tracks and fire breaks, with the exception of the south-eastern corner, which has been historically cleared.</p>
Encumbrances	<ul style="list-style-type: none"> • Access easement for the right of carriageway purposes; • Easement in favour of the electricity corporation; • Class A reserve for the purpose of conservation of flora and fauna limited to a depth of 200 m from the natural surface; and • Management Order - M845092.
Extent of site environmental values	<ul style="list-style-type: none"> • 926 ha - <i>Caladenia huegelii</i> potential habitat (Based on extent of Banksia Woodlands) (Vegetation condition - Excellent - 354.88 ha; Very Good - 403.99 ha; Good - 165.75 ha; Degraded 1.35 ha). • 926 ha - Banksia Woodland (Vegetation condition - Excellent - 354.88 ha; Very Good - 403.99 ha; Good - 165.75 ha; Degraded 1.35 ha). • 1,122 ha - Carnaby's Cockatoo foraging habitat (High Value – 940.3 ha; Low/Moderate Value - 181.7 ha). • 1063.72 ha - Baudin's and Forest Red-tailed Black Cockatoo foraging habitat (High Value – 940.3 ha; Low/Moderate Value - 181.7 ha). • 1,023.65 ha - Bush Forever. • 8,096 - Potential breeding trees. <p>The extent of <i>Caladenia huegelii</i> habitat, Banksia woodlands and Black Cockatoo foraging habitat and vegetation condition is shown on Figures 3 and 4.</p>



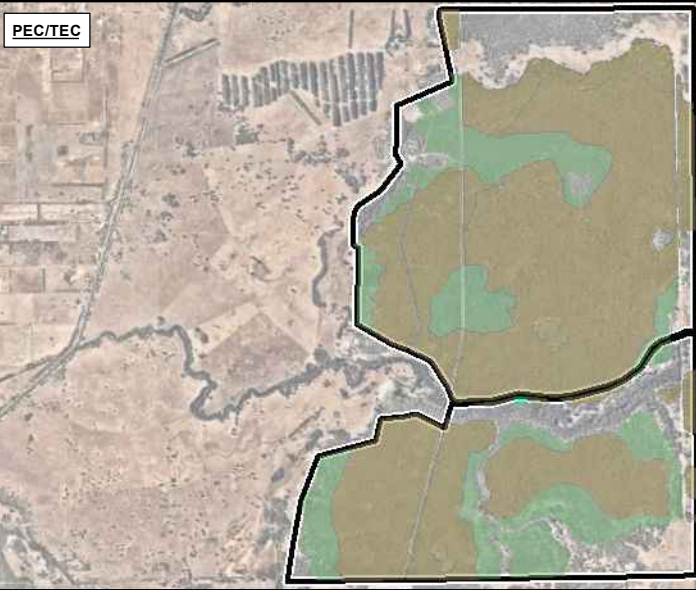
Site Plan for Lowlands Offset Site

Legend

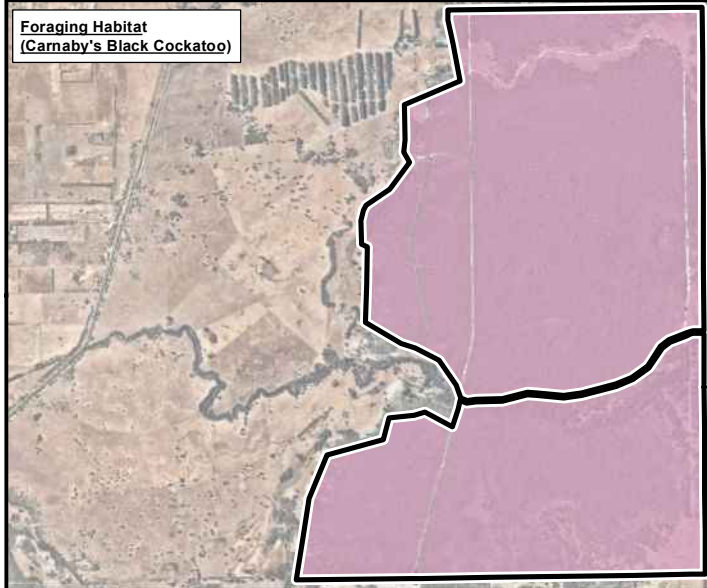
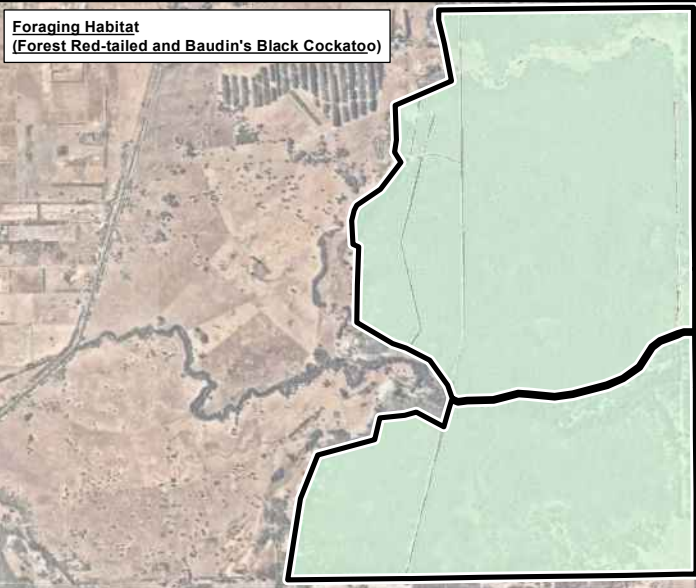
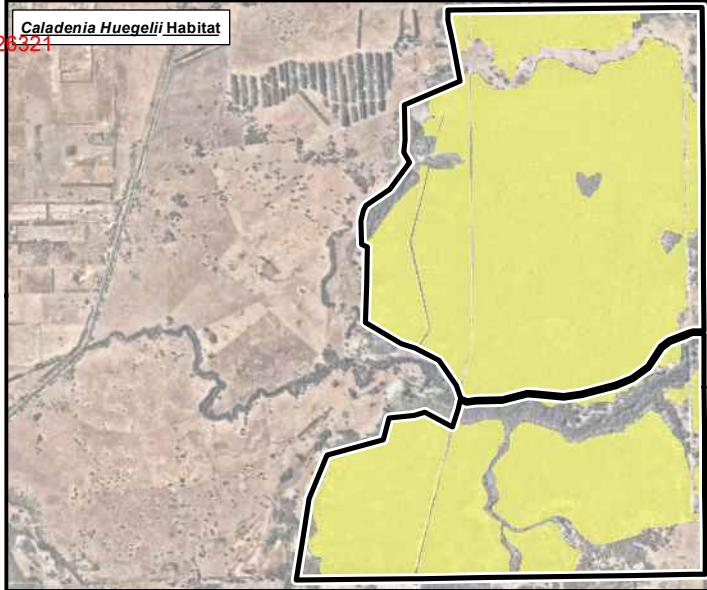


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Figure 3 Lowlands Offset Site Environmental Values

Legend

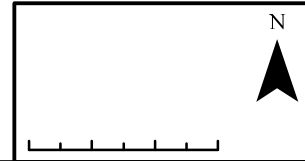
- PEC/TEC (GHD Vegetation Mapping, 2020)
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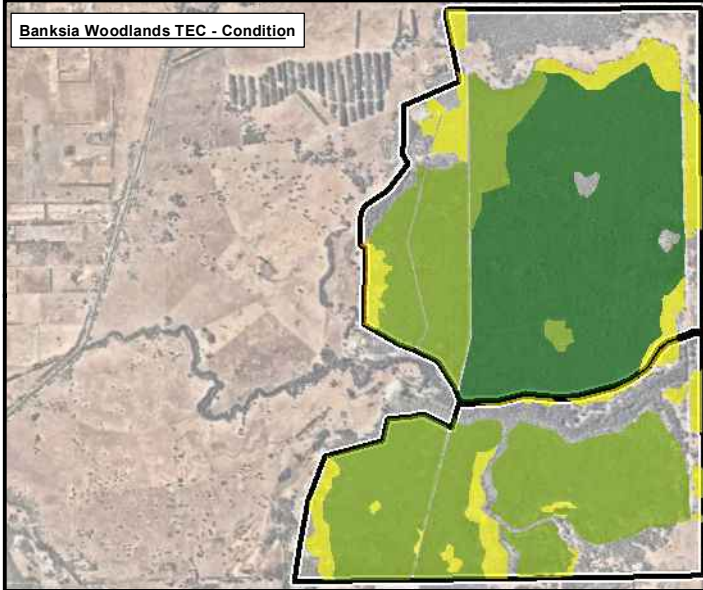
Vegetation Mapping (GHD, 2020)

- Caladenia Huegelii
- Haŋŋa
- Haŋŋa

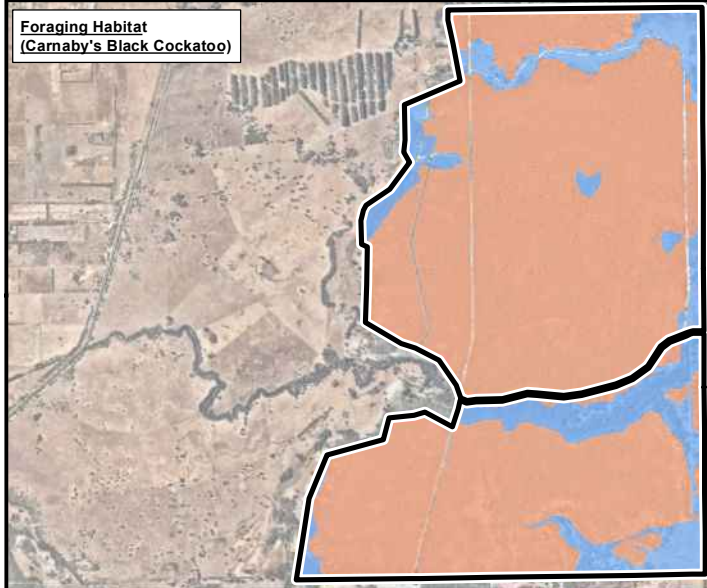
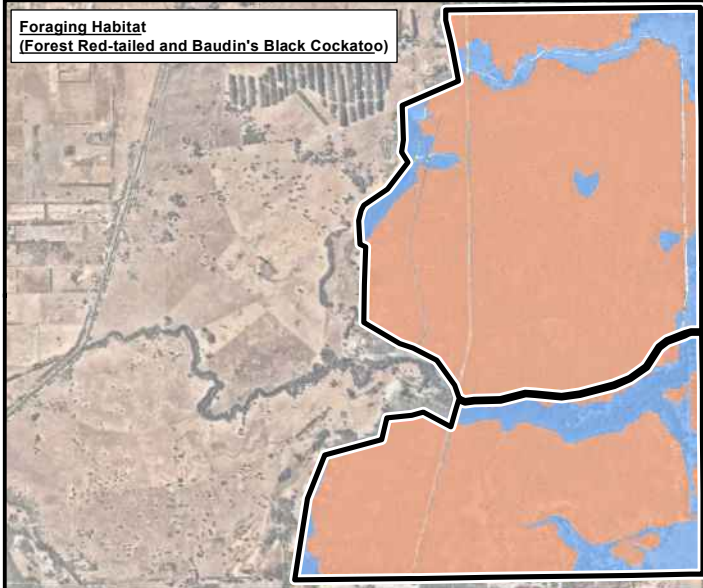
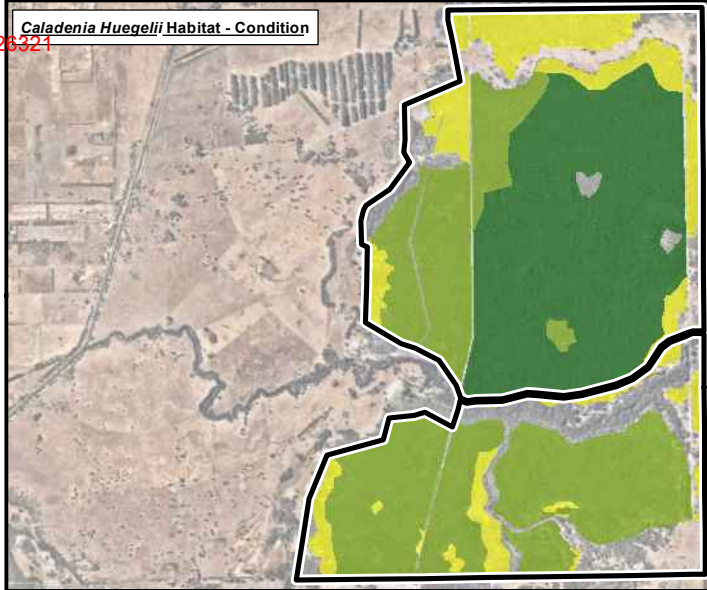
Foraging Habitat (GHD, 2020)

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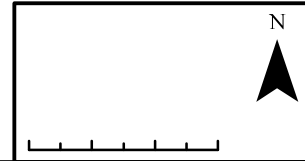
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 Figure 4 Lowlands Offset Site Environmental Condition

Legend

- Offset Site Boundary
- Vegetation Mapping (GHD, 2020)**
 - High
 - Medium
 - Low
 - Very Low
- Foraging Habitat (GHD, 2020)**
 - Foraging Habitat
 - Water



3.1.3. Environmental surveys

The following reports have been prepared based on environmental surveys conducted at the Lowlands site:

- *Floristics of Lowlands* (Keighery et. al 1995). This report was reviewed as part of the GHD (2020a) Lowlands Site desktop assessment scope of work.
- *METRONET Potential Offset Sites - Lowlands Site Environmental Values Assessment* (GHD 2020a). A copy of the report has been provided in Appendix C.
- *Lowlands Reserve Weed Survey - Final* (Woodgis 2020), a copy has been provided in Appendix D.

3.1.4. Environmental values

The Lowlands site is an intact area of native vegetation dominated by mixed Eucalyptus and Banksia woodlands. The site has small areas of partial clearings and lower elevation areas with associated damp land vegetation associations. The site is generally surrounded by cleared land with low-density semi-rural residential properties. The Serpentine River transects the central part of the site and there is some connectivity along this river via riparian woodland, and remnant patches of scattered trees in the surrounding setting provide some canopy connectivity. The environmental values survey identified four declared weeds, with one species listed as a weed of national significance (WONS). Since the completion of the GHD (2020a) survey, another environmental consultant (Woodgis 2020) was engaged to complete a comprehensive weed survey of the site, which will be used to develop weed management plans for the DBCA to implement through a Memorandum of Understanding (MOU).

The Lowlands site's environmental values are summarised in Table 9 and shown on Figure 2 and Figure 3. Vegetation condition mapping is provided in Figure 4.

Table 9: Lowlands site environmental values

Environmental value	Lowlands site description
Conservation categories	<ul style="list-style-type: none"> • Class 'A' conservation status - 1,122 ha • Bush Forever status - 1,122 ha (An amendment was approved on 28/02/2020 to Bush Forever site 368 to reserve the land to Parks and Recreation and to rationalise the boundary to the cadastre (WAPC 2019, Government of Western Australia 2020))
Native vegetation	The site consists of approximately 1001.5 ha of native vegetation, in Excellent to Degraded condition, with the majority of the vegetation in Excellent or Very Good condition. The site is mostly covered by vegetation, with some access tracks and fire breaks.
Regional vegetation complexes	<ul style="list-style-type: none"> • Southern River Complex; • Dardanup Complex; • Guildford Complex; and • Bassendean Complex-Central and South Complexes.
Vegetation types	<ul style="list-style-type: none"> • 712.6 ha - <i>Eucalyptus Banksia</i> woodland (EBw) (FCT21a and 23a); • 63.2 ha - <i>Allocasuarina Banksia</i> woodland (ABw) (FCT21c); • 3.3 ha - <i>Banksia ilicifolia</i> woodland (Biw) (FCT22); • 14.4 ha - <i>Corymbia calophylla</i> open woodland (Cw); • 143.9 ha - <i>Banksia Kunzea</i> woodland (BKw) (FCT21c); • 19.7 ha - <i>Eucalyptus Melaleuca</i> woodland (EMw) (FCT4); • 36 ha - <i>Eucalyptus rudis</i> forest (Ef) (FCT11); • 4.8 ha - <i>Melaleuca</i> woodland (Mw) (FCT5);

Environmental value	Lowlands site description						
	<ul style="list-style-type: none"> 0.6 ha - Tuart woodland (Tw); 120.6 ha - Scattered natives over weeds (Sn); and 16.9 ha - Tracks. 						
Vegetation condition	<ul style="list-style-type: none"> 712.58 ha - <i>Eucalyptus Banksia</i> woodland (EBw) (FCT21a and 23a) 312.7 ha - Excellent; 300.44 ha Very Good; 99.45 ha - Good. 63.23 ha - <i>Allocasuarina Banksia</i> woodland (ABw) (FCT21c) 42.18 ha - Excellent; 21.05 ha - Very Good. 3.27 ha - <i>Banksia ilicifolia</i> woodland (Biw) (FCT22) 3.27 ha - Good. 14.37 ha - <i>Corymbia calophylla</i> open woodland (Cw) 14.37 ha - Good. 146.91 ha - <i>Banksia Kunzea</i> woodland (BKw) (FCT21c) 82.5 ha - Very Good; 63.06 ha Good; 1.35 ha - Degraded. 19.69 ha - <i>Eucalyptus Melaleuca</i> woodland (EMw) (FCT4) 3.4 ha - Very Good; 15.57 ha Good; 0.55 ha Degraded. 19.69 ha - <i>Eucalyptus rudis</i> forest (Ef) (FCT11) 34.51 ha - Very Good; 1.53 ha - Good. 4.82 ha - <i>Melaleuca</i> woodland (Mw) (FCT5) 4.66 ha - Good; 0.17 ha Degraded. 0.57 ha - Tuart woodland (Tw) 0.57 ha - Good. 120.66 ha - Scattered natives over weeds (Sn) 120.66 ha - Degraded. 16.69 ha - Tracks 16.69 ha - Completely Degraded. 						
Conservation significant communities	<ul style="list-style-type: none"> Banksia woodlands of the SCP TEC; Low lying <i>Banksia attenuata</i> woodlands or shrublands (SCP21c) PEC; Banksia dominated woodlands of the SCP IBRA region PEC; and Tuart (<i>Eucalyptus gomphocephala</i>) woodlands of the SCP PEC. 						
Priority flora	<p>Four conservation significant flora have historically been recorded within the survey area:</p> <ul style="list-style-type: none"> <i>Caladenia huegelii</i> (listed as Endangered under the EPBC Act and Critically Endangered under the BC Act); <i>Drakaea elastica</i> (listed as Endangered under the EPBC Act and Critically Endangered under the BC Act); <i>Johnsonia pubescens</i> subsp. <i>cygnorum</i> (P2) listed by DBCA; and <i>Dillwynia dillwynioides</i> (Priority 3) listed by DBCA. <p>During the field survey a new location of <i>Johnsonia pubescens</i> subsp. <i>cygnorum</i> (Priority 2) was recorded.</p>						
Fauna habitat types	<p>Four broad fauna habitats were identified within the survey area based on the mapped vegetation types:</p> <ul style="list-style-type: none"> Mixed Eucalyptus Banksia Woodland; Flooded Gum Melaleuca woodlands; Riparian; and Pasture with scattered trees. 						
Black Cockatoo habitat	<p>During the one day field visit, Carnaby's Cockatoo were seen and heard calling over the survey area. Forest Red-tailed Black Cockatoos were also observed feeding at two locations during the subsequent two day field assessment. Foraging evidence (chewed Marri, Jarrah, Banksia and <i>Allocasuarina</i> nuts) were recorded extensively throughout the Mixed Eucalyptus Banksia Woodlands, and Scattered native tree habitat types with both Carnaby's and Forest Red-tailed Black Cockatoo distinctive mandible marks evident.</p> <p>A summary of the Black Cockatoo habitat is provided below:</p> <table border="1"> <thead> <tr> <th>Habitat Type</th> <th>Extent (ha)</th> <th>Comments</th> </tr> </thead> <tbody> <tr> <td>Breeding</td> <td>1,122</td> <td>Each of the habitat types provides for potential breeding habitat.</td> </tr> </tbody> </table>	Habitat Type	Extent (ha)	Comments	Breeding	1,122	Each of the habitat types provides for potential breeding habitat.
Habitat Type	Extent (ha)	Comments					
Breeding	1,122	Each of the habitat types provides for potential breeding habitat.					

Environmental value	Lowlands site description																														
	Foraging	1,122	The Mixed Eucalyptus Banksia woodland provide high foraging potential, and the scattered natives, Flooded Gum Melaleuca woodlands and Riparian habitat provide low to moderate potential foraging habitat.																												
	Roosting	36.6	Only the Riparian habitat was identified as being suitable for roosting activities.																												
Black Cockatoo potential breeding trees	GHD (2020a) states that the Lowlands site contains approximately 7.2 Black Cockatoo potential breeding trees per hectare, totalling an estimated 8,096 Black Cockatoo potential breeding trees within the site.																														
	<table border="1"> <thead> <tr> <th>Habitat Vegetation Type</th> <th>Extent (ha)</th> <th>Potential breeding trees - mean (trees/ha)</th> <th>Estimated potential breeding trees in habitat type</th> </tr> </thead> <tbody> <tr> <td>Mixed Eucalyptus Banksia Sheoak woodland</td> <td>940.3</td> <td>6.3</td> <td>5,923</td> </tr> <tr> <td>Scattered native trees</td> <td>120.6</td> <td>2.4</td> <td>289</td> </tr> <tr> <td>Flooded Gum Melaleuca woodland</td> <td>24.5</td> <td>4</td> <td>98</td> </tr> <tr> <td>Riparian</td> <td>36.6</td> <td>48.8</td> <td>1,786</td> </tr> <tr> <td>Total</td> <td>1,122.0</td> <td>-</td> <td>8,096</td> </tr> <tr> <td>Total estimated potential breeding trees / ha at the site</td> <td></td> <td></td> <td>7.2</td> </tr> </tbody> </table>			Habitat Vegetation Type	Extent (ha)	Potential breeding trees - mean (trees/ha)	Estimated potential breeding trees in habitat type	Mixed Eucalyptus Banksia Sheoak woodland	940.3	6.3	5,923	Scattered native trees	120.6	2.4	289	Flooded Gum Melaleuca woodland	24.5	4	98	Riparian	36.6	48.8	1,786	Total	1,122.0	-	8,096	Total estimated potential breeding trees / ha at the site			7.2
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Riparian	36.6	48.8	1,786																												
Total	1,122.0	-	8,096																												
Total estimated potential breeding trees / ha at the site			7.2																												
<i>Caladenia huegelii</i> potential habitat	<p>923 ha of vegetation is considered to be <i>Caladenia huegelii</i> potential habitat, assuming the following Banksia woodlands vegetation types provide suitable habitat;</p> <ul style="list-style-type: none"> • <i>Eucalyptus Banksia</i> woodland (EBw) (FCT21a and 23) - 712.6 ha • <i>Allocasuarina Banksia</i> woodland (ABw) (FCT-21c) – 63.2 ha • <i>Banksia ilicifolia</i> woodland (Biw) (FCT22) – 3.3 ha • <i>Banksia Kunzea</i> woodland (BKw) (FCT21c) – 143.9 ha. 																														
Wetlands	<p>According to GHD (2020a) and based on the DBCA Geomorphic Wetlands SCP database (DBCA – 019), there are eight wetlands that occur within or intersect the Lowlands site:</p> <ul style="list-style-type: none"> • Two CCWs – 4.6 ha <ul style="list-style-type: none"> ○ 3.17 ha - UFI 7296 ○ 1.43 ha - UFI 14848 • Four REWs – 10.64 ha <ul style="list-style-type: none"> ○ 1.77 ha - UFI 7244 ○ 1.6 ha - UFI 14744 ○ 6.42 ha - UFI 14749 ○ 0.85 ha - UFI 14846 • Two MUWs – 104.89 ha <ul style="list-style-type: none"> ○ 31.67 ha - UFI 15250 ○ 73.22 ha - UFI 16021 																														
Wetland condition	<p>Based on the GHD (2020a) survey report:</p> <ul style="list-style-type: none"> • Wetlands are comprised of the following habitat types: <ul style="list-style-type: none"> ○ 24.5 ha of Moderate value Flooded Gum Melaleuca woodlands: 																														

Environmental value	Lowlands site description
	<ul style="list-style-type: none"> ▪ Corresponding vegetation associations: Mw, Cw ▪ Comprised an overstorey of Paperbarks with occasional emergent Marri and Flooded gum over sparse to dense shrublands and mixed herbs and sedges, and introduced species such as Arum Lily. ▪ Occurs in lower elevation poor retainage damplands and ephemeral swamp areas. ▪ Moderate structural diversity, likely to be seasonally inundated. ○ 36.6 ha of High value riparian habitat: <ul style="list-style-type: none"> ▪ Corresponding vegetation associations: Ef, Emw, Tw. ▪ Includes banks of the Serpentine River, the waterway and associated tributaries, and sumpland areas. ▪ Comprises dense and very tall stands of Flooded gum forest with occasional Tuart and Paperbarks over Bracken and sedges. • Corresponding vegetation types within the wetlands include: <ul style="list-style-type: none"> ○ 19.7 ha of <i>Eucalyptus Melaleuca</i> woodland (EMw) (FCT4) ○ 30 ha of <i>Eucalyptus rudis</i> forest (Ef) (FCT 11) ○ 0.6 ha of Tuart woodland (Tw). ○ 4.8 ha of <i>Melaleuca</i> woodland (Mw) (FCT5) ○ 14.4 ha of <i>Corymbia calophylla</i> open woodland (Cw). <p>Wetland condition based on GHD (2020a) survey mapping data:</p> <ul style="list-style-type: none"> • 3.17 ha - UFI 7296 CCW – Good 2.67 ha, Degraded 0.50 ha. • 1.43 ha - UFI 14848 CCW – Good 0.85 ha, Degraded 0.58 ha. • 1.77 ha - UFI 7244 REW – Good 1.52 ha, Degraded 0.25 ha. • 1.60 ha - UFI 14744 REW – Very Good 1.15 ha, Good 0.32 ha, Degraded 0.13 ha. • 6.42 ha – UFI 14749 REW – Very Good 1.89 h, Good 4.52 ha, Degraded 0.01 ha. • 0.85 ha – UFI 14846 REW – Degraded 0.85 ha. • 31.67 ha - UFI 15250 MUW – Very Good 0.02 ha, Good 2.73 ha, Degraded 28.80 ha, Completely Degraded 0.12 ha. • 73.22 ha - UFI 16021 MUW – Very Good 4.07 ha, Good 13.24 ha, Degraded 52.64 ha, Completely Degraded 3.27 ha. <p>CCWs are comprised of the following vegetation types and extents:</p> <ul style="list-style-type: none"> • 0.85 ha - <i>Eucalyptus rudis</i> forest 0.85 ha Good • 2.68 ha - <i>Corymbia calophylla</i> open woodland 2.68 ha Good • 1.07 ha - Scattered natives over weeds 1.08 ha Degraded <p>REWs are comprised of the following vegetation types and extents:</p> <ul style="list-style-type: none"> • 0.72 ha - <i>Banksia Kunzea</i> woodland 0.40 ha Very Good, 0.31 ha Good, 0.01 ha Degraded • 1.52 ha - <i>Corymbia calophylla</i> open woodland 1.52 ha Good • 0.09 ha - <i>Eucalyptus Banksia</i> woodland 0.09 ha Very Good • 7.08 ha - <i>Eucalyptus Melaleuca</i> woodland 2.56 ha Very Good, 4.52 ha Good • 1.23 ha - Scattered natives over weeds 1.23 ha Degraded

3.1.5. Overlapping environmental values

Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo foraging habitat and potential breeding trees have all been identified by GHD (2020a) and the DBCA as occurring within the Low lying Banksia Woodlands of the SCP TEC mapped within the Lowlands site. Therefore, the proposed physical portions of the Lowlands site applied as the offset for these environmental values and MNES will likely overlap.

3.2. Keysbrook site

3.2.1. Background

A privately-owned lot in Keysbrook located within Bush Forever Site 77 (referred to as the Keysbrook site) was acquired by the WAPC in 2018. The State acquired the site as an 'Advanced offset' with the intention to use it to offset significant residual environmental impacts of WA Government Proposals. Through consultation with the WAPC, in 2019 the Keysbrook site was allocated to the PTA to offset METRONET Proposals. The site is zoned Rural and as part of this Offsets Strategy, the site is intended to be transferred to Parks and Recreation to increase its conservation status.

The Keysbrook site is located in the Shire of Serpentine Jarrahdale and is 257 ha. GHD (2020b) surveyed the site to assess environmental values and opportunities for on ground management actions to assess the site's suitability as a land acquisition offset.

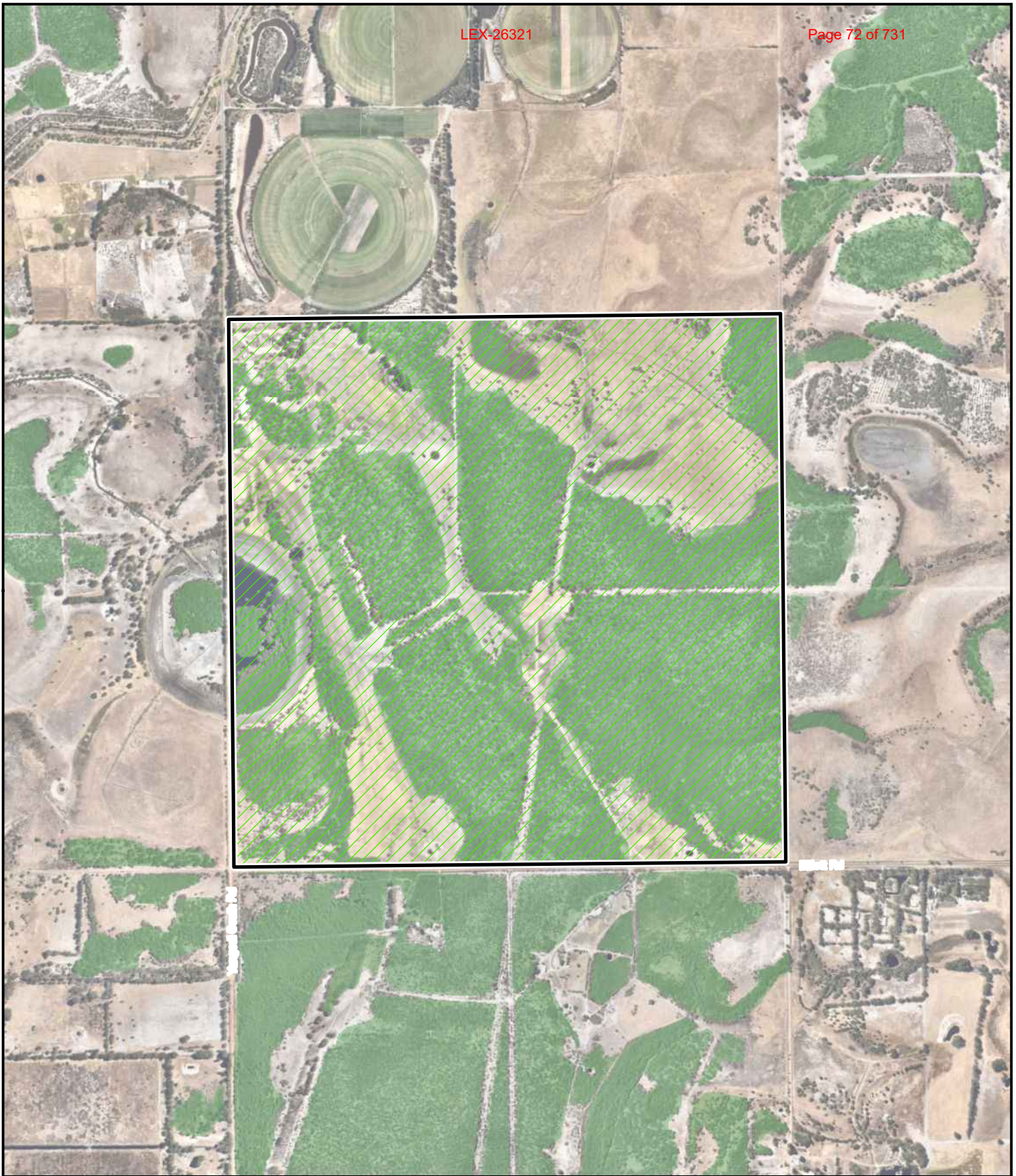
3.2.2. Site description

A description of the Keysbrook Site is presented in Table 10.

Table 10: Keysbrook site description

Site aspect	Description
Name of site	Keysbrook
Address	674 Yangedi Road, Keysbrook
Lot on Plan	Lot 77 on Plan 000739
Local Government	Shire of Serpentine Jarrahdale
Local Zoning	Rural
Size	257 ha
Owner	The site is owned by the WAPC.
Land manager	The site is currently managed by the WAPC.
Allocation	The site was purchased in 2018 and allocated to the PTA to offset METRONET proposals.
Site Plan	Figure 5 - Site plan for Keysbrook site
Layout	The site is regular in shape with road frontages of approximately 1610 m to both Elliot Road and Yangedi Road.
Encumbrances	Nil
Extent of site environmental values	<p>GHD (2020b) mapped values:</p> <ul style="list-style-type: none"> • 99.94 ha of Banksia low woodlands 99.94 ha in Degraded Condition. • 36.54 ha of <i>Melaleuca spp.</i> over a tall shrubland 9.28 ha in Good Condition and 27.26 ha in Degraded Condition. • 1.67 ha of <i>Melaleuca spp</i> low open woodland 1.67 ha in Degraded Condition. • 4.35 ha of <i>Melaleuca preissiana</i> low woodland 4.35 in Good Condition. • 110.48 ha of Black Cockatoo Breeding habitat. • 246 ha of Black Cockatoo foraging habitat 99.94 ha - High Quality; 147.02 ha - Low quality.

Site aspect	Description
	<ul style="list-style-type: none"> • 110.48 ha of Black Cockatoo Roosting habitat. • 257 ha of Bush Forever. <p>Extent of environmental values and vegetation condition are shown on Figure 6.</p>
Wetlands	<p>In accordance with DBCA data, the site contains approximately:</p> <ul style="list-style-type: none"> • 43.15 ha CCWs; • 15.17 ha REWs; and • 71.25 ha of Multiple use wetlands. <p>Extent and location of wetlands are mapped in Figure 6.</p>



Site Plan for Keysbrook Offset Site

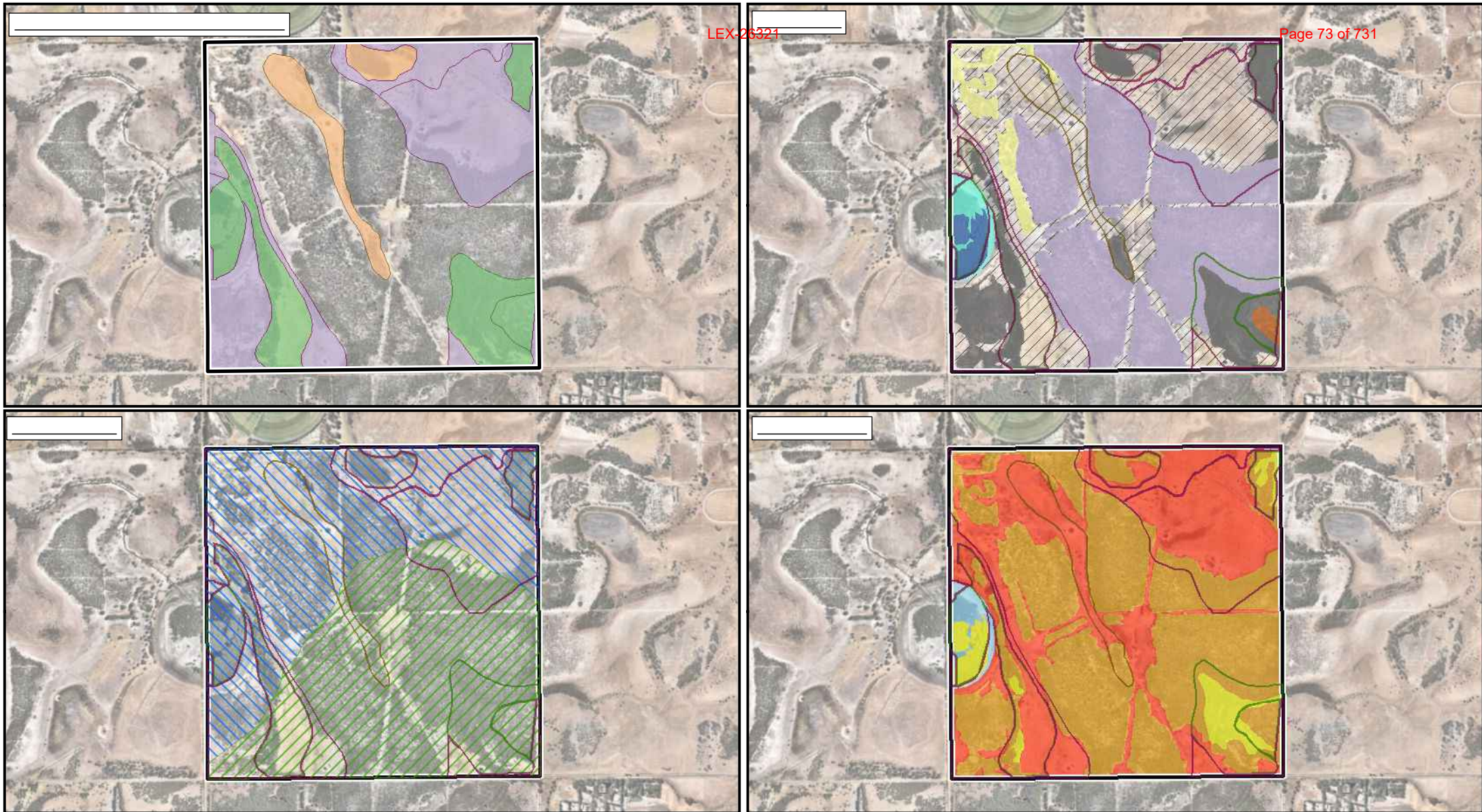
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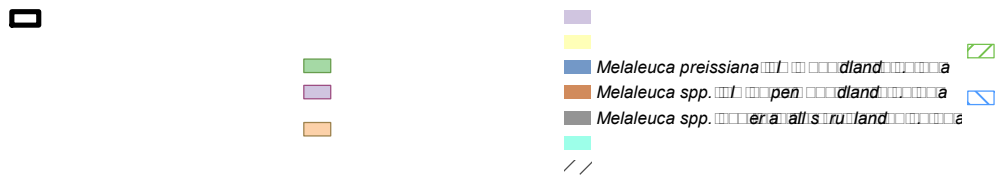


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 Figure 6 **Keybrook Offset Site Environmental Values**



3.2.3. Environmental surveys

The following environmental surveys have been conducted at the Keysbrook site:

- 671 Lot 77 Yangedi Road, Keysbrook Environmental Report for Bush Forever Area (Hollick 2014). This report was reviewed under the GHD (2020b) Keysbrook site environmental values survey scope of works.
- Keysbrook Site Environmental Values Assessment (GHD 2020b). A copy of the report has been provided in Appendix E.

3.2.4. Environmental values

The vegetation at the Keysbrook site ranges from Good to Completely Degraded. The majority of the site comprises Degraded and Completely Degraded vegetation. Completely Degraded areas were represented by cleared agricultural land that comprised of isolated occurrences of native trees over pasture. The Degraded condition is due to significant impact by cattle grazing and trampling. Areas in Good condition had dense mid-storey species such as *Astartea scoparia* and/or *Kunzea glabrescens* that inhibited the cattle grazing/movement. While the site is in a generally Degraded condition, it still holds a number of environmental values suitable for offsets. The environmental values of the site are anticipated to improve in condition over time as all cattle grazing has now been ceased as a result of the WAPC land purchase.

The DBCA Geomorphic Wetland SCP dataset (DBCA-019) has been used to assign wetland category and boundary extent within the Keysbrook site. GHD (2020b) was used to ascertain wetland condition.

The Keysbrook site's environmental values are summarised in Table 11 and Figure 6, based on the information presented in GHD (2020b).

Table 11: Keysbrook site environmental values

Environmental value	Keysbrook site description
Conservation categories	Bush Forever status - 257 ha
Native vegetation	The lot consists of approximately 152.25 ha of native vegetation, in Good to Degraded condition. The site also includes 100.73 ha of Completely Degraded vegetation and 4.43 ha of open water associated with the wetlands.
Regional vegetation complexes	<ul style="list-style-type: none"> • Southern River Complex; and • Bassendean Complex - Central and South.
Vegetation types	<ul style="list-style-type: none"> • 99.94 ha - <i>Banksia</i> low woodland (FCT23a); • 36.54 ha - <i>Melaleuca</i> spp. over a tall shrubland (S01); • 1.67 ha - <i>Melaleuca</i> spp. low open woodland (FCT15); • 4.35 ha - <i>Melaleuca preissiana</i> low woodland (S01); • 9.76 ha - Isolated native trees over weeds; • 100.73 ha - Cleared/agricultural land; and • 4.43 ha - Open water.
Vegetation condition	<ul style="list-style-type: none"> • 99.94 ha - <i>Banksia</i> low woodland (FCT23a) 99.94 ha Degraded. • 36.54 ha - <i>Melaleuca</i> spp. over a tall shrubland (S01) 9.28 ha Good and 27.26 ha Degraded. • 1.67 ha - <i>Melaleuca</i> spp low open woodland (FCT15) 1.67 ha Degraded. • 4.35 ha - <i>Melaleuca preissiana</i> low woodland (S01) 4.35 ha Good. • 9.76 ha - Isolated native trees over weeds 9.76 ha Degraded.

Environmental value	Keysbrook site description												
	<ul style="list-style-type: none"> • 100.73 ha - Cleared/ agricultural land 100.73 ha Completely Degraded. • 4.43 ha - Open water. 												
Conservation significant communities	<ul style="list-style-type: none"> • Forests and woodlands of deep seasonal wetlands (SCP15) (TEC); and • Banksia dominated woodlands of the SCP IBRA region (PEC). 												
Priority flora	<p>The desktop review noted that <i>Stylidium longitubum</i> (Priority 4) had historically been recorded within the survey area, and the site could potentially contain five conservation significant flora taxa. GHD (2019) however did not record any priority species during the survey.</p>												
Fauna habitat types	<p>The following four broad fauna habitats were identified within the survey area based on the mapped vegetation types:</p> <ul style="list-style-type: none"> • Mixed Banksia Woodland; • Isolated native and planted trees over weeds; • Wetlands; and • Melaleuca over tall shrubland. 												
Black Cockatoo habitat	<p>During the GHD (2020b) survey, seven Forest Red-tailed Black Cockatoos were observed within the Mixed Banksia Woodland. Feeding evidence on Marri nuts was also recorded within the isolated native and planted trees over weeds habitat type. Both Carnaby's and Forest Red-tailed Black Cockatoo are known to breed and roost in Marri, Jarrah and introduced eucalypts. The survey area is considered to provide foraging habitat, but limited roosting habitat and very limited (to nil) potential breeding habitat for both Black Cockatoo species.</p> <p>A summary of the Black Cockatoo habitat is provided below:</p> <table border="1"> <thead> <tr> <th>Habitat type</th> <th>Extent (ha)</th> <th>Comments</th> </tr> </thead> <tbody> <tr> <td>Breeding</td> <td>110.48</td> <td>Overall the habitats are likely to have very limited to nil breeding habitat present, and where present, the breeding habitat would be considered low quality. No hollows or potential hollow trees were observed during the reconnaissance level survey.</td> </tr> <tr> <td>Foraging</td> <td>99.94 ha of High Quality habitat 147.02 ha of Low Quality habitat</td> <td>The foraging extent is based on high level vegetation type (and fauna habitat) mapping, Mixed Banksia Woodland (99.94 ha), isolated native and planted trees over weeds (110.48 ha) and <i>Melaleuca</i> over tall shrubland (36.54 ha) contain suitable feeding species for Black Cockatoos.</td> </tr> <tr> <td>Roosting</td> <td>110.48</td> <td>Overall the habitats are likely to have limited (to nil) roosting habitat present, and where present, the roosting habitat would be considered low quality. An unconfirmed roost area (Department of Biodiversity, Conservation and Attractions 2018) intersects the southern boundary of the survey area.</td> </tr> </tbody> </table>	Habitat type	Extent (ha)	Comments	Breeding	110.48	Overall the habitats are likely to have very limited to nil breeding habitat present, and where present, the breeding habitat would be considered low quality. No hollows or potential hollow trees were observed during the reconnaissance level survey.	Foraging	99.94 ha of High Quality habitat 147.02 ha of Low Quality habitat	The foraging extent is based on high level vegetation type (and fauna habitat) mapping, Mixed Banksia Woodland (99.94 ha), isolated native and planted trees over weeds (110.48 ha) and <i>Melaleuca</i> over tall shrubland (36.54 ha) contain suitable feeding species for Black Cockatoos.	Roosting	110.48	Overall the habitats are likely to have limited (to nil) roosting habitat present, and where present, the roosting habitat would be considered low quality. An unconfirmed roost area (Department of Biodiversity, Conservation and Attractions 2018) intersects the southern boundary of the survey area.
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Wetlands	<p>According to GHD (2020b) and based on the DBCA Geomorphic Wetlands SCP database (DBCA – 019), there are 11 wetlands that occur within or intersect the Keysbrook site:</p> <ul style="list-style-type: none"> • Five CCWs – 42.18 ha <ul style="list-style-type: none"> ○ 3.41 ha - UFI 7000 ○ 14.06 ha - UFI 14725 ○ 6.8 ha - UFI 14727 ○ 4.02 ha - UFI 14763 												

Environmental value	Keysbrook site description
	<ul style="list-style-type: none"> ○ 13.89 ha - UFI 14798 ● Two REWs – 15.17 ha <ul style="list-style-type: none"> ○ 10.51 ha - UFI 7031 ○ 4.66 ha - UFI 14796 ● Four MUWs – 72.22 ha <ul style="list-style-type: none"> ○ 0.05 ha - UFI 14712 ○ 0.97 ha - UFI 14726 ○ 34.74 ha - UFI 15246 ○ 36.46 ha - UFI 16021
Wetland condition	<p>Based on the GHD (2020b) report the following vegetation types were identified within the Keysbrook site that are associated with wetlands:</p> <ul style="list-style-type: none"> ● 1.67 ha of <i>Melaleuca</i> spp low open woodland - <i>Melaleuca preissiana</i>, <i>M. teretifolia</i> and <i>M. viminea</i> low open woodland over *<i>Cotula coronopifolia</i>, *<i>Crassula natans</i> and <i>Lemna disperma</i> herbland (inundated) in Degraded condition (FCT 15); ● 4.35 ha of <i>Melaleuca preissiana</i> low woodland - <i>Melaleuca preissiana</i> low woodland over open water in Good condition (S01); and ● 36.54 ha of <i>Melaleuca</i> spp. over a tall shrubland - <i>Eucalyptus rudis</i> isolated trees over <i>Melaleuca preissiana</i> and <i>M. raphiophylla</i> low open forest over <i>Astartea scoparia</i>, <i>M. teretifolia</i> and <i>Kunzea glabrescens</i> tall shrubland over <i>Juncus pallidus</i> and <i>Lepidosperma</i> sp. open sedgeland, (S01) comprised: <ul style="list-style-type: none"> ○ 9.28 ha in Good condition ○ 27.26 ha in Degraded condition. <p>Wetland condition based on GHD (2020b) survey mapping data:</p> <ul style="list-style-type: none"> ● 3.41 ha - UFI 7000 CCW - Good 1.26 ha, Degraded 2.11 ha, Completely Degraded 0.04 ha. ● 14.06 ha - UFI 14725 CCW - Good 0.88 ha, Degraded 4.51 ha, Completely Degraded 8.57 ha, Open Water 0.1 ha. ● 6.8 ha - UFI 14727 CCW - Good 3.8 ha, Completely Degraded 0.13 ha, Open Water 2.87 ha. ● 4.02 ha - UFI 14763 CCW - Good 1.21 ha, Degraded 2.81 ha. ● 13.89 ha - UFI 14798 CCW - Good 5.46 ha, Degraded 6.79 ha, Completely Degraded 1.64 ha. ● 0.05 ha - UFI 14712 MUW - Degraded 0.03 ha, Completely Degraded 0.02 ha. ● 0.97 ha - UFI 14726 MUW - Good 0.14 ha, Completely Degraded 0.17 ha, Open Water 0.66 ha. ● 34.74 ha - UFI 15246 MUW - Good 0.43 ha, Degraded 8.72 ha, Completely Degraded 25.59 ha. ● 36.46 ha - UFI 16021 MUW - Good 0.43 ha, Degraded 11.38 ha, Completely Degraded 23.84 ha, Open Water 0.81 ha. ● 10.51 ha - UFI 7031 REW - Degraded 1.83 ha, Completely Degraded 8.68 ha. ● 4.66 ha - UFI 14796 REW - Degraded 2.77 ha, Completely Degraded 1.89 ha. <p>CCWs are comprised of the following vegetation types and extents:</p> <ul style="list-style-type: none"> ● 19.46 ha - <i>Melaleuca</i> spp. over a tall shrubland 8.81 ha Good, 10.65 ha Degraded ● 3.8 ha - <i>Melaleuca preissiana</i> low woodland 3.8 ha Good ● 4.25 ha - <i>Banksia</i> low woodland 4.25 ha Degraded ● 1.32 ha - <i>Melaleuca</i> spp. low open woodland 1.32 ha Degraded ● 10.38 ha - Cleared 10.38 ha Completely Degraded

Environmental value	Keysbrook site description
	<ul style="list-style-type: none"> • 2.97 ha - Open Water <p>REWs are comprised of the following vegetation types and extents:</p> <ul style="list-style-type: none"> • 4.21 ha - <i>Melaleuca preissiana</i> low woodland 4.21 ha Degraded • 0.21 ha - Banksia low woodland 0.21 ha Degraded • 0.17 ha - Isolated native trees over weeds 0.17 ha Degraded • 10.58 ha - Cleared 10.58 ha Completely Degraded

3.2.1. Overlapping environmental values

The DBCA Geomorphic Wetlands SCP dataset (DBCA-019) mapped CCWs and REWs at Keysbrook within Bush Forever site 77. As such, the proposed physical portions of the Keysbrook site applied as offsets for CCWs, REWs and Bush Forever will likely overlap.

4. Proposed Environmental Offsets Strategy

4.1. Summary

The PTA's primary Offsets Strategy for the Proposal is through direct land acquisition. Table 12 provides a summary of the Draft Offsets Strategy for the significant residual impacts.

Table 12: Draft Offsets Strategy summary for the Proposal

Environmental value/MNES	Listing	Significant residual impacts to Footprint ^A	Total quantum of impact	Minimum area to offset	Offsets Strategy	Comparable environmental values of the offset site	Figure reference
Banksia Woodlands of the Swan Coastal Plain (SCP) Threatened Ecological Community (TEC) including Banksia dominated woodlands of the SCP IBRA region Priority Ecological Community (PEC)	State & Commonwealth MNES	Impacts to 10.05 ha comprised of: <ul style="list-style-type: none"> • 7.01 ha in Very Good condition; • 2.31 ha in Good condition; and • 0.73 ha in Degraded condition. 	8.04 ha ^B	62.34 ha ^B	Direct land acquisition and management of the Lowlands site (100%)	926 ha of Banksia Woodlands of the SCP TEC comprised: <ul style="list-style-type: none"> • 354.88 ha in Excellent condition; • 403.99 ha in Very Good condition; and • 165.75 ha in Good condition. 	Lowlands site Figures 2-4
Carnaby's Cockatoo foraging habitat	State & Commonwealth MNES	Impacts to 81.4 ha comprised of: <ul style="list-style-type: none"> • 42.8 ha High value habitat; • 11.3 ha Moderate value habitat; and • 27.3 ha Low value habitat. 	48.8 ha ^B	340.9 ha ^B	Direct land acquisition and management of the Lowlands site (90%) Funding to Murdoch University for the advanced indirect Black Cockatoo research proposal (10%)	1,122 ha - Carnaby's Cockatoo foraging habitat comprised: <ul style="list-style-type: none"> • 939.8 ha High Value habitat; and • 181.7 ha Low/Moderate Value habitat. 	Lowlands site Figures 2-4
Forest Red-tailed Black Cockatoo foraging habitat		Impacts to 68.1 ha comprised of: <ul style="list-style-type: none"> • 33.6 ha High value habitat; • 4.3 ha Moderate value habitat; and 	40.7 ha ^B	260.1 ha ^B		1,122 ha - Forest Red-tailed Black Cockatoo foraging habitat comprised: <ul style="list-style-type: none"> • 939.8 ha of High Value habitat; and • 181.7 ha of Low/Moderate Value habitat. 	Lowlands site Figures 2-4

Environmental value/MNES	Listing	Significant residual impacts to Footprint ^A	Total quantum of impact	Minimum area to offset	Offsets Strategy	Comparable environmental values of the offset site	Figure reference
		<ul style="list-style-type: none"> 30.2 ha Low value habitat. 					
Baudin's Cockatoo foraging habitat		Impacts to 81.4 ha comprised of: <ul style="list-style-type: none"> 42.8 ha Moderate value habitat; and 38.6 ha Low value habitat. 	40.7 ha ^B	284.1 ha ^B		1,122 ha - Baudin's Cockatoo foraging habitat comprised: <ul style="list-style-type: none"> 939.8 ha of High Value habitat; and 181.7 ha of Low/Moderate Value habitat. 	Lowlands site Figures 2-4
Black Cockatoo potential breeding trees	State & Commonwealth MNES	Clearing of 423 Black Cockatoo potential breeding trees	423 trees	1,269 trees ^C	Direct land acquisition and management of the Lowlands site (100%)	8,096 Black Cockatoo potential breeding trees.	N/A
Conservation Category Wetlands (CCWs)	State	Impacts to 1.9 ha of CCWs comprised: <ul style="list-style-type: none"> 0.5 ha Good condition; 1.2 ha Degraded condition; and 0.2 ha Completely Degraded condition. 	1.9 ha	5.7 ha ^C	Direct land acquisition and management of the Keysbrook site (100%)	43.1 ha of CCWs in predominantly Good condition.	Keysbrook site figures 5-7
Resource Enhancement Wetlands (REWs)	State	Impacts to 0.5 ha as a portion of one REW comprised:	0.5 ha	1.5 ha ^C	Direct land acquisition and management of the Keysbrook site	15.18 ha of REWs in predominantly Completely Degraded condition.	Keysbrook site figures 5-7

Environmental value/MNES	Listing	Significant residual impacts to Footprint ^A	Total quantum of impact	Minimum area to offset	Offsets Strategy	Comparable environmental values of the offset site	Figure reference
		<ul style="list-style-type: none"> 0.3 Excellent condition; 0.1 Good condition; and 0.1 Degraded condition. 			(100%)		
Bush Forever site 304 (Whiteman Park)	State	Impacts to 17.2 ha of Bush Forever comprised of: <ul style="list-style-type: none"> 0.3 ha of Very Good condition; 0.3 ha of Very Good - Good condition; 3.9 ha of Good condition; 2.1 ha of Good - Degraded condition; and 10.6 ha of Degraded condition. 	17.2 ha	34.4 ha ^C	Direct land acquisition and management of the Keysbrook site (100%)	257.3 ha of Bush Forever in predominantly Degraded condition.	Keysbrook site figures 5-7

A - Calculated based on information provided within the Malaga to Ellenbrook Rail Works Environmental Review Document (ERD) (PTA 2020).

B - Calculated using the Commonwealth Offsets Calculator unless otherwise indicated.

C - Calculated using assigned offset ratios.

4.2. Lowlands offset

4.2.1. Overview

An overview of the Lowlands site offset is provided in Table 13.

Table 13: Lowlands site offset overview

Offset component	Lowlands
Type of offset	Direct offset. State acquisition of privately-owned land.
Environmental values being offset	<p>The site will be used to offset:</p> <ul style="list-style-type: none"> • 100% of the 10.05 ha of Banksia Woodlands TEC ((including the Banksia Woodlands PEC); • 90% of the 81.4 ha of Carnaby's Cockatoo foraging habitat; • 90% of the 68.1 ha of Forest Red-tailed Black Cockatoo foraging habitat; • 90% of the 81.4 ha of Baudin's Cockatoo foraging habitat; and • 100% of the 423 Black Cockatoo potential breeding trees.
Offset objectives	<ul style="list-style-type: none"> • Counterbalance the significant residual impact of the Proposal. • Prevent future loss of and degradation to the existing environmental values. • Address the threatening processes specific to the site's environmental values/MNES, identified within the following documents: <ul style="list-style-type: none"> – Carnaby's Black Cockatoo Recovery Plan (Department of Parks and Wildlife (DPaW) 2013); – Forest Black Cockatoo (Baudin's Cockatoo <i>Calyptorhynchus baudinii</i> and Forest Red-tailed Black Cockatoo <i>Calyptorhynchus banksii naso</i>) Recovery Plan (Australian Government, 2008); – Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community (TSSC 2016); and – EPA Technical Report: Carnaby's Black Cockatoo in Environmental Impact Assessment in the Perth and Peel Region (Government of WA 2019).
Security of offset	<ul style="list-style-type: none"> • The State's acquisition of privately-owned land. Acquisition for offset purposes resulted in the direct protection of site's environmental values. • Application as a State and Commonwealth Offset Site, recorded on the WA Offsets Register. • The State of Western Australia is the new landowner with the DBCA the nominated land manager on the Certificate of Title (refer to Appendix B). This ensures long-term protection and management of the site by the DBCA. • The site was made a Class A reserve following the State's acquisition.
On-ground management	<p>Provision of funding to the DBCA to provide on-ground management activities for a period of seven years. Management activities propose to:</p> <ul style="list-style-type: none"> • Extend the current budget allocated to manage the site. • Avert the risk of loss of environmental values over time through on-ground management. • Address threatening processes. • Provide secure funding arrangements for long-term conservation.

4.2.2. Previous use as an offset

The Lowlands site has previously been used as an environmental offset to counterbalance impacts from the METRONET TCL Proposal. An overview of the extent and location of environmental

values and MNES applied as an offset for the TCL Proposal is provided in Appendix F. This supports the PTA's position that there is sufficient quantity of suitable and applicable offsets available to use the Lowlands site as an offset site for this Proposal. Final offset allocation mapping for this Proposal will be provided in the Final Offsets Strategy.

4.2.3. Application of the Commonwealth offsets calculator

Banksia Woodlands TEC

The Lowlands site contains Banksia Woodlands TEC ranging from Excellent to Good condition, while the impacted site contains Banksia Woodlands TEC ranging from Very Good to Degraded condition. As such, the Lowlands site can provide a Banksia Woodlands TEC offset in equivalent or better condition. Based on calculations undertaken by the PTA using the Commonwealth Offsets Calculator, the extent of Banksia Woodlands TEC offset required to meet 100% of the impact is 62.34 ha. This is based on a start quality of 8 for the Lowlands site. The details of the calculator's working is provided in the Start area column in Table 14 and Appendix G.

Table 14: Lowlands site Banksia Woodlands TEC (including the Banksia Woodlands PEC) offset calculations in accordance with the Commonwealth Offsets Calculator (Appendix G)

Criteria	Rating	Explanation
Start area (ha)	62.34	Area of Banksia Woodlands TEC (including the Banksia Woodlands PEC) required calculated to meet 100% of the offset requirement, based on a start quality of 8.
Start quality	8	8 represents the start quality of Banksia Woodland TEC within the Lowlands site with the majority being High value habitat, generally in Very Good to Excellent Condition.
Future quality without offset	7	It is assumed that without active on-ground management measures there will be a small reduction in quality due to weed incursion and other threats.
Future quality with offset	8	Security of the offset and provision of capped funds to the DBCA to provide seven years of on-ground management of the site is expected to maintain the start quality of the offset.
Risk of loss (%) without offset	15	The site was formerly privately owned. This rating has been applied to the site's status prior to being acquired by the State. The 15% acknowledges that that risk is moderated by the known high conservation value of the site limiting the potential for development and that the site has been transferred into conservation estate.
Risk of loss (%) with offset	5	Protection of the offset site will substantially reduce the risk of future loss.
Confidence in result (averted loss) (%)	90	The protection mechanisms and proposed management provide a high level of certainty that the offset will be conserved, averting the level of loss that would likely occur should no formal protection measures be implemented.
Confidence in result (habitat quality) (%)	85	There is a high degree of confidence in this prediction based on the DBCA's proposed involvement in providing on-ground management.
Time over which loss is averted (years)	20	Provision of offset for long-term protection.
Time until ecological benefit (years)	0	Ecological benefit was immediate following acquisition of land due to the additional protection placed on the site
Total offset % represented by Lowlands	100	100% of the offset requirement will be achieved.

Carnaby's Cockatoo

The Lowlands site contains predominantly High quality Carnaby's Cockatoo foraging habitat, while the impacted site contains High, Moderate and Low quality Carnaby's Cockatoo foraging habitat. As such, the Lowlands site can provide a Carnaby's Cockatoo foraging habitat offset in equivalent or better condition.

Based on calculations undertaken by the PTA using the Commonwealth Offsets Calculator, the extent of Carnaby's Cockatoo foraging habitat required to meet 90% of the impact is 340.9 ha. This is based on a start quality of 8 for the Lowlands site. The details of the calculator's working is provided in the Start area column in Table 15 and Appendix G.

An indirect offset is also being applied to offset significant residual environmental impacts to Carnaby's Cockatoo foraging habitat. This will comprise the remaining 10% of the offset requirement and is discussed in Section 4.4.

Table 15: Lowlands site Carnaby's Cockatoo foraging habitat offset requirement based on Commonwealth Offset Calculator (Appendix G)

Criteria	Rating	Explanation
Start area (ha)	340.9	Required offset area calculated to meet 90% of the offset requirement, based on a start quality of 8. The other 10% of the offset requirement will be met through indirect research offsets.
Start quality	8	8 represents the start quality of Carnaby's Cockatoo foraging habitat within the Lowlands site. (High Value 939.8 - ha; Low/Moderate Value - 181.7 ha)
Future quality without offset	7	It is assumed that 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	8	Security of the offset and provision of capped funds to the DBCA to provide seven years of on-ground management of the site is expected to maintain the start quality of the offset.
Risk of loss (%) without offset	15	The site was formerly privately owned. This rating applies to the site's status prior to being acquired by the State. The 15% acknowledges that that risk is moderated by the known high conservation value of the site limiting the potential for development.
Risk of loss (%) with offset	5	Protection of the offset site will substantially reduce the risk of future loss.
Confidence in result (averted loss) (%)	90	The protection mechanisms and proposed management provide a high level of certainty that the offset will be conserved, averting the level of loss that would likely occur should no formal protection measures be implemented.
Confidence in result (habitat quality) (%)	85	There is a high degree of confidence in this prediction based on the DBCA's proposed involvement in providing on-ground management.
Time over which loss is averted (years)	20	Provision of offset for long-term protection.
Time until ecological benefit (years)	0	Ecological benefit was immediate following acquisition of land due to the additional protection placed on the site.
Total offset % represented by Lowlands	90	90% of the offset requirement will be achieved.

Forest Red-tailed Black Cockatoo

The Lowlands site contains predominantly High quality Forest Red-tailed Black Cockatoo foraging habitat, while the impacted site contains High, Moderate and Low quality Forest Red-tailed Black Cockatoo foraging habitat. As such, the Lowlands site can provide a Forest Red-tailed Black Cockatoo foraging habitat offset in equivalent or better condition.

Based on calculations undertaken by the PTA using the Commonwealth Offsets Calculator, the extent of Forest Red-tailed Black Cockatoo foraging habitat required to meet 90% of the impact is 260.1 ha. This is based on a start quality of 8 for the Lowlands site. The details of the calculator's

working is provided in the Start area column in Table 16 and Appendix G. An indirect offset is also being applied to offset significant residual environmental impacts to Forest Red-tailed Black Cockatoo foraging habitat. This will comprise the remaining 10% of the offset requirement and is discussed in Section 4.4.

Table 16: Lowlands site Forest Red-Tailed Black Cockatoo foraging habitat offset requirement based on Commonwealth Offset Calculator (Appendix G)

Criteria	Rating	Explanation
Start area (ha) - requirement to meet 90% of offset	260.1	Required offset area calculated to meet 90% of the offset requirement, based on a start quality of 8. The remaining 10% of the offset requirement will be met through indirect research offsets.
Start quality	8	8 represents the start quality of Forest Red-tailed Black Cockatoo foraging habitat within the Lowlands site. (High Value - 939.8 ha; Low/Moderate Value - 181.7 ha)
Future quality without offset	7	It is assumed that without active on-ground management actions there will be a small reduction in quality due to weed incursion and other impacts.
Future quality with offset	8	Security of the offset and provision of capped funds to the DBCA to provide seven years of on-ground management of the site is expected to maintain the start quality of the offset.
Risk of loss (%) without offset	15	This rating has been applied as the site was formerly privately owned prior to being acquired by the State. The 15% acknowledges that the risk is moderated by the known high conservation value of the site limiting the potential for development.
Risk of loss (%) with offset	5	Protection of the offset site will substantially reduce the risk of future loss.
Confidence in result (averted loss) (%)	90	The protection mechanisms and proposed management provide a high level of certainty that the offset will be conserved, averting the level of loss that would likely occur should no formal protection measures be implemented.
Confidence in result (habitat quality) (%)	85	There is a high degree of confidence in this prediction based on the DBCA's proposed involvement in providing on-ground management.
Time over which loss is averted (years)	20	Provision of offset for long-term protection.
Time until ecological benefit (years)	0	Ecological benefit was immediate following acquisition of land due to the additional protection placed on the site.
% of impact offset	90	90% of the offset requirement will be achieved.

Baudin's Cockatoo

The Lowlands site contains predominantly High quality Baudin's Cockatoo foraging habitat, while the impacted site contains Moderate to Low quality Baudin's Cockatoo foraging habitat. As such Lowlands can provide a Baudin's Cockatoo foraging habitat offset in equivalent or better condition.

Based on calculations undertaken by the PTA using the Commonwealth Offsets Calculator, the extent of Baudin's Cockatoo foraging habitat required to meet 90% of the impact is 284.1 ha. This

is based on a start quality of 8 for the Lowlands site. The details of the calculator's working is provided in the Start area column in Table 17 and Appendix G. An indirect offset is also being applied to offset significant residual environmental impacts to Baudin's Cockatoo foraging habitat. This will comprise the remaining 10% of the offset requirement and is discussed in Section 4.4.

Table 17: Lowlands site Baudin's Cockatoo foraging habitat offset requirement based on Commonwealth Offset Calculator (Appendix G)

Criteria	Rating	Explanation
Start area (ha) - requirement to meet 90% of offset	284.1	Required offset area calculated to meet 90% of the offset requirement, based on a start quality of 8. The remaining 10% of the offset requirement will be met through indirect research offsets.
Start quality	8	8 represents the start quality of Baudin's Cockatoo foraging habitat within the Lowlands site. (High Value - 939.8 ha; Low/Moderate Value - 181.7 ha)
Future quality without offset	7	It is assumed that without active on-ground management actions there will be a small reduction in quality due to weed incursion and other impacts.
Future quality with offset	8	Security of the offset and provision of capped funds to the DBCA to provide seven years of on-ground management of the site is expected to maintain the start quality of the offset.
Risk of loss (%) without offset	15	This rating has been applied as the site was formerly privately owned prior to being acquired by the State. The 15% acknowledges that the risk is moderated by the known high conservation value of the site limiting the potential for development.
Risk of loss (%) with offset	5	Protection of the offset site will substantially reduce the risk of future loss.
Confidence in result (averted loss) (%)	90	The protection mechanisms and proposed management provide a high level of certainty that the offset will be conserved, averting the level of loss that would likely occur should no formal protection measures be implemented.
Confidence in result (habitat quality) (%)	85	There is a high degree of confidence in this prediction based on the DBCA's proposed involvement in providing on-ground management.
Time over which loss is averted (years)	20	Provision of offset for long-term protection.
Time until ecological benefit (years)	0	Ecological benefit was immediate following acquisition of land due to the additional protection placed on the site.
% of impact offset	90	90% of the offset requirement will be achieved.

Potential Black Cockatoo breeding trees

The Lowlands site EVA (GHD, 2020) estimated there were 8,096 potential Black Cockatoo breeding trees at the Lowlands site. Although the Commonwealth calculator provides guidance for calculating the impact of removing breeding trees, a 3:1 ratio was used following consultation with the DWER and DAWE assessing officers. Therefore, it is considered that there is a sufficient number of Black Cockatoo potential breeding trees at the Lowlands site to offset the 1,269 potential breeding trees requirement.

4.2.4. Protection mechanism

Prior to the WAPC's purchase of the Lowlands site in 2014 as an Advanced offset, the site was a privately-owned Bush Forever site.

Following State purchase of the Lowlands site in 2014, the site was made into a Class 'A' conservation reserve in 2015. Raising the site's protection level reduces the risk of future clearing or risk of the site's environmental values diminishing. The DBCA has been managing the site since 2015.

Without the State purchasing the site as an Advanced offset, these protection mechanisms and DBCA site management would not be in place and the site would be at risk of potential development or degradation.

Under this Draft Offset Strategy, the site will also be listed on the DWER Offsets Register and published on the PTA website as an offset site under the EPBC Act, further increasing the level of protection. Funding will also be provided to the DBCA to extend their management of the Lowlands site for seven years.

4.2.5. Actions undertaken to date to secure and manage offset

The following actions to implement this offset have been undertaken to date:

- Liaison with the DBCA, DWER, EPA and DAWE regarding the suitability of the site to be used as an offset;
- Completed a desktop review of the site to understand site environmental values;
- Conducted site EVA which included the following:
 - fauna and targeted Black Cockatoo survey of the site to:
 - assess terrestrial fauna values;
 - assess the extent of Black Cockatoo habitat and values;
 - map the area of Carnaby's Cockatoo foraging habitat, breeding habitat (not including individual tree mapping), roosting habitat;
 - identify existing threatening processes relevant to Black Cockatoos; and
 - identify potential breeding trees within Lowlands;
 - vegetation survey to:
 - map the extent and condition of each type; and
 - identify existing threatening processes relevant to the site.
- The DBCA have provided site management actions and funding required to manage the site for a period of seven years; and
- Completed a comprehensive weed survey and mapping.

4.2.6. Actions to be undertaken to secure and manage offset

The following actions to implement this offset are yet to be undertaken:

- Prepare a weed management plan for the site and other site specific site management plans and/or documentation in consultation with the DBCA.
- Finalise and sign an MOU between the PTA and DBCA regarding the conditions and requirements of environmental management over the site for seven years in which PTA will fund.

- Provide funding to the DBCA to manage the site for a period of seven years.
- The DBCA to manage the offset site and provide the PTA with annual reports for the pre-arranged time period.
- The DBCA to manage the site in perpetuity once the funding ceases from the PTA.

4.2.7. Roles and responsibilities

The primary roles and responsibilities of the PTA in the implementation of this Draft Offsets Strategy include:

- Finalise and sign the MOU establishing the formal funding agreement and program of works with the DBCA.
- Provide funding to the DBCA for the management of the site for a period of seven years.
- Report annual compliance to the DWER and DAWE until such time as it is determined that offset reporting requirements have been met.
- Audit the DBCA's management of the site, as required.

The primary roles and responsibilities of the DBCA in the implementation of this Draft Offsets Strategy include:

- Agree to and sign the MOU establishing the formal funding agreement and program of works with the PTA.
- Participate in the establishment of a formal funding agreement and program of works with the PTA.
- Implement site management, monitoring and reporting for a period of seven years.
- Manage the site in perpetuity for the purposes of conservation.

4.2.8. Management actions and schedule

The PTA will provide funding to the DBCA to undertake on-ground management actions for seven years. The Lowlands site indicative management actions and schedule is provided in Table 18.

Table 18: Lowlands site management actions and schedule

Activity	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
16.0km electrified fencing material (incl. 4 gates) and installation	X	X					
Management access tracks upgrade and maintenance	X		X		X		X
Reserve Management Officer Salary and associated costs	X	X	X	X	X	X	X
Signage - materials and installation	X	X	X	X			
<i>Phytophthora cinnamomi</i> (Dieback) mapping (years 3 and 7) and management plan	X		X	X			X
Weed mapping			X				X
Weed control- materials and program implementation	X	X	X	X	X	X	X
Flora and vegetation survey	X	X	X	X	X	X	X
Rubbish removal	X	X	X	X	X	X	X
Fire management - prescribed burn			X		X		X
Feral animal monitoring and control (cat, fox, rabbit, kangaroos and pigs)	X	X	X	X	X	X	X
Carnaby's Cockatoo watering point establishment			X				

The management actions have been developed to:

- Conserve the significant residual impacts of the environmental values and MNES being offset;
- Result in tangible improvement to the environmental values and MNES being offset; and
- Align with the targets and objectives of relevant recovery plans or area management plans.

This will manage, reduce, minimise and/or mitigate the environmental risks and pressures to the environmental values, MNES and the site from:

- Weeds;
- Unauthorised access;
- Dumping, littering and contamination;
- Fire;
- Feral animal activities; and
- Unauthorised clearing/degradation.

A summary of how the management of the site for conservation purposes aligns with relevant recovery/management plan is provided within Section 4.2.9, with a complete assessment provided in Appendix H.

The DBCA developed the abovementioned management actions in conjunction with the PTA, which were based on the findings from the EVA (GHD 2020a) and comprehensive weed mapping completed at the Lowlands site in 2019.

The anticipated tangible improvement experienced at the site will be of a qualitative nature with no extensive monitoring proposed to measure improvements quantitatively. Nonetheless, weeds and Dieback will be mapped throughout the seven years of management and this will provide an opportunity to compare current and future results. Further, high-level flora and fauna surveys will also be undertaken throughout. The DBCA will be required to provide annual compliance reporting to the PTA outlining the management actions carried out, budget spent, projected future works and demonstration of compliance with the MOU. These reports will provide the opportunity to report on the tangible improvements experienced within the site.

4.2.9. Recovery Plans

Carnaby's Cockatoo (*Calyptorhynchus latirostris*) Recovery Plan

The Carnaby's Cockatoo Recovery Plan (Australian Government 2013) was developed to provide advice and guidance on management actions to protect the Carnaby's Cockatoo. The protection of the Lowlands site 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 Lowlands site was purchased as an Advanced offset site by the Western Australian Government and allocated to the PTA for METRONET offset purposes. The Lowland site'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 site as an offset site will ensure achievement of Action 1 through further protection and management. Details of proposed site management actions are provided within Section 4.2.8.

A breakdown of the individual actions, targets and objects, timings and completion criteria is provided in Appendix H.

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 (Government of Western Australia 2019) was developed to provide guidance on habitat restoration and protection of Carnaby's Cockatoo habitat. The protection of the Lowlands site achieves both short and long term management options (detailed in Table 5 of Government of Western Australia 2019) as outlined in Table 19. Table 19 also includes a breakdown of the individual actions, targets and objects, timings and completion criteria.

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 (Australian Government 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 site aligns with *Section 14.9 Identify and manage important sites and protect from threatening processes* of the Plan.

The Lowlands site was identified as an important site within the region for a range of species, including Baudin's and Forest Red-tailed Black Cockatoos. The land acquisition and management will ensure the site is maintained for conservation purposes. Management actions such as fencing, weed management and fire management will reduce the risks of threatening processes such as dieback and weed spread.

A breakdown of the individual actions, targets and objects, timings and completion criteria has been provided in Appendix H.

Table 19: Lowlands site management alignment with EPA Technical Report: Carnaby's Black Cockatoo in Environmental Impact Assessment in the Perth and Peel Region (Government of Western Australia 2019)

Management strategy	Management objectives	Management actions	Relevant Lowlands site management actions
Short-term	Habitat management	<ul style="list-style-type: none"> Feral animal and nest competitor control; Disease and pest control (e.g. <i>Phytophthora</i> and Marri Canker); Fire management; Fencing; and Weed control. 	<ul style="list-style-type: none"> Feral animal monitoring and control. <i>Phytophthora cinnamomi</i> (dieback) mapping and management plan. Fire management - prescribed burns. 16km of electrified fencing (including 4 gates). Weed control.
	Habitat enhancement	<ul style="list-style-type: none"> Natural nest hollow repair; Installation of artificial nest boxes (with long-term management); Improve access to drinking water near roosts and breeding sites; and Urban forest planning for cockatoos. 	<ul style="list-style-type: none"> Establishment of Carnaby's Cockatoo watering points. Flora and vegetation survey - these surveys may identify activities to be undertaken including improvements to hollows.
	Increase vital rates	<ul style="list-style-type: none"> Rehabilitation of injured cockatoos to wild; Disease and toxicity prevention; Reduce cockatoo road mortality (road signage, speed limits, appropriate verge planting); and Prevent illegal shooting and poaching. 	<p>Installation of fencing which will reduce illegal access, reducing the risk of illegal shooting and/or poaching.</p> <p>The PTA is also proposing to fund Murdoch University Black Cockatoo research. This research is likely to include recommendations for reduction in disease and toxicity. Details on the funding will be provided under a separate confidential memo to the appropriate Department(s).</p>
Long-term	Retain and protect habitat	<ul style="list-style-type: none"> Avoidance of important habitat and sites; Minimise native vegetation clearing; and Land acquisition of existing important habitat and sites, and inclusion into parks and reserve. 	<p>Acquisition and management of the Lowlands site has protected the existing important habitat, and will prevent clearing. Protection mechanisms over the site are discussed in Section 4.2.4.</p>

Management strategy	Management objectives	Management actions	Relevant Lowlands site management actions
	Rehabilitation and restoration	<ul style="list-style-type: none"> • Improve succession of natural nest hollows; • Increase amount of breeding habitat; and • Increase amount and quality of foraging habitat. 	Management actions propose to provide tangible environmental improvement to environmental values.
	Population monitoring	<ul style="list-style-type: none"> • Population trends; • Breeding rates and juvenile survival; and • Health of breeding populations. 	The PTA is also proposing to fund Murdoch University Black Cockatoo research. This research is likely to include the items listed left. Details on the funding will be provided under a separate confidential memo to the appropriate Department(s).
Information Management		<ul style="list-style-type: none"> • Data sharing (including compliance reporting and monitoring); • Habitat modelling; • Climatic modelling; and • Population viability analysis and modelling. 	

Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community

Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community (Australian Government 2016a) was developed with the following objective:

To mitigate the risk of extinction of the Banksia Woodlands of the Swan Coastal Plain ecological community, and maintain its biodiversity and function, through the protections provided under the Environment Protection and Biodiversity Conservation Act 1999 and through the implementation of priority conservation action.

The acquisition of the Lowlands site aligns with the following sections (Australian Government 2016a):

Section 5.2 Priority Protection and Restoration Actions

PROTECT the ecological community to prevent further loss of extent and condition

The acquisition of the Lowlands site will ensure the protection of the community through increased conservation status, management and allocation of the site as an offset under DWER and DAWE legislation, policy and guidance.

Section 5.1.2 Protect

Avoid the requirement for offsetting, by avoiding and mitigating impacts to the ecological community first. Further to 'like-for-like' principles, match offsets to the same sub-community (usually Floristic Community Type), as it is not appropriate to offset losses of one component with other components of the ecological community, given the high local endemism and biodiversity

The Lowlands site has been selected as an offset as it contains the same floristic community type as the impacted type within the Proposal. Further surveys are being undertaken to confirm FCTs of one patch of Banksia Woodlands TEC being impacted by the Proposal and this information will be incorporated into revised and final versions of this Draft Offsets Strategy as it becomes available. A breakdown of the individual actions, targets and objectives, timings and completion criteria has been provided in Appendix H.

4.2.10. Risks and contingency measures

Risks and contingency measures for the Lowlands site are summarised in Table 20.

Table 20: Lowlands site risks and contingency measures

Risk/trigger	Contingency measure
Condition/quality of area of environmental values degrades over time despite management actions	<ul style="list-style-type: none"> • Restrict access to affected areas. • Investigate cause and extent of vegetation decline (disturbance, pest, weed, pathogen, climate). • Review vegetation management actions. • Implement control and remedial measures in consultation with regulators, including weed spraying, feral animal control, access management as required. • Monitor success of control and remedial measures and consult with the DBCA.
Land manager deviates from the agreed management actions	<ul style="list-style-type: none"> • The DBCA to provide annual reporting outlining the tasks undertaken on site and future tasks, including deviations from those proposed. • The PTA to review these reports and identify any shortfall in project delivery and/or approve deviations, if appropriate • The PTA to carry out onsite inspections and/or audits as required to ensure management actions are carried out as agreed. • Should actions not be carried out as agreed, the PTA to intervene and withhold funding until the DBCA can assure the PTA appropriate management actions will resume.
Fire impacts the site	<ul style="list-style-type: none"> • The DBCA to map the fire. • The DBCA to reallocate resources and funds to respond accordingly, in consultation with the PTA. • Response, cost, contingency and impacts of the fire to be reported to the PTA annually.

4.2.11. Monitoring, reporting and evaluation

The PTA will monitor and evaluate the DBCA's implementation of management actions through:

- Ad hoc meetings, as required;
- The DBCA's reports, to be submitted annually;
- Audits, as required;
- Site inspections, as required; and
- Conversations with appropriate personnel.

The DBCA will provide annual reports to the PTA, reporting on the compliance with the management actions, budget spent and future projected activities.

The PTA will provide the DBCA reports to the DWER and DAWE annually with compliance reports.

4.3. Keysbrook offset

4.3.1. Overview

The Keysbrook site will be used to offset CCWs, a REW and Bush Forever. An overview of the Keysbrook site offset is provided in Table 21.

The PTA is continuing to consult with the DPLH regarding METRONET offsets and future discussions will include opportunities to conduct on-ground revegetation within Whiteman Park. For example, revegetation may be considered within an existing Whiteman Park wetland as an alternate to the Keysbrook site wetland offset discussed within this Offsets Strategy.

Table 21: Keysbrook site offset overview

Offset component	Keysbrook
Type of offset	Direct offset. State acquisition of privately-owned land.
Environmental values being offset	<p>The site will be used to offset</p> <ul style="list-style-type: none"> • 100% of the 1.9 ha of CCWs • 100% of the 0.5 ha of REW; and • 100% of the 17.2 ha of Bush Forever.
Offset objectives	<ul style="list-style-type: none"> • Counterbalance the significant residual impact of the Proposal. • Prevent future loss of and degradation to the existing environmental values. • Address the threatening processes specific to the site's environmental values.
Security of offset	<ul style="list-style-type: none"> • The State's acquisition of privately-owned land. Acquisition for offset purposes resulted in the direct protection of the site's environmental values. • Proposal to change zoning for conservation purposes (this would be dependent on internal state government processes) • Inclusion on the DWER Offsets Register. • The site is owned by the WAPC and is proposed to be managed by the SSJ for a period of seven years. • The site is to retain the conservation status of Bush Forever.
On-ground management	<p>Proposal to provide funding to the SSJ to provide seven years of on-ground management. Management activities propose to:</p> <ul style="list-style-type: none"> • Avert the risk of loss of environmental values over time through on-ground management. • Address threatening processes. <p>Following the cessation of the seven years of management, the WAPC, the landowner, will revert back to manage the site for the long term as part of their Bush Forever portfolio.</p>

4.3.1. Previous use as an offset

The Keysbrook site has previously been used as an environmental offset to counterbalance impacts from the TCL Proposal. An overview of the extent and location of environmental values applied as an offset for the TCL Proposal is provided in Appendix F. This supports the PTA's position that there is sufficient quantity of suitable and applicable offsets available to use the Keysbrook site as an offset site for this Proposal. Final offset allocation mapping will be provided in the Final Offsets Strategy.

4.3.1. Conservation Category wetlands

Based on a ratio of 3:1, the extent of CCWs required at the Keysbrook site to meet 100% of the impact is 5.7 ha. The Keysbrook site has 42.18 ha of mapped CCWs (DBCA-019), which includes 12.61 ha of vegetation in Good condition, 16.22 ha in Degraded condition, 10.38 in Completely Degraded condition and 2.97 ha open water. As such, Keysbrook can provide a CCW offset in equivalent or better condition.

4.3.2. Resource Enhancement wetland

Based on a ratio of 3:1, the extent of REWs required at the Keysbrook site to meet 100% of the impact is 1.5 ha. The Keysbrook site has 15.17 ha of mapped REWs (DBCA-019), which includes 4.59 ha in Degraded condition and 10.58 ha in Completely Degraded condition, however Keysbrook contains *Melaleuca spp.* vegetation, of which 9.27 ha is in Good condition. As such, Keysbrook can provide a REW offset in equivalent or better condition.

4.3.3. Bush Forever

Based on a ratio of 2:1, the extent of Bush Forever at the Keysbrook site required to meet 100% of the impact is 34.4 ha. Table 22 summarises how the Keysbrook Bush Forever Site 289 is relevant and proportional to the environmental values being impacted at the Bush Forever site 304 (Whiteman Park) in accordance with the *WA Environmental Offsets Guidelines* (Government of Western Australia 2014a).

Both Bush Forever site 304 (Whiteman Park) (the impacted site) and Keysbrook (the offset site) are considered to have high conservation significance based on their environmental values and presence of TECs, PECs and priority flora and flora species. However the extent of Bush Forever site 304 (Whiteman Park) being impacted by the Footprint is generally considered to have slightly lower environmental values given that much of the site is already cleared or vegetation is considered Degraded due to earlier road project works. As such the Keysbrook site can provide a Bush Forever offset in equivalent or better condition.

Justification of the use of Bush Forever Site 289 as an offset site in accordance with the requirements of the *WA Offsets Template* (Government of Western Australia 2014) is provided in Appendix I.

Table 22: Evaluation of Keysbrook site against desirable characteristics in accordance with Government of Western Australia (2014)

Value	Bush Forever site 304 (Whiteman Park)	Bush Forever site 77, Keysbrook
Owner	State of Western Australia (WAPC)	State of Western Australia (WAPC)
Land manager	DBCA	WAPC (negotiations underway with SSJ to manage the site for a period of seven years)
MRS Zoning	Parks and Recreation	Rural
Area (ha)	2,801.22	257
Local Government	City of Swan	Shire of Serpentine Jarrahdale
IBRA Region	Swan Coastal Plain	Swan Coastal Plain
IBRA Sub region	Perth SWA02	Perth SWA02
In proximity to the area of impact	N/A	The Keysbrook site is located approximately 64.6 km south of the Proposal.
Coastal vs Inland Environmental Values	Bush Forever site 304 (Whiteman Park) is located approximately 17 km inland from the coast.	The Keysbrook Bush Forever site is located approximately 12 km inland from the coast.
Vegetation Complex (as described by Heddl et al. 1980)	<ul style="list-style-type: none"> • Bassendean Complex Central and South; • Southern River Complex; and • Bassendean Complex North. 	<ul style="list-style-type: none"> • Bassendean Complex Central and South; and • Southern River Complex.
Similar or better vegetation condition than area impacted.	<p>Based on survey data (RPS 2020) the condition of vegetation within the Footprint is:</p> <ul style="list-style-type: none"> • 0.3 ha - Very Good; • 0.3 ha - Very Good-Good; • 3.9 ha - Good; • 2.1 ha - Good-Degraded; • 10.6 ha - Degraded; • 37.5 ha - Completely Degraded; and • 10.0 ha - Cleared. 	<p>Based on an EVA at the Keysbrook site (GHD 2020b) the vegetation condition is:</p> <ul style="list-style-type: none"> • 13.6 ha - Good; • 138.6 ha - Degraded; • 100.7 ha - Completely Degraded; and • 4.4 ha - Not rated - Open water. <p>Vegetation at Keysbrook is considered in a similar condition to vegetation impacted by the Proposal at Bush Forever site 304 (Whiteman Park) as much of the Footprint is already cleared or vegetation is in predominantly Degraded or worse condition. It is also to be noted that given the Keysbrook site will be managed by the DBCA, and grazing pressures have been removed, environmental values of the Keysbrook site are anticipated to improve over time.</p>
Similar habitat structure to undisturbed examples of impacted vegetation type	<p>The Proposal's Footprint contains the following broad habitat types:</p> <ul style="list-style-type: none"> • Banksia Woodland; 	<p>Bush Forever site 77 contains the following broad habitat types:</p> <ul style="list-style-type: none"> • Mixed Banksia Woodland;

Value	Bush Forever site 304 (Whiteman Park)	Bush Forever site 77, Keysbrook
	<ul style="list-style-type: none"> • Mixed Eucalyptus/Corymbia Woodland; • Mixed Banksia/Eucalyptus/Corymbia Woodland; • Flooded Gum Woodland; • Paperbark Woodland; • Wetland/water course (open water areas); • Shrubland; • Pine Plantation; • Scattered trees/shrubs; • Paddock with Eucalyptus/Corymbia; • Paddock with Melaleuca; • Constructed wetland/drainage; • Modified vegetation; • Parkland cleared; and • Cleared Paddock. <p>However it is noted that these habitats are highly disturbed due to other infrastructure projects in the area.</p>	<ul style="list-style-type: none"> • Isolated native and planted trees over weeds; • Wetlands; and • Melaleuca over tall shrubland. <p>These habitats have been highly disturbed due to cattle grazing however this site is no longer used for cattle grazing.</p>
Contains additional rare or otherwise significant species and threatened species or community compared with the impact site.	No significant impacts to any rare or otherwise significant species, threatened species or community (other than that described above) are within the Footprint.	<p>The Keysbrook site contains the following conservation significant species:</p> <ul style="list-style-type: none"> • Central <i>Banksia attenuata</i> - <i>B. menziesii</i> woodlands (FCT23a); • <i>Astartea aff. fascicularis</i>/ Melaleuca species dense shrublands (S01); and • Forests and woodlands of deep seasonal wetlands (FCT15). <p>Hollick (2014) noted that <i>Stylidium longitubum</i> (Priority 4) had historically been recorded within the survey area.</p>
Conservation significant fauna likely to be present	<p>The Footprint was surveyed and may contain:</p> <ul style="list-style-type: none"> • Forest Red-tailed Black Cockatoo; • Carnaby's Cockatoo; • Baudin's Cockatoo; • Quenda; and • Rainbow Bee-eater. <p>As the Rainbow Bee-eater is common in the Whiteman Park area it is not expected to be impacted by the Proposal.</p>	<p>The following fauna species were also recorded as present or likely to be present at the Keysbrook site:</p> <ul style="list-style-type: none"> • Forest Red-tailed Black Cockatoo; • Carnaby's Cockatoo; • Quenda; and • South-western brush-tailed phascogale.

Value	Bush Forever site 304 (Whiteman Park)	Bush Forever site 77, Keysbrook
CCWs and REWs present	Yes, CCWs and REWs are present at Whiteman Park. , A total of 2.4 ha of CCWs and REWs in Excellent to Completely Degraded condition will be impacted due to the Proposal.	Yes, CCWs and REWs are present at the Keysbrook Bush Forever site in predominantly Good condition.
Close to or contiguous with an existing conservation area (e.g. Bush Forever).	Bush Forever site 304 (Whiteman Park) is a large Bush Forever site, located in close proximity to other Bush Forever sites. The Proposal will impact primarily Degraded, Completely Degraded and Cleared portion of the Bush Forever site 304 (Whiteman Park) located predominantly on the site boundary.	Keysbrook Bush Forever Site 77 continues to the south of the offset site and is located west of Serpentine National Park.
Likely to enhance ecological linkages between conservation areas.	Perth Peel Vegetation Connectivity shows Bush Forever site 304 (Whiteman Park) is part of a large compact or regionally well connected area. Bush Forever site 304 (Whiteman Park) forms part of regionally significant ecological linkages including Greenways 32, 39, 21, 40, and 38 (Tingay and Associates 1998), which extends from Bennett Brook north through Whiteman Park to the northern-most part of the survey area in Ellenbrook.	Perth Peel Vegetation Connectivity shows the Keysbrook Bush Forever site is part of a medium-large compact or regionally well connected area. Keysbrook forms part of three regionally significant ecological linkages, Greenways 83, 86 and 87 (Tingay and Associates 1998). Given the site can be added to the conservation estate this will enhance regional ecological linkages.

4.3.4. Protection mechanism

The privately-owned Bush Forever Site 77 (Keysbrook site) was acquired by the WAPC in 2018. The State acquired the site as an Advanced offset with the intention to use it to offset significant residual environmental impacts of future WA Government Proposals. The State's purchase of the Bush Forever Site provided greater protection of the site, reducing the likelihood that the site would be developed, cleared or degraded by the former private landowner. The WAPC also worked to remove grazing from the site following purchase, reducing pressures to environmental values.

Through consultation with the WAPC, the Keysbrook site was allocated to the PTA in 2019 to offset METRONET Proposals. The site is zoned Rural and is intended to be transferred to Parks and Recreation to increase its conservation. This transfer however will be completed by the State Government and will be dependent on their internal processes.

The PTA propose to provide funding to the SSJ to undertake on-ground management actions to further protect the site's environmental values. The site will also be listed on the DWER Offsets Register.

4.3.5. Actions undertaken to date to secure and manage offset

The following actions to implement this offset have been undertaken to date:

- Liaison with the DBCA, DWER, EPA and SSJ regarding the suitability of the site to be used as an offset.
- Completed a desktop review of the site to understand site environmental values.
- Conducted site EVA which included the following:
 - fauna and targeted Black Cockatoo survey of the site to:
 - assess terrestrial fauna values;
 - assess the extent of Black Cockatoo habitat and values;
 - map the area of Carnaby's Cockatoo foraging habitat, breeding habitat (not including individual tree mapping), roosting habitat; and
 - identify existing threatening processes relevant to Black Cockatoos;
 - vegetation survey to:
 - map the extent and condition of each vegetation type; and
 - identify existing threatening processes relevant to the site.
- Due to limited resources the DBCA advised that it is their preference that management of the site was allocated to another stakeholder; and
- Liaison with the SSJ to manage the site for conservation purposes with funding from the PTA.

4.3.6. Actions to be undertaken to secure and manage offset

The following actions to implement this offset are yet to be undertaken:

- SSJ to provide proposed management actions and allocated budget to manage the site for seven years.
- Weed survey, mapping and the development of a weed management plan for the site.
- Prepare and sign an MOU between the PTA and SSJ regarding the conditions and requirements of environmental management over the site for seven years in which PTA will fund.
- Provide funding to the SSJ to manage the site for a period of seven years.

- The SSJ to manage the offset site and provide the PTA with annual reports for the pre-arranged time period.
- The WAPC to manage the site in the longer term once the funding for the SSJ ceases from PTA.

4.3.7. Roles and responsibilities

The primary roles and responsibilities of the PTA in the implementation of this Draft Offsets Strategy include:

- Draft and sign the MOU establishing the formal funding agreement and program of works with the SSJ.
- Provide funding to the SSJ for the management of the site for a period of seven years.
- Report annual compliance to the DWER until such time as it is determined that offset reporting requirements have been met.
- Audit the SSJ's management of the site, as required.

The primary roles and responsibilities of the SSJ in the implementation of this Offsets Strategy include:

- Participate in the establishment of a formal funding agreement and program of works with the PTA.
- Implement site management, monitoring and reporting for a period of seven years.

The primary roles and responsibilities of the WAPC in the implementation of this Offsets Strategy include:

- Allow legal access to the site for SSJ to allow the management actions to be implemented.
- Manage the site in the long term once the funding from the PTA has ceased.

4.3.8. Management actions and schedule

The PTA propose to provide funding to the SSJ to undertake on-ground management activities for seven years. Management actions and timings for the Keysbrook site are provided in Table 23. Management actions for the Keysbrook site are indicative, based on the management actions provided by the DBCA for the Lowlands site. Negotiations between the SSJ and PTA are still being finalised and final management actions and schedule will be provided to the DWER in the form of a revised Offsets Strategy when available.

Table 23: Keysbrook site indicative management actions and schedule

Activity	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Fencing (including gates) and installation	X	X					
Management access tracks upgrade and maintenance	X		X		X		X
Environmental Officer (or similar) salary and/or associated costs	X	X	X	X	X	X	X
Signage - materials and installation	X	X	X	X			
<i>Phytophthora cinnamomi</i> (Dieback) mapping (years 3 and 7) and management plan	X		X				X
Weed mapping			X				X
Weed control- materials and program implementation	X	X	X	X	X	X	X
Flora and vegetation survey	X						X
Fauna survey	X						X
Rubbish removal	X	X	X	X	X	X	X
Fire Management - prescribed burn			X		X		X
Feral animal monitoring and control (cat, fox, rabbit, kangaroos and pigs)	X	X	X	X	X	X	X

The management actions have been developed to achieve the following objectives within the seven years:

- Conserve the significant residual impacts of the environmental values being offset;
- Result in tangible improvement to the environmental values being offset; and
- Align with the targets and objectives of relevant recovery plans or area management plans.

This will manage, reduce, minimise and/or mitigate the environmental risks and pressures to the environmental values and the site from:

- Weeds;
- Unauthorised access;
- Dumping, littering and contamination;
- Fire;
- Feral animal activities; and
- Unauthorised clearing/degradation.

The anticipated tangible improvement experienced at the site will be of a qualitative nature with no extensive monitoring proposed to measure improvements quantitatively. In saying that, weed and Dieback will be mapped throughout the seven years of management and this will provide an opportunity to compare current and future results. Further, flora and fauna surveys will also likely be undertaken throughout. The SSJ will be required to provide annual compliance reporting to the

PTA outlining the management actions carried out, budget spent and demonstration of compliance with the MOUs. These reports will provide the opportunity to report on the tangible improvements experienced within the site.

4.3.9. Risks and contingency measures

Risks and contingency measures for the Keysbrook site are summarised in Table 24.

Table 24: Keysbrook site risks and contingency measures

Risk/trigger	Contingency measure
Condition/quality of area of environmental values degrades over time despite management actions.	<ul style="list-style-type: none"> • Restrict access to affected areas. • Investigate cause and extent of vegetation decline (disturbance, pest, weed, pathogen, and climate). • Review vegetation management actions. • Implement control and remedial measures in consultation with regulators, including weed spraying, feral animal control, and access management as required. • Monitor success of control and remedial measures and consult with the SSJ.
Land manager deviates from the agreed management actions.	<ul style="list-style-type: none"> • SSJ to provide annual reporting outlining the tasks undertaken on site and future tasks, including deviations from those proposed. The PTA to review these reports and identify any shortfall in project delivery and/or approve deviations, if appropriate. • The PTA to carry out onsite inspections and/or audits as required to ensure management actions are carried out as agreed. • Should actions not be carried out as agreed, PTA to intervene and withhold funding until SSJ can assure the PTA appropriate management actions will resume.
Fire impacts the site.	<ul style="list-style-type: none"> • SSJ to map the fire. • SSJ to reallocate resources and funds to respond accordingly, in consultation with the PTA. • Response, cost, contingency and impacts of the fire to be reported to the PTA annually.

4.3.10. Monitoring, reporting and evaluation

The PTA will monitor and evaluate the SSJ's implementation of management actions through:

- Ad hoc meetings, as required.
- SSJ's reports, to be submitted annually.
- Audits, as required.
- Site inspections, as required.
- Conversations with appropriate personnel.

The SSJ will provide annual reports to the PTA, reporting on the compliance with the management actions, budget spent and future projected activities.

The PTA will provide the SSJ reports to the DWER and DAWE annually with compliance reports.

4.4. Black Cockatoo research proposal funding

4.4.1. Background

The PTA proposes to provide funding to Murdoch University to finance Black Cockatoo research. Murdoch's research proposal (Warren et al. 2019) is being considered by the PTA and negotiations are ongoing. Funding for research is intended to comprise 10% of the total Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo offset requirement, when delivered in addition to the land acquisition component outlined in this Draft Offsets Strategy.

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

4.4.2. Overview of offset

Western Australia's three endemic Black Cockatoo species, Carnaby's Cockatoos (*Calyptorhynchus latirostris*), Baudin's Cockatoos (*Calyptorhynchus baudinii*) and Forest Red-tailed Black Cockatoos (*Calyptorhynchus banksii naso*) are threatened and receive special protection as MNES under the EPBC Act. Threats to the survivorship of these black cockatoo species are well documented, and include habitat loss and modification, urban and industrial expansion, disease, displacement by competing species, and climate shifts. Despite significant research to date, key information required to address the National Recovery Plan remains outstanding (Warren et. al. 2019).

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

Research will use remote sensing to produce predictive modelling of black cockatoo population movements and habitat use, in association with existing and emerging threats across key range areas. The Proposal combines satellite/GPS derived movement data; other remotely sensed landscape data (e.g. vegetation, water); and existing fire and climate models, to identify crucial habitat characteristics and regions most resilient to impacts of threatening processes (fire, climate shifts, habitat modification, tree health, disease, urban expansion). The generated data and information will allow collaborators to develop policies and take action to manage land changes, and build resilience into modified landscapes to address black cockatoo declines.

4.4.3. Objectives

The research proposal (Warren et. al. 2019) has the following objectives:

- Characterise black cockatoo movement and habitat use across the Perth-Peel Coastal Plain and in the south-west forest region of Greenbushes for all three black cockatoo species.
- Study known Carnaby's Cockatoo breeding sites, focussing on characterising habitat suitability, food resource availability and selection, nestling health, specific threatening processes and fledgling dispersal routes.
- Identify new breeding sites in inland or southern areas for all three species based on migratory movement of birds to breeding grounds.
- Apply new ecotoxicology methods to investigate Carnaby's Cockatoo Hindlimb Paralysis Syndrome (CHiPs) toxicity cases, particularly in the agricultural zone.

- Predictively model survivorship scenarios for all three species of black cockatoo using movement, habitat use and threats.

The research proposal will deliver new flock movement and habitat use information and conservation outcomes with a clear focus on conservation and management in breeding regions and population source-sink dynamics within the northern and southern populations.

The proposal has the following direct conservation management outcomes:

- Identification and prioritisation of key habitat resources, including food, water and vegetation corridors, to maximise the retention of critical conservation value habitat for the long-term retention of Carnaby's, Baudin's and Forest Red-tailed Black Cockatoos across their distribution range.
- Characterisation of appropriate roosting habitat for all three species of black cockatoo, particularly on the Perth-Peel Coastal Plain - this is important as it is not necessarily synonymous with appropriate feeding or nesting habitat.
- Characterisation of optimal provisioning distances based on energetics work to inform future offset purchases.
- Identification of new breeding sites (and nest hollow identification) for all three species of black cockatoo, facilitating additional long-term monitoring and protection of stronghold populations, and informing the purchase of offset land.
- Additional knowledge about key threatening processes (disease, displacement species, pesticide exposure etc.) on Perth-Peel Coastal Plain, in the south-west forest region and at breeding sites.
- Correlation of realised species movement ecology with existing population viability analysis models.
- Facilitation of consultation with local, State and Federal governments to maximise future urban and peri-urban design to retain birds on the Perth-Peel Coastal Plain and maximise conservation management.
- Continued liaison with stakeholder groups which consult with private landowners and industry, to manage properties and to maximise landscape and habitat integrity suitable to sustain Black Cockatoo populations over the long-term.

4.4.4. Success criteria

Based on the offset's objective, success criteria for this offset is:

- Contribute partial funding to Murdoch University to conduct their proposed research.
- Murdoch University achieves research proposal objectives and outcomes.
- The State obtains data and deliverables which contribute to the identification of critical habitat, areas under threat and areas for potential future offsets.

4.4.5. Compliance with Commonwealth criteria

Application of Commonwealth criteria for research (Australian Government 2012a) to the research proposal (Warren et. al. 2019) is summarised in Table 25.

Table 25: Consideration of Commonwealth criteria for research (Australian Government 2012a) with respect to the Murdoch University research proposal (Warren et. al. 2019)

Commonwealth criteria for research	Application of criteria to Murdoch University research proposal
A suitable research program must endeavour to improve the viability of the impacted protected matter.	The objectives of the research proposal summarised in Section 4.4.3 and endeavour to improve the viability of black cockatoos and inform future black cockatoo offset options.
A suitable research program must be targeted toward key research as identified in the relevant Commonwealth approved recovery plan, threat abatement plan, conservation advice, ecological character description, management plan or listing document. Where Commonwealth approved guidance documents are not available or are insufficient in detail, the department will consider additional information sources such as state management plans or peer reviewed scientific literature to inform priority offset activities.	The proposal has been developed in collaboration with DBCA to meet the requirements of the <i>EPBC Act referral guidelines for three black cockatoo species</i> (Australian Government 2012c), as well as priority actions and recommendations from the national <i>Carnaby's Cockatoo (Calyptorhynchus latirostris) Recovery Plan</i> (Government of Western Australia 2013), <i>Forest Black Cockatoo (Baudin's Cockatoo Calyptorhynchus baudinii and Forest Red-tailed Black Cockatoo Calyptorhynchus banksii naso) Recovery Plan</i> (Australian Government 2008), <i>MNES Significant Impact Guidelines</i> (Australian Government 2013) and the Consideration of Matters of National Environmental Significance by the WA land use planning system Discussion Paper (Department of Environment, Water, Heritage and the Arts 2009).
A suitable research program must be undertaken in a transparent and scientifically robust and timely manner.	The research program will be: <ul style="list-style-type: none"> • Transparent as regular reporting will be provided to the PTA and the results will be published and made publicly accessible. • Scientifically robust as it has been based on similar research programs conducted by the same team since 2015. This includes the successful deployment of 84 tags and production of over 140,000 GPS location fixes, 33,000 km of track movement and over 2.8M accelerometer records. The methodology is proven, and facilitates individual and flock movement characterisation at spatial and temporal scales previously unattainable. • Conducted over a period of five years.
A suitable research program must be undertaken by a suitably qualified individual or organisation in a manner approved by the department	The research program will be undertaken by suitably qualified and experienced Murdoch University research scientists and has been developed in collaboration with DBCA to meet the requirements of the <i>EPBC Act referral guidelines for three black cockatoo species</i> (Australian Government 2012c), as well as priority actions and recommendations from the national <i>Carnaby's Cockatoo (Calyptorhynchus latirostris) Recovery Plan</i> (Government of Western Australia 2013), <i>Forest Black Cockatoo (Baudin's Cockatoo Calyptorhynchus baudinii and Forest Red-tailed Black Cockatoo Calyptorhynchus banksii naso) Recovery Plan</i> (Australian Government 2008), <i>MNES Significant Impact Guidelines</i> (Australian Government 2013) and the Consideration of Matters of National Environmental Significance by the WA land use planning system Discussion Paper (Department of Environment, Water, Heritage and the Arts 2009).
A suitable research program must consider best practice research approaches.	The research proposal will consider best practice research approaches.

Commonwealth criteria for research	Application of criteria to Murdoch University research proposal
The proponent is required to select an institution through an internationally available open tender process or provide evidence that the program can be undertaken in-house. Where appropriate, the tender should complement an existing research institution's work program as it relates to the MNES. This will be the responsibility of the proponent; however, the department will require that the proponents follow the department's guidelines.	The PTA will not be using an open market tender to award this work; instead, it will award funding direct to Murdoch University based on its existing successful Black Cockatoo research program, prior experience undertaking similar research and proposal.
The proponent is required to provide updates on progress and key findings to the department through periodic reporting.	The PTA will require that regular progress reports are submitted to track research progress, with annual progress reports provided to regulators.
The proponent is required to ensure that funds are managed appropriately and that auditable financial records are kept and maintained.	The PTA will require that annual progress reports include distribution of PTA funding and that auditable financial records are kept and maintained.
The proponent is required to apply a 'no surprises' policy to the publication, whereby research publications and outputs are provided to the department at least five working days before release.	Research publications and outputs will be provided to the department at least five working days before release.
Research programs will be tailored to at least a postgraduate level; however, there will be scope to engage other educational levels in educational programs.	The research proposal is tailored to at least a postgraduate level.
Research programs will present findings that can be peer reviewed.	The research proposal will present findings that can be peer reviewed.
Research programs will publish findings in an internationally recognised peer-reviewed scientific journal or be of a standard that would be acceptable for publication in such a journal. Publications should be submitted to free open access journals. Data and information collected should have creative commons licensing and be free and accessible.	The research proposal will publish findings in an internationally recognised peer-reviewed scientific journal or be of a standard that would be acceptable for publication in such a journal. Data and information collected will have creative commons licensing and be free and accessible.
Research outputs should inform future management decisions on the protected matter and, where possible, be readily applicable to other similar matters (species groupings etc.)	Research outputs will inform future management decisions on the protected matter and, where possible, be readily applicable to other similar matters (species groupings etc.)

4.4.6. Compliance with State criteria

Application of research proposal criteria within the *WA Environmental Offsets Guidelines* (Government of Western Australia 2014a) to the research proposal (Warren et. al. 2019) is summarised in Table 26.

Table 26: Application of research proposals criteria within the WA Environmental Offsets Guidelines (Government of Western Australia 2014a) to the research proposal (Warren et. al. 2019)

State criteria for research proposals	Application of criteria to Murdoch University research proposal
Research proposals must be reasonably related to the impact.	The research proposal involves a movement ecology study of three threatened black cockatoo species, to determine habitat use and threatening processes in modified landscapes. This includes tracking the three species of black cockatoos on the Perth-Peel Coastal Plain and tracking Carnaby's Cockatoos at key breeding sites to better understand movement dynamics of this species across its distribution range. This relates to the impact as the Proposal is proposing to clear Carnaby's Cockatoo habitat and potential breeding trees within the SCP.
The research must be designed to result in positive conservation outcomes.	The research proposal will result in positive conservation management outcomes, summarised in Section 4.4.3.
Research that may include field surveys should be designed to address priority knowledge gaps with the outcomes publicly available to improve management of the environment generally, and provide information that will improve environmental assessment of future Proposals.	The proposal will address priority knowledge gaps which are summarised in the proposal's outcomes, provided in Section 4.4.3. This aligns with the knowledge gaps provided within the <i>EPA Technical Report: Carnaby's Black Cockatoo in Environmental Impact Assessment in the Perth and Peel Region</i> (Government of Western Australia 2019b).
Research Proposals are generally only appropriate as offsets where there is a high degree of uncertainty regarding impacts of a Proposal and new science is required to develop better mitigation measures or predictive tools to avoid and minimise the particular type of impact.	
For offsets involving research, current conditions require all validated environmental data (including sampling design, sampling methodologies, empirical data and derived information products such as maps) relevant to the offset to be made publicly available.	All validated environmental data (including sampling design, sampling methodologies, empirical data and derived information products such as maps) relevant to the offset will be made publicly available.
Research results are expected to be published or communicated via public articles and presentations.	Research results will be published or communicated via public articles and presentations.

4.4.7. Actions undertaken to date

The PTA has undertaken the following actions to implement this offset to date:

- Attended a Murdoch University presentation summarising the research proposal objectives, methods and outcomes.
- Liaised with the DWER EPA Services and DAWE regarding the research proposal, with in principle support provided to use it as a component of the Black Cockatoo offset package.
- Met with Main Roads Western Australia, another proponent intending to provide funding to Murdoch University to undertake the proposal.
- Provided extensive comments on the draft research proposal and met to discuss comments and the proposed funding arrangement.

- Attended a teleconference hosted by DAWE to discuss this proposed offset with all relevant stakeholders.
- Sought principle endorsement from the DWER and DAWE to provide funding to Murdoch to implement the Black Cockatoo Research as an advanced indirect offset for this Proposal. Ongoing liaison with stakeholders to agree to the research proposal and financial and governance arrangements for this Proposal.

4.4.8. Actions to be undertaken

The following actions are to be undertaken to implement this offset:

- Liaise with Murdoch University conducting the research and other agencies contributing to fund the research proposal to establish the terms between the parties.
- Prepare and execute an MOU between the PTA and Murdoch University specifying funding approach, amount, delivery of this research proposal offset and deliverables. This would include, but not be limited to, annual reporting requirements including transparent allocation of funds, key milestones and distribution and publication of data.
- Provide funding to Murdoch University.
- Murdoch University shall provide updates and periodic reporting throughout the duration of the research and associated reporting and publication of results.

4.4.9. Risks and contingency measures

Risks and contingency measures for this offset proposal are summarised in Table 27.

Table 27: Murdoch University research proposal risks and contingency measures

Risk/Trigger	Potential contingency measures
Murdoch University is unable to secure enough funding to commence the research proposal (i.e. funding from other parties falls through or is unable to be obtained in time for/to allow commencement of the research).	Consider future METRONET or other state government proposals that may be able to contribute to funding as part of their offsets strategies.
Research results are unavailable for use in future METRONET offset strategies due to delay in obtaining the data.	Where data is delayed or METRONET proposals are brought forward prior to data becoming available, the PTA will endeavour to use the data to inform offset strategies and future planning for future Proposals. Data will be published and will be publicly available for use by other government agencies and industrial and commercial proponents.

5. Application of the WA Environmental Offsets Guidelines offset values



Table 28 summarises how each site is relevant and proportional to the significance of the environmental values being impacted through consideration of the values of appropriate offsets listed within the *WA Environmental Offsets Guidelines* (Government of Western Australia 2014a).

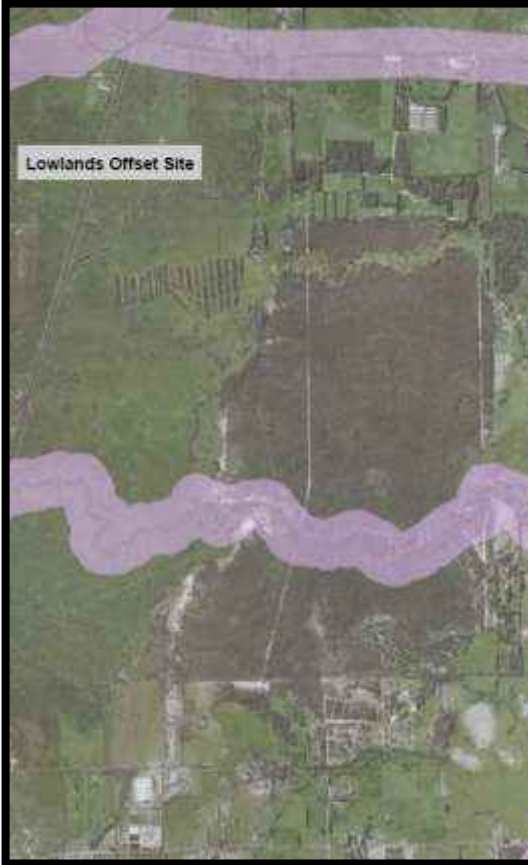

Justification of the use of the sites as offset sites in accordance with the requirements of the *WA Offsets Template* (Government of Western Australia 2014b) is provided in Appendix I.

Table 28: Evaluation of the offset sites against offset values in accordance with Government of Western Australia (2014a)

Value	Lowlands site	Keysbrook site
In proximity to the area of impact	<p>The Lowlands site is located approximately 32.5 km south of the Proposal.</p> <p>It is noted that the Development Envelope and the offset site are both wholly located within the SCP Bioregion, holding similar environmental values.</p> <p>The Lowlands site was selected by the State Government for its exceptional conservation values and has been accepted by the State and Commonwealth Government as a suitable advanced offset site for METRONET Proposals.</p> <p>It is noted that the Proposal is located generally within an area which has already been subject to significant development thereby limiting potential offset sites for acquisition in closer proximity.</p>	<p>The Keysbrook site is located approximately 64.6 km south of the Proposal.</p> <p>It is noted that the Development Envelope and the offset site are both wholly located within the SCP Bioregion, holding similar environmental values.</p> <p>Keysbrook has been selected as it contains similar values to the area requiring offsets and holds additional conservation values.</p> <p>It is noted that the Proposal is located generally within an area which has already been subject to significant development thereby limiting potential offset sites for acquisition in closer proximity.</p>
Provides better condition / less disturbance compared with the impacted environmental value.	<p>The Lowlands site comprises vegetation generally in Very Good to Excellent condition. The values to be offset by the Lowlands site all have vegetation condition similar or better than the area being impacted.</p>	<p>The vegetation impacted by the Proposal is generally in a Degraded to Completely Degraded condition or Cleared.</p> <p>The Keysbrook site comprises of vegetation ranging from Good to Completely Degraded.</p> <p>CCWs and REWs at the Keysbrook site are in predominantly Good condition.</p> <p>The Keysbrook site is being used to offset Bush Forever, CCWs and REWs, both of which have similar or better conditions than that impacted by the Proposal.</p> <p>The proposed management of the Keysbrook site has the potential to improve the condition of other environmental values over time, such as Black Cockatoo foraging habitat and Banksia Woodlands.</p>
Contains habitat structure as similar as possible to undisturbed examples of the vegetation	<p>The Lowlands site has a high conservation value and has been relatively undisturbed, as such it contains habitat structure in Very Good to Excellent condition.</p> <p>The impacted area is generally considered disturbed due to prior infrastructure projects (roads). Vegetation structure at</p>	<p>While the Keysbrook site has been heavily impacted by cattle grazing, the CCWs and REWs are considered to be in Good condition, this is similar or better than that being impacted by the Proposal.</p>

Value	Lowlands site	Keysbrook site
type to be impacted.	<p>the impacted area is generally in Degraded, Cleared or Completely Degraded condition.</p> <p>The Lowlands site contains low lying <i>Banksia attenuata</i> woodland or shrublands (FCT21c) and the Central <i>Banksia attenuata</i> - <i>B. menziesii</i> woodlands (FCT23a), both listed as sub-communities of the Banksia Woodlands of the SCP TEC. Based on the vegetation association and condition mapping by Keighery et al. (1995), updates from DBCA and field survey results the <i>Eucalyptus Banksia</i> woodland (EBw), <i>Allocasuarina Banksia</i> woodland (ABw) and <i>Banksia Kunzea</i> woodland (BKw) vegetation types are considered likely to meet the key diagnostic characteristics for the Banksia Woodlands of the SCP TEC. There are five separate patches present within the survey area which are considered representative of the Banksia TEC (GHD 2020a).</p>	<p>Habitat structure of the Bush Forever site is also considered to be similar or better than that impacted by the Proposal as the area within Bush Forever site 304 (Whiteman Park) to be impacted by the Proposal is already cleared or vegetation is Degraded or cleared due to earlier road project works.</p>
Has a better area to perimeter ratio than the impacted site.	<p>Clearing a rail corridor by nature has a poor area to perimeter ratio. The Proposal is generally clearing edge portions of larger areas of vegetation.</p> <p>Lowlands has a better area to perimeter ratio, with large areas not impacted by edge effects.</p>	<p>Clearing a rail corridor by nature has a poor area to perimeter ratio. The Proposal is generally clearing edge portions of larger areas of vegetation.</p> <p>Keysbrook has a better area to perimeter ratio, with large areas not impacted by edge effects.</p>
Contains additional rare or otherwise significant species and threatened species or community compared with the impact site.	<p>The Lowlands site contains the following conservation significant species:</p> <ul style="list-style-type: none"> • <i>Caladenia huegelii</i> (listed as Endangered under the EPBC Act and Critically Endangered under the BC Act); • <i>Drakaea elastica</i> (listed as Endangered under the EPBC Act and Critically Endangered under the BC Act); • <i>Johnsonia pubescens subsp. cygnorum</i> (Priority 2) listed by DBCA; and • <i>Dillwynia dillwynioides</i> (Priority 3) listed by DBCA. <p>The following fauna species were also recorded at the Lowlands site:</p> <ul style="list-style-type: none"> • Chuditch (<i>Dasyurus geoffroii</i>) (a single male individual); • Rakali (<i>Hydromys chrysogaster</i>); • Pouched lamprey (<i>Geotria australia</i>); • Carters Freshwater Mussel (<i>Westralunio carteri</i>); • Quenda (<i>Isodoon fusciventer</i>); and 	<p>The Keysbrook site contains the following conservation significant species:</p> <ul style="list-style-type: none"> • Central <i>Banksia attenuata</i> - <i>B. menziesii</i> woodlands (FCT23a); • <i>Astartea aff. fascicularis</i>/ <i>Melaleuca</i> species dense shrublands (S01); and • Forests and woodlands of deep seasonal wetlands (FCT15). <p>Hollick (2014) noted that <i>Stylidium longitubum</i> (Priority 4) had historically been recorded within the survey area.</p> <p>The following fauna species were also recorded to be present or likely to be present at the Keysbrook site:</p> <ul style="list-style-type: none"> • Quenda (<i>Isodoon fusciventer</i>); and • Brush-tailed Phascogale (<i>Phascogale tapoatafa wambenger</i>).

Value	Lowlands site	Keysbrook site
<p>Contiguous with an existing conservation area (e.g. Bush Forever).</p>	<ul style="list-style-type: none"> Brush-tailed Phascogale (<i>Phascogale tapoatafa wambenger</i>). <p>The Lowlands site does not directly adjoin areas of conservation, however the regional creek line of the Serpentine River connects the Lowlands site to the greater State Forest area to the east of Perth. An image depicting this connection is provided below:</p> 	<p>The Keysbrook site forms part of a larger Bush Forever network, as shown on the below image:</p> 

Value	Lowlands site	Keysbrook site
<p>Enhances biological corridors or ecological linkages between conservation areas</p>	<p>The Lowlands site is identified within the Ecological Linkages of the greater Perth Region. Utilising this site as an offset will help secure and protect the values of the linkage. An image of the site in relation to the ecological linkage is shown below:</p>  <p>Source - BDCA GIS Data Layer Ecological Linkages</p>	<p>The Keysbrook site is identified within the Ecological Linkages of the greater Perth Region. Utilising this site as an offset will help secure and protect the values of the linkage. An image of the site in relation to the ecological linkage is shown below:</p>  <p>Source - BDCA GIS Data Layer Ecological Linkages</p>
<p>It includes actions to address threatening processes</p>	<p>The PTA will provide funding to the DBCA to manage the site for seven years. Management actions will address threatening processes and are provided in Section 4.2.8.</p>	<p>The PTA propose to provide funding to the SSJ to manage the site for seven years. Management actions will address threatening processes and are provided in Section 4.3.8.</p>
<p>Allows for secure management arrangements in place that will provide for long term conservation.</p>	<p>The DBCA has been nominated as the land manager for the site, and will manage it for the purposes of conservation in perpetuity.</p>	<p>The SSJ has been proposed as the land manager for the site for a period of seven years. Beyond the funding allocation and management arrangement, the site will be returned to WAPC for long-term management, remaining on the DWER offset register and maintaining the Bush Forever conservation status.</p>

6. Consistency with Principles of WA *Environmental Offsets Policy*

This Draft Offsets Strategy has been prepared considering the six principles of the *WA Environmental Offset Policy* (Government of Western Australia 2011) as shown in Table 29.

Table 29: Principles of the WA Offset Policy (Government of Western Australia 2011) considered in development of this Draft Offsets Strategy

Principle	Banksia Woodlands TEC (including the Banksia Woodlands PEC)	Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo	CCWs and REWs	Bush Forever
Environmental offsets will only be considered after avoidance and mitigation options have been pursued.	<p>The Development Envelope and Footprint has thus far been designed to avoid or minimise potential impacts, wherever possible. Ongoing refinements to the Footprint may result in further reductions of impacts (i.e. in the positioning of laydown areas, etc.).</p> <p>The Environmental Review Document (PTA, 2020) demonstrates how avoidance and minimisation have been applied to the Proposal prior to the application of offsets to counterbalance the significant residual impacts.</p> <p>Offsets are being considered in the early stages of the assessment and decision-making process in order to allow for greater transparency and certainty. This Draft Offsets Strategy will be revised once the Footprint is confirmed and if any preferred offset sites are identified.</p>			
Environmental offsets are not appropriate for all Proposals.	<p>Environmental offsets are considered to be appropriate for this Proposal. This Proposal is for a major public works program and all due consideration has been given to reducing the environmental impacts. Significant environmental impacts remaining after avoidance and minimisation strategies are proposed to be offset.</p>			
Environmental offsets will be cost-effective, as well as relevant and proportionate to the significance of the environmental value being impacted.	<p>The PTA has proposed a direct offset to counterbalance Proposal impacts to Banksia Woodlands TEC (including the Banksia Woodlands PEC).</p> <p>The Banksia Woodlands TEC offset site (Lowlands) presents value for money as it has already been acquired by the State.</p> <p>Banksia Woodlands TEC is co-located with the Black Cockatoo habitat.</p> <p>The direct offset will protect Banksia Woodlands TEC with the same vegetation sub-type impacted by the Proposal.</p>	<p>The PTA has proposed a direct offset to counterbalance Proposal impacts to Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo habitat and potential breeding trees.</p> <p>The Black Cockatoo offset site (Lowlands) presents value for money as it has already been acquired by the State.</p> <p>The Carnaby's Cockatoo habitat is co-located with the Banksia Woodlands TEC.</p> <p>Further, the Baudin's and Forest Red-tailed Black Cockatoo habitat is co-located with the Carnaby's Cockatoo habitat within one site.</p> <p>The direct offset will protect the same type of Black Cockatoo habitat impacted by and within the vicinity of the Proposal.</p> <p>The area and condition of Black Cockatoo habitat and potential breeding trees located within the offset site is</p>	<p>The PTA has proposed a direct offset to counterbalance Proposal impacts to CCWs and one REW.</p> <p>The CCWs and REW offset site (Keysbrook) presents value for money as it has already been acquired by the State.</p> <p>In addition to the CCW and REWs, other environmental values impacted by the Proposal are co-located within the offset site.</p> <p>The direct offset will protect the site from development, as it was previously privately owned.</p> <p>The direct offset will protect CCWs and REWs the same vegetation sub-type impacted by the Proposal.</p>	<p>The PTA has proposed a direct offset to counterbalance Proposal impacts to Bush Forever site 304 (Whiteman Park).</p> <p>The Bush Forever offset site (Keysbrook) presents value for money as it has already been acquired by the State.</p> <p>In addition to Bush Forever, other environmental values impacted by the Proposal are co-located within the offset site.</p> <p>The direct offset will protect Bush Forever, the same vegetation sub-type</p>

Principle	Banksia Woodlands TEC (including the Banksia Woodlands PEC)	Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo	CCWs and REWs	Bush Forever
	The area and condition of vegetation located within the offset site is proportionate to that impacted by the Proposal, as calculated using the Commonwealth Offsets Calculator.	proportionate to that impacted by the Proposal, as calculated using the Commonwealth Offsets Calculator. The direct offset will comprise 90% of the requirement. Indirect offsets are also proposed to make up the final 10% of the Black Cockatoo offset package.	The area and condition of CCWs and REWs located within the offset site is proportionate to that impacted by the Proposal, as calculated using the Commonwealth Offsets Calculator.	impacted by the Proposal. The area and environmental values of the Bush Forever site are proportionate to that impacted by the Proposal.
Environmental offsets will be based on sound environmental information and knowledge.	The quantum of impact to be offset has been calculated using reliable field survey data and the Commonwealth offsets Calculator, where applicable. Offsets were selected based on information and guidance provided within State and Commonwealth policy and guidelines. The offset proposal for Banksia Woodlands TEC (including the Banksia Woodlands PEC) have been based on objectives and sites identified in the TEC conservation notice (TSSC 2016).	The offset proposals for Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo have been based on objectives and actions to preserve important habitat as identified in: <ul style="list-style-type: none"> • <i>Carnaby's Cockatoo Recovery Plan (Calyptorhynchus latirostris)</i> (Government of Western Australia 2013); • <i>EPA Technical Report: Carnaby's Black Cockatoo in Environmental Impact Assessment in the Perth and Peel Region</i> (Government of Western Australia 2019b); and • <i>Forest Black Cockatoo (Baudin's Cockatoo Calyptorhynchus baudinii and Forest Red-tailed Black Cockatoo Calyptorhynchus banksii naso) Recovery Plan</i> (Australian Government 2008). 	The CCW and REW offset proposal has been based on the DBCA's <i>Geomorphic Wetlands SCP</i> dataset (DBCA-019) and recent vegetation surveys to delineate vegetation condition and extent within the Proposal Development Envelope and Footprint and Keysbrook site.	A recent field survey (GHD, 2020) of the proposed Bush Forever offset site was conducted to confirm environmental values and the existing condition of vegetation and habitat.
Environmental offsets will be applied within a	Risks, monitoring and contingency measures have been identified for all proposed offsets. Offsets have been selected based on information provided within State and Commonwealth policy and guidelines and the Commonwealth Offsets Calculator, where applicable. Tools including the Commonwealth Offset Calculator take into consideration risk and time-lag.			

Principle	Banksia Woodlands TEC (including the Banksia Woodlands PEC)	Carnaby’s, Baudin’s and Forest Red-tailed Black Cockatoo	CCWs and REWs	Bush Forever
framework of adaptive management.	<p>The PTA propose to enter into an MOU with the DBCA, SSJ and other relevant parties, such as land owners, as required to implement the management of the offset sites. The MOU will include the identification of potential risks, outline strategies to mitigate potential risks and require regular reporting on implementation and performance. Adaptive management will be adopted including mechanisms to account for risks and other unintended consequences. Regular audits to assess compliance against the site management plans will be conducted.</p>			
Environmental offsets will be focused on longer-term strategic outcomes	<p>Land acquisition offsets present a long-term strategic outcome due to:</p> <ul style="list-style-type: none"> • State ownership of offset sites. • Provision for funding for management of the offset sites by the DBCA and SSJ for a period of seven years. • Rezoning Keysbrook to Parks and Recreation. • The intention to transfer offset sites to the Conservation Estate. 			
	<p>Banksia Woodlands TEC offsets focus on long-term preservation of areas consistent with the TEC conservation notice (TSSC 2016).</p>	<p>Black Cockatoo offset areas focus on the long-term protection of important habitat, consistent with recovery plans for the species.</p>	<p>The CCW and REW offset is focused on the long-term preservation and management of the wetlands with the intention to transfer the site to Conservation Estate.</p>	<p>The Bush Forever offset focusses on the long-term preservation and management of the site with the intention to transfer the site to Conservation Estate.</p>

7. Consistency with Commonwealth Offset Principles

The described approach to mitigation and proposed offsets is consistent with the ten offset principles outlined in the *Commonwealth Environmental Offset Policy* (Australian Government 2012a). Table 30 summarises how these principles were considered in the development of the offset approach for Banksia Woodlands TEC and Carnaby's, Baudin's and Forest Red-tailed Black Cockatoos.

Table 30: Consideration of the Commonwealth offsets principles against MNES

Principle	Banksia Woodlands TEC	Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo's
Suitable offsets must 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 acquisition of sites that contain existing Banksia Woodlands TEC, Black Cockatoo habitat and potential breeding trees and the provision of funding to the DBCA for seven years of on-ground management will deliver an overall conservation outcome that maintains the viability of MNES being protected.	
Suitable offsets must be built around direct offsets but may include other compensatory measures.	<p>The acquisition of land containing Banksia Woodlands TEC and provision of funding to the DBCA to provide on-ground management measures for seven years is a direct offset.</p> <p>No indirect offsets are proposed as part of the Banksia Woodlands TEC offset package.</p> <p>The minimum area of Banksia Woodlands TEC to be acquired will meet 100% of the offset requirement as calculated using the Commonwealth Offsets Calculator.</p>	<p>The acquisition of land containing Black Cockatoo habitat and potential breeding trees and provision of funding to the DBCA to provide on-ground management measures for seven years is a direct offset. The minimum area of Black Cockatoo habitat to be acquired will meet 90% of the offset requirement as calculated using the Commonwealth Offsets Calculator.</p> <p>The remaining 10% will be met through other compensatory measures, namely, provision of funding to Murdoch University to conduct Black Cockatoo research.</p> <p>The PTA has enough Black Cockatoo habitat to meet 100% of the offset requirement should the research proposal not proceed.</p>
Suitable offsets must be in proportion to the level of statutory protection that applies to the protected matter.	<p>Total offset requirement was calculated using the Commonwealth Offsets Calculator.</p> <p>This Calculator factors the level of statutory protection into the determination of the area required and nature of offset. As such, the offset is expected to be suitable and in proportion to the level of statutory protection applied to Banksia Woodlands TEC and Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo habitat. Direct offsets have been provided for all MNES, with the minimum 90% of the direct offset requirement being exceeded.</p>	

Principle	Banksia Woodlands TEC	Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo's
<p>Suitable offsets must be of a size and scale proportionate to the residual impacts on the protected matter.</p>	<p>The PTA has proposed direct offsets to counterbalance Proposal impacts to Banksia Woodlands TEC. The direct offset will protect Banksia Woodlands TEC with the same vegetation sub-type being impacted by the Proposal.</p> <p>The area and condition of vegetation located within the offset site is proportionate to that being impacted by the Proposal, as calculated using the Commonwealth Offsets Calculator.</p> <p>Direct offsets have been provided with the minimum 90% of the direct offset requirement being exceeded (in this case, the direct offset is 100%).</p>	<p>The PTA has proposed direct offsets to counterbalance Proposal impacts to Black Cockatoo habitat and potential breeding trees. The direct offset will protect the same type of Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo habitat being impacted by and within the vicinity of the Proposal.</p> <p>The area and condition of Black Cockatoo habitat and potential breeding trees located within the offset site is proportionate to that being impacted by the Proposal, as calculated using the Commonwealth Offsets Calculator. The direct offset will comprise 90% of the requirement.</p> <p>Indirect offsets are proposed to comprise the final 10% of the Black Cockatoo offset package.</p>
<p>Suitable offsets must effectively account for and manage the risks of the offset not succeeding.</p>	<p>All offset sites have been acquired by the State. The risk of the offset option not succeeding is expected to be very low with a 90% confidence in the result applied within the Commonwealth Offsets Calculator. Following acquisition, it is reasonable to expect that the acquisition and on-ground management of the sites will reduce the risk of loss and prevent degradation of habitat over the long term.</p>	
<p>Suitable offsets must 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).</p>	<p>State acquisition of privately-owned land and provision of funding for active on-ground management by the DBCA presents a conservation outcome beyond what would occur without implementation of this Offsets Strategy. State Government acquisition of privately-owned sites for conservation is initiated by their proposed use as offset sites. Further, conservation and on-ground management of these sites is not required or planned under any other planning or approval process and is entirely instigated as a result of this Offsets Strategy. Management of acquired land will be over and above that which is already experienced onsite</p>	
<p>Suitable offsets must be efficient, effective, timely, transparent, scientifically robust and reasonable</p>	<p>The proposed acquisition sites contain multiple environmental values that require offsetting and land acquisition provides an efficient offset option as there is minimal time-lag in achieving benefits following site purchase.</p> <p>Proposed offsets are effective in meeting and in some cases exceeding the significant residual impacts. Further, land acquisition and management is an effective offset proposal.</p> <p>The offsets strategy will be provided to the DWER, DAWE and other government agencies as required for review and approval. Offsets are published on the DWER offsets register which provides public transparency.</p> <p>Further, the public were able to comment on the Proposal's referral document, and will be able to comment on the Proposal's Environmental Review Document and this Draft Offsets Strategy.</p>	

Principle	Banksia Woodlands TEC	Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo's
		It is proposed that offset sites will be efficiently managed in a transparent manner by the DBCA or SSJ. Offsets and associated conservation measures will be reviewed and approved by the DWER, DAWE and other government agencies including the DBCA recognised for applying scientifically robust methods in conservation management.
Suitable offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.		The PTA propose to enter into an MOU with the DBCA, SSJ, WAPC and a Grant agreement with Murdoch University as required to implement the management of the offsets. This will include transparent governance and regular reporting on implementation and performance. Regular audits to assess compliance against the site management plans will be conducted.
Suitable offsets must be informed by scientifically robust information and incorporate the precautionary principle in the absence of scientific certainty.		Offsets will be informed by scientifically robust information and will incorporate the precautionary principle in the absence of scientific certainty.
Suitable offsets must be conducted in a consistent and transparent manner.		As a State Government Proposal, offsets will be conducted in a consistent and transparent manner, with implementation and performance reported annually to DWER and DAWE.

8. Offset Proposal Governance

The following sections describe the governance structure for the offsets. Governance will be specified and bound within specific MOU agreements.

8.1. Timelines and milestones

Milestones and timing for implementation of offsets including funding and delivery of offsets will be agreed with the DBCA, SSJ, Murdoch University and WAPC as part of the development of the various MOUs or other mechanisms. Timeline progression, achievement of milestones and budget will be reported monthly or annually in accordance with the terms of the MOU.

8.2. Monitoring to assess offset implementation

The PTA will monitor offset delivery, implementation of management measures and overall progress through liaison with the DBCA, SSJ and Murdoch University and review of monthly or annual reports. This process will be conducted in accordance with the MOUs/Grant Agreements and would include reporting on the completed management measures, those scheduled, those not completed and allocated budget. Specific monitoring results will also be reported.

The MOU or other mechanism between the SSJ/DBCA and the PTA (and other parties as required) will dictate the format, content and timing of reporting required. Monitoring would be supported for the first five years and only extended if monitoring indicates that success criteria have not or are unlikely to be met at seven years.

8.3. Reporting and timing

The PTA will provide an annual Compliance Assessment Report to DWER and/or DAWE (as required) regarding:

- The activities undertaken in the previous 12 months for each offset.
- The activities proposed in the next 12 months for each offset.
- A summary of compliance with the final Offsets Strategy with regard to each offset.
- An evaluation of the results of site assessments and monitoring to identify progress in meeting the success criteria.

8.4. Financial arrangements

The PTA will fully fund the relevant actions proposed under this Offsets Strategy including the:

- Provision of funding for on-ground management measures to maintain the offset sites' vegetation condition and habitat.
- Contribution of funding to Murdoch University for the Black Cockatoo research proposal.

8.5. Review and revision

The Offsets Strategy will be revised based on one or more of the following:

- Notification of environmental conditions (under both the EP Act and EPBC Act);
- Confirmation of the final project footprint (if changed);
- Revision of significant environmental impacts (if required);
- Receipt of information addressing any data gaps (if required and where available); and
- Any additional offset sites that become available for use in METRONET projects (if suitable or preferable).

9. Stakeholder Consultation

Stakeholder consultation in relation to the coordination, development and implementation of this Offsets Strategy conducted to date is summarised in Table 31.

Please note that the PTA is progressing multiple offsets strategies for METRONET proposals, and this may be reflected in the below discussions.

Table 31: Offsets Strategy stakeholder consultation

Stakeholder ¹	Date	Issues/topics	PTA response/outcome
WAPC/DPLH	28 July 2020	Proposed meeting to discuss the Proposal's Draft Offsets Strategy and the use of State acquired Advanced offset sites.	TBA
City of Bayswater	July 2020	Proposed meeting to discuss the Proposal's Draft Offsets Strategy and potential offset opportunities within the City, for future consideration.	TBA
City of Swan	17/06/2020	Meeting to discuss the Proposal's Draft Offsets Strategy and potential offset opportunities within the City, for future consideration. Included discussion with representative from Friends of Bennett Brook regarding potential on ground offsets.	The PTA to look at the offset site proposed at the meeting and other potential offset sites and methods. The City of Swan to provide any further potential offset options.
MRWA METRONET DWER DBCA DAWE	08/05/2020	Discussed the proposed Malaga to Ellenbrook Rail Works Proposal offsets strategy and the use of State acquired Advanced offset sites.	The PTA is to include information in the Offsets Strategy regarding on-ground management of the Lowlands site. PTA to liaise with DBCA with regards to changes to wetlands mapping dataset.
MRWA METRONET	05/05/2020	Offsets meeting - discussed Offsets Strategy for Malaga to Ellenbrook Rail Works.	Schedule additional offset meetings to further collaborate as required.
SSJ	06/04/2020	Discussed the option of SSJ carrying out the site management of the Keysbrook site.	The PTA provided a written offer to the SSJ for the management of the Keysbrook site.
SSJ	21/01/2020	Discussed the option of SSJ carrying out the site management of the Keysbrook site.	SSJ to follow up on internal departments if the Shire would be able to implement a management plan.
EPA Services MU	23/10/2019	Discussed the Black Cockatoo Research Proposal.	Research proposal finalised. Details on which will be provided under separate cover.
DBCA	10/10/2019	Proposed management and funding arrangement for the Lowlands offset proposal discussed.	DBCA to provide proposed management actions and funding requests as discussed in the meeting in writing.
MU	21/08/2019	Discussed the PTA's comments on Murdoch's Black Cockatoo research proposal and the revised proposal	PTA to provide the revised proposal to the State and Commonwealth and discuss the

Stakeholder ¹	Date	Issues/topics	PTA response/outcome
		prepared to address the PTA's comments.	proposal with all stakeholders including Government in October 2019 teleconference.
DBCA	21/08/2019	Discussed the proposed Lowlands Offsets Strategy and site management.	Schedule further meeting to discuss details, Keysbrook and Ningana Bush Forever Offset Sites.
MRWA	09/08/2019	Offsets meeting - discussed shared offset opportunities.	Schedule additional offset meeting to further collaborate as required.
EPA Services DPC	25/06/2019	Offsets teleconference to discuss the Proposal offsets strategy and the Commonwealth's comments on the draft Offsets Strategy.	The PTA is to provide written evidence to DWER to support the allocation of advanced offset sites to METRONET and to discuss the draft offset Calculator.
WAPC	24/05/2019	Discussed the proposed Proposal offsets strategy, the use of State acquired Advanced offset sites and the proposed Bush Forever offset.	The PTA to schedule a further meeting to discuss the proposed Bush Forever offset with all relevant stakeholders.
DWER	23/05/2019	Discussed the proposed Proposal offsets strategy and the use of State acquired Advanced offset sites.	The PTA is to provide written evidence to DWER to support the allocation of advanced offset sites to METRONET.
WAPC	1/05/2019	Discussed WAPC's historical purchase of land for the Strategic Assessment of the Perth and Peel Region (SAPPR) for future offset requirements including METRONET.	A future meeting with EPA Chairman Dr Tom Hatton was scheduled to discuss further, with a discussion paper and briefing notes to the Transport Minister and the Commonwealth Minister of Environment summarising the matter to be prepared.
DPC DBCA METRONET	5/04/2019	<ul style="list-style-type: none"> Coordinated approach to METRONET offsets. Proposed METRONET Offsets Strategy, specifically, land acquisition options and strategy. State and Commonwealth Offsets Strategy timeframes. Use of SAPPR offsets. 	<ul style="list-style-type: none"> PTA scheduled a future meeting with EPA Services to discuss meeting outcomes. The PTA agreed to provide DPC, DBCA, and WAPC with regular METRONET offsets.
DPC DBCA	3/04/2019	Discussed land acquisition offset options for each Proposal significant residual impact including timing, strategy, risks and issues.	The PTA strategised potential sites and agreed to conduct further research prior to presenting them to EPA Services for consideration.
WAPC	27/03/2019	Discussed WAPC purchased advanced offset sites available for METRONET use.	PTA to obtain written authorisation to use the sites for METRONET.

Stakeholder ¹	Date	Issues/topics	PTA response/outcome
DPC METRONET	27/03/2019	<ul style="list-style-type: none"> Coordinated approach to METRONET offsets. Proposed METRONET Offsets Strategy, specifically, land acquisition options and strategy. State and Commonwealth Offsets Strategy timeframes. Use of (SAPPR) offsets. 	PTA to obtain written authorisation to use the SAPPR offset sites for METRONET.
DBCA	21/03/2019	Discussed land acquisition offset options for each Proposal significant residual impact including timing, strategy, risks and issues. DBCA proposed acquisition sites and strategies.	Schedule further meeting as required.
DPLH	14/03/2019	Discussed cost to manage Bush Forever sites, namely Bush Forever Site north of Roe Highway and WAPC/DBCA reserve management process.	Schedule further meeting as required.
MRWA	1/03/2019	Discussed co-funding of Murdoch's Black Cockatoo research proposal offset case studies/experience/examples.	MRWA and the PTA agreed to continue to liaise with regards to co-funding Murdoch Black Cockatoo research.
MU	1/02/2019	Discussed Murdoch's Black Cockatoo research proposal.	Murdoch to provide a Black Cockatoo research proposal to the PTA for consideration and inclusion within the Offsets Strategy.
DBCA ELA	24/10/2018	Discussed land acquisition offset options for each Proposal significant residual impact including timing, strategy, risks and issues. DBCA proposed acquisition sites and strategies.	ELA to prepare an Offsets Strategy.

¹ Stakeholders are identified using the following abbreviations:

DAWE - Department of Agriculture, Water and the Environment (Commonwealth)

DBCA - Department of Biodiversity, Conservation and Attractions (State)

DPC - Department of Premier and Cabinet (Commonwealth)

DPLH - Department of Planning, Lands and Heritage (State)

DWER - Department of Water and Environmental Regulation (State)

ELA - Ecological Australia (Consultant)

EPA Services - Environmental Protection Authority (State)

SSJ - Shire Serpentine Jarrahdale (Local Government)

MRWA - Main Roads Western Australia

MU - Murdoch University

WAPC - Western Australian Planning Commission (State)

10. Finalisation and Implementation of Offsets

This Draft Offsets Strategy will be submitted to the State and Commonwealth for consideration as part of the Proposals Environmental Review Document. The Offsets Strategy will be finalised following comments from regulators, conditions imposed by the State and/or Commonwealth and results of further PTA investigations or surveys into the Proposal or offset land acquisition sites.

11. Conclusion

After considering all the information provided in the State and Commonwealth guidance documents and tools, the holistic environmental value of an impacted factor, including information specific to the Proposal, the PTA has calculated the significant residual environmental impacts.

The PTA propose to use direct land acquisition offsets and one indirect research offset to counterbalance the significant residual impacts from the Proposal. The sites selected as offset sites are owned by the State and are managed (or will be managed) by the DBCA or SSJ.

The PTA has provided this strategy to demonstrate the approach to offsets; to demonstrate offsets are available for counterbalancing the significant residual impacts of the Proposal, and that proposed offsets meet both State and Commonwealth requirements.

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Appendix A – Residual Impact Significance Model

Environmental Factor	Predicted Direct Impact(s)	Mitigation			Unacceptable significant impacts	Significant impacts that will be offset	Insignificant impacts that will not be offset
		Avoidance	Minimisation	Rehabilitation			
Flora and Vegetation	<ul style="list-style-type: none"> Permanent loss of 59.9 ha of native vegetation in Degraded or better condition from within a 249 ha Footprint including: <ul style="list-style-type: none"> 10.05 ha of Commonwealth listed Banksia Woodlands of the Swan Coastal Plain (SCP) Threatened Ecological Community (TEC), synonymous with the State listed Priority 3 Banksia Dominated Woodlands of the SCP Priority Ecological Community (PEC) within the Footprint comprising of two patches, Patch 1 (8.54 ha and Patch 5 (1.51 ha). 17.2 ha of regionally significant bushland within Bush Forever site 304 (Whiteman Park). 112.3 ha of wetland vegetation in Completely Degraded or better condition, of which 1.9 ha is associated with Conservation Category Wetlands (CCWs) and 60.4 ha is associated with Resource Enhancement Wetlands (REW). Severance of regional ecological linkages. 	<ul style="list-style-type: none"> The Proposal design has been modified iteratively to avoid known populations of, and direct impacts to, threatened flora and native vegetation, with a particular emphasis on avoiding vegetation in Degraded or better condition, as far as practicable. The establishment of Native Vegetation Retention Areas (NVRAs) within the Development Envelope. NVRAs are designated no-clearing zones within the Development Envelope to reduce the impacts on native vegetation, Bush Forever site 304 (Whiteman Park), avoid clearing mature trees and/or CCWs/REWs. The Proposal has been designed to avoid three patches (Patch 2, 3 and 4) of TEC that were mapped within close proximity to, or within, the Development Envelope and Footprint. A significant portion of the highest quality vegetation within Patch 1 TEC (6.95 ha, approximately 30% of the total mapped area) has been incorporated into a NVRA. A significant portion of Patch 1 TEC (7.74 ha, approximately 33% of the total mapped area) has been excluded from the Development Envelope. A significant portion of Patch 5 TEC (35.94 ha, approximately 97.8% of the total mapped area) has been excluded from the Development Envelope. The Proposal design has been developed to avoid clearing of CCW in Good – Degraded condition wherever practicable. Avoidance of areas of Bush Forever sites 198 Beechboro Road Bushland, Ballajura; 200 Caversham Airbase Bushland, West Swan / Whiteman; and 305 Bennett Brook Reserve. 	<ul style="list-style-type: none"> Refinement of the Development Envelope and Footprint to the minimal extent necessary whilst accommodating the construction and operation of the project, allowing some degree of flexibility in detailed design. The Development Envelope was positioned so as to minimise impacts on Bennett Brook by crossing it at its narrowest practicable point, commensurate with the requirements of rail design geometry. The Footprint has been aligned along the edge of Drumpellier Drive to minimise clearing within the Bush Forever Site 304 (Whiteman Park) eastern edge. The majority of the alignment has been designed to avoid dissecting areas of native vegetation, thus limiting edge effects to one side of the Proposal. Design included a bridge over Bennett Brook to minimise any interruptions to the dispersal of flora and fauna along ecological linkages. Permanent access paths where the rail alignment crosses the junction between Drumpellier Drive and Gnangara Road have been relocated to minimise the impact on TEC Patch 5. Embankment and alignment have been modified to minimise the impact on TEC Patch 5. The location of the dive structure under the southbound carriageway of Tonkin Highway was modified to allow the rail to cross Patch 1 through the lowest condition vegetation possible. The Development Envelope and the Footprint have been amended to minimise impacts on several CCWs along the alignment. 	<ul style="list-style-type: none"> Areas cleared for the Proposal will be revegetated where not required for permanent infrastructure or management access with consideration for operational safety requirements. Areas cleared for the Proposal within the riparian zone of Bennett Brook not required for permanent infrastructure or ongoing management of the railway will be revegetated. 	Not applicable.	Permanent loss of: <ul style="list-style-type: none"> 10.05 ha of Banksia Woodlands of the SCP TEC and PEC. 17.2 ha of regionally significant bushland in Bush Forever site 304 (Whiteman Park). 1.9 ha of CCW vegetation in Completely Degraded or better condition, of which 1.62 ha is located within Bush Forever site 304 (Whiteman Park). 0.5 ha of REW 8678 vegetation in Degraded or better condition. 	<ul style="list-style-type: none"> 47.5 ha of Bush Forever site 304 (Whiteman Park) in Completely Degraded or worse condition. 109.9 ha of vegetation in Completely Degraded or better condition, associated with REWs and Multiple Use wetlands. Severance of regional ecological linkages.

Environmental Factor	Predicted Direct Impact(s)	Mitigation			Unacceptable significant impacts	Significant impacts that will be offset	Insignificant impacts that will not be offset
		Avoidance	Minimisation	Rehabilitation			
		<ul style="list-style-type: none"> The Proposal was designed to prioritise placement within existing linear infrastructure corridors where practicable, avoiding clearing of native vegetation within the Bush Forever site 304 (Whiteman Park). Where possible, native vegetation within Bush Forever has been included within NVRAs to avoid clearing during construction activities Wherever practicable, the temporary construction footprint has been positioned to avoid clearing of native vegetation. Construction and operational access tracks have been designed to coincide with existing tracks or aligned along cleared areas where practicable. Thus far changes to the Proposal have reduced the Development Envelope from 501 ha to 463.8 ha and the Footprint from 365.9 ha to 249 ha; reducing the impacts on: <ul style="list-style-type: none"> - Native vegetation from 313 ha to 152.1 ha; - Native vegetation by introducing 44.9 ha of NVRAs. - Banksia Woodlands TEC from 23.06 ha to 10.05 ha; - Bush Forever from 81.7 ha to 17.2 ha; and - Wetlands vegetation from 220.5 ha to 105.2 ha. 	<ul style="list-style-type: none"> Impacts to GDE have been minimised by aligning the project footprint away from native vegetation wherever practicable. A CEMP will be developed and maintained in accordance with current DWER guidance and policies to minimise Flora and Vegetation impacts. A Flora and Vegetation Management Plan will be developed and maintained to manage potential impacts to the TEC/PEC. Existing cleared areas will be used for temporary construction requirements, where practicable. Temporary clearing of Bush Forever Site 304 (Whiteman Park) will be minimised wherever practicable. Areas cleared for the Proposal within the riparian zone of Bennett Brook that are not required for permanent infrastructure or ongoing management of the railway will be rehabilitated. 				
Inland Waters	<p>Sixteen Geomorphic wetlands intersect the Footprint comprising a total area of 125.4 ha of wetland habitat that may be impacted, by the Proposal, including:</p> <ul style="list-style-type: none"> Nine multiple use wetlands (MUW) – 63.1 ha intersects the Footprint; Four REWs – 60.4 ha intersects the Footprint; and 	<ul style="list-style-type: none"> The Proposal has been designed to avoid clearing of CCW in Good – Degraded condition wherever practicable. The Proposal was designed to ensure CCW UFI 8724 (Horse Swamp) was outside the Development Envelope. 	<ul style="list-style-type: none"> The Development Envelope and the Footprint have been amended to minimise impacts on several CCWs along the alignment. Impacts to Bennett Brook have been minimised by minimising the width at which the Development Envelope intersects Bennett Brook. 	<ul style="list-style-type: none"> If required, surface water deemed to be contaminated will be remediated in accordance with the CEMP. 	Not applicable	<p>Impacts to:</p> <ul style="list-style-type: none"> 1.9 ha of CCWs comprised: <ul style="list-style-type: none"> - 0.1 ha of UFI 8429 comprised of vegetation in Degraded condition located north of the proposed Malaga Station site. 	<p>Impacts to the following wetlands located outside the Footprint, intersecting the Development Envelope:</p> <ul style="list-style-type: none"> CCW UFI 8417 (within a NVRA and will not be directly impacted).

Environmental Factor	Predicted Direct Impact(s)	Mitigation			Unacceptable significant impacts	Significant impacts that will be offset	Insignificant impacts that will not be offset
		Avoidance	Minimisation	Rehabilitation			
	<ul style="list-style-type: none"> Three CCWs – 1.9 ha intersects the Footprint. 	<ul style="list-style-type: none"> Establishment of NVRAs within the Development Envelope to reduce the impacts on native vegetation and avoid clearing CCWs, including UFI 8417. The PTA will further investigate avoiding areas of CCWs during the detailed design phase, where practicable. Avoidance of dewatering during construction, where practicable and consistent with construction requirements, will continue to be investigated through the development of design and construction methods. Impacts will be avoided as much as practicable by placing the bores away from sensitive receptors. Where practicable, the design will remain above the water table. No chemicals and/or fuel will be stored or transferred within: <ul style="list-style-type: none"> DPWSA P1 or wellhead protection zones; the Gnamara UWPCA in the northern portion of the Development Envelope; or 50 m of existing waterways or wetlands. Where practicable, construction chemicals that are biodegradable and/or less hazardous will be used. 	<ul style="list-style-type: none"> A CEMP and Acid Sulfate Soil (ASS) Management Plan will be developed in accordance with current DWER guidance and policies to: <ul style="list-style-type: none"> minimise abstraction impacts to groundwater and surface water; minimise impacts associated with drawdown effects on ASS including the potential oxidation of ASS in or near wetlands; include engineering controls and/or reinjection bores or recharge basins where practicable to minimise impacts from aquifer reinjection; and manage chemical and fuel storage and use. Groundwater will be extracted in accordance with a <i>Rights in Water and Irrigation Act 1914</i> Section 5C licence to minimise potential impacts to environmental values including groundwater dependent vegetation. Impacts from overland railway embankments will be minimised by designing them to include (where necessary) under-drainage and/or surface drainage to minimise the change. Detailed drainage design will incorporate management measures to avoid impacts to water course/stream bed/drainage/flow and the management of runoff and turbidity. Bennett Brook Bridge will be engineered to avoid as far as practicable impacts and disturbance to the water course. Water Sensitive Urban Design principles will be incorporated into the stormwater drainage design where feasible to: 			<ul style="list-style-type: none"> 1.2 ha of CCW UFI 8728 comprised of vegetation in Degraded to Completely Degraded condition located to the north of the future Bennett Springs East Station. 0.6 ha of CCW UFI 15259 comprised of vegetation in Good to Completely Degraded condition located to the north of the proposed future Bennett Springs East Station. 0.5 ha of REW UFI 8678 comprised of vegetation in Excellent to Degraded condition located north of the proposed Whiteman Park Station. 	<ul style="list-style-type: none"> REW UFI 8806 REW UFI 15752 REW UFI 15757 MUW UFI 8663 MUW UFI 8720 MUW UFI 8727 MUW UFI 8729 MUW UFI 13396 MUW UFI 15029 MUW UFI 15200 MUW UFI 15511 MUW UFI 15751

Environmental Factor	Predicted Direct Impact(s)	Mitigation			Unacceptable significant impacts	Significant impacts that will be offset	Insignificant impacts that will not be offset
		Avoidance	Minimisation	Rehabilitation			
			<ul style="list-style-type: none"> - Manage the first 15 mm of rainfall at-source as much as practicable. - Minimise the volume of water directed to large drainage basins by maximising infiltration at source within the railway corridor open drains and installing smaller detention/infiltration areas where applicable. 				
Terrestrial Fauna	<p>Clearing of up to:</p> <ul style="list-style-type: none"> • 43 ha of fauna habitat within the Footprint including: <ul style="list-style-type: none"> - 21 ha of Moderate value habitat; and - 22 ha of Low value habitat. • 81.4 ha of Black Cockatoo foraging habitat including: <ul style="list-style-type: none"> - 42.8 ha of High quality habitat; - 11.3 ha of Moderate quality habitat; and - 27.3 ha of Low quality habitat. • 68.1 ha of Forest Red-tailed Black Cockatoo foraging habitat comprised of: <ul style="list-style-type: none"> - 33.6 ha High quality habitat; - 4.3 ha of Moderate quality habitat; and - 30.15 ha of Low quality habitat. • 81.4 ha Baudin's Cockatoo foraging habitat comprised of: <ul style="list-style-type: none"> - 42.8 ha of Moderate quality habitat; and - 38.6 ha of Low quality habitat. • 423 Black Cockatoo potential breeding trees (trees with Diameter Breast Height (DBH)>500mm); 33 with (unsuitable) hollows. 	<ul style="list-style-type: none"> • The Proposal was designed to prioritise placement within existing linear infrastructure corridors where practicable, to avoid clearing of vegetation and fauna habitat. • For the northern portion of the Development Envelope, the PTA aligned the rail corridor adjacent to Drumpellier Drive, near existing cleared road infrastructure along the eastern boundary of Whiteman Park to reduce fauna habitat disturbance and avoid fragmenting areas of high value fauna habitat. • To the south of the Development Envelope, the PTA has largely avoided high value fauna habitat by aligning the rail corridor through the largely cleared Marshall Paddocks. • Iterative changes to the Development Envelope have avoided impacts to wetland habitats, including a 50 m precautionary buffer from the maximum known extent of Horse Swamp. • The Development Envelope has been modified to avoid Black Cockatoo potential breeding trees and foraging habitat. 	<ul style="list-style-type: none"> • The Proposal was designed to prioritise placement within low value fauna habitat areas where possible to minimise impacts to fauna habitat. More than 75% of the Development Envelope is comprised of cleared land or low value fauna habitat. • The Proposal was designed to place the temporary construction areas within existing cleared or Completely Degraded areas adjacent or near to the rail corridors where practicable, to minimise vegetation clearing and impacts to fauna habitat. • A CEMP will be developed and implemented during construction and includes mitigation and management measures. • Black Cockatoo potential breeding trees will be inspected prior to clearing and any trees with active nests will be temporarily protected, including a 10 m buffer. • Provision of a fauna crossing at Bennett Bridge and the provision of a second fauna crossing between Bennet Brook and Beechboro Road North. • Detailed drainage design will incorporate management measures to avoid impacts to water course/stream bed/drainage/flow and the management of runoff and turbidity. 	<ul style="list-style-type: none"> • Areas cleared for the Proposal not required for future infrastructure or management access will be rehabilitated with consideration for operational safety requirements. • Disturbed and cleared riparian vegetation at Bennett Brook which was cleared for temporary construction areas will be rehabilitated. 	Not applicable.	<p>Clearing of up to:</p> <ul style="list-style-type: none"> • 81.4 ha of Black Cockatoo foraging habitat including: <ul style="list-style-type: none"> - 42.8 ha of High quality habitat; - 11.3 ha of Moderate quality habitat; and - 27.3 ha of Low quality habitat. • 68.1 ha of Forest Red-tailed Black Cockatoo foraging habitat comprised of: <ul style="list-style-type: none"> - 33.6 ha High quality habitat; - 4.3 ha of Moderate quality habitat; and - 30.15 ha of Low quality habitat. • 81.4 ha Baudin's Cockatoo foraging habitat comprised of: <ul style="list-style-type: none"> - 42.8 ha of Moderate quality habitat; and - 38.6 ha of Low quality habitat. • 423 Black Cockatoo potential breeding trees (trees with DBH>500mm); 33 with (unsuitable) hollows. 	<p>Clearing of up to:</p> <ul style="list-style-type: none"> • 43 ha of fauna habitat within the Footprint including: <ul style="list-style-type: none"> - 21 ha of Moderate value habitat; and - 22 ha of Low value habitat.

Environmental Factor	Predicted Direct Impact(s)	Mitigation			Unacceptable significant impacts	Significant impacts that will be offset	Insignificant impacts that will not be offset
		Avoidance	Minimisation	Rehabilitation			
		<ul style="list-style-type: none"> NVRAs have avoided clearing approximately 44.5 ha of high value fauna habitat within the Development Envelope, including 25.6 ha of Black Cockatoo foraging habitat. NVRAs have avoided clearing approximately 201 Black Cockatoo potential breeding trees within the Development Envelope. An NVRA has included CCW UFI 8417, avoiding clearing 0.7 ha of this wetland. The Proposal has been designed to place temporary construction areas within existing cleared or Completely Degraded areas adjacent or near to the rail corridors where practicable, to minimise clearing of terrestrial fauna habitat. The PTA will further investigate avoiding areas of fauna habitat during the detailed design phase, where practicable. Water sensitive urban design principles will be implemented as part of detailed drainage design. This will include infiltration of stormwater as a preference to reduce incidence of pooling of water on the surface which may act as an attractant for fauna species such as black cockatoos and place them at increased risk of being struck by a passenger train. The Proposed Action includes high fencing to deter Black Cockatoos from entering the rail corridor. No Black Cockatoo foraging species will be planted near the train corridor for landscaping to deter use of these areas by Black Cockatoos. 	<ul style="list-style-type: none"> Construction of Bennett Brook Bridge will be planned and undertaken in a manner that manages and avoids impacts to the water course and water quality, with particular consideration of Carter's Freshwater Mussels. Provision of transverse drainage design, to maintain fish passage movement (particularly the Black-stripe Minnow) through the drainage network/impacted drainage and wetland area. 				

Appendix B - Lowlands and Keysbrook Certificates of Title



REGISTER NUMBER 301/DP77559	
DUPLICATE EDITION N/A	DATE DUPLICATE ISSUED N/A

RECORD OF CERTIFICATE
OF
CROWN LAND TITLE
UNDER THE TRANSFER OF LAND ACT 1893
AND THE LAND ADMINISTRATION ACT 1997
NO DUPLICATE CREATED

VOLUME **LR3164** FOLIO **969**

The undermentioned land is Crown land in the name of the STATE OF WESTERN AUSTRALIA, subject to the interests and Status Orders shown in the first schedule which are in turn subject to the limitations, interests, encumbrances and notifications shown in the second schedule.



REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 301 ON DEPOSITED PLAN 77559

**STATUS ORDER AND PRIMARY INTEREST HOLDER:
(FIRST SCHEDULE)**

STATUS ORDER/INTEREST: RESERVE UNDER MANAGEMENT ORDER

PRIMARY INTEREST HOLDER: CONSERVATION COMMISSION OF WESTERN AUSTRALIA OF CARE OF DEPARTMENT OF PARKS AND WILDLIFE OF LOCKED BAG 104, BENTLEY DELIVERY CENTRE

(XE M845092) REGISTERED 26/3/2015

**LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)**

- EASEMENT BENEFIT CREATED UNDER SECTION 136C T.L.A. FOR RIGHT OF CARRIAGEWAY PURPOSES - SEE DEPOSITED PLAN 77559.
- F854772 EASEMENT TO ELECTRICITY CORPORATION. SEE SKETCH ON DEPOSITED PLAN 77559. REGISTERED 13/4/1995.
- M950769 CLASS A RESERVE 51784 FOR THE PURPOSE OF CONSERVATION OF FLORA AND FAUNA LIMITED TO A DEPTH OF 200 METRES FROM THE NATURAL SURFACE. REGISTERED 26/3/2015.
M845092 MANAGEMENT ORDER. CONTAINS CONDITIONS TO BE OBSERVED. REGISTERED 26/3/2015.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required. Lot as described in the land description may be a lot or location.

-----END OF CERTIFICATE OF CROWN LAND TITLE-----

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

END OF PAGE 1 - CONTINUED OVER

ORIGINAL CERTIFICATE OF CROWN LAND TITLE

REGISTER NUMBER: 301/DP77559

VOLUME/FOLIO: LR3164-969

PAGE 2

SKETCH OF LAND:

DP77559

PREVIOUS TITLE:

1089-276, 2040-535

PROPERTY STREET ADDRESS:

NO STREET ADDRESS INFORMATION AVAILABLE.

LOCAL GOVERNMENT AUTHORITY:

SHIRE OF SERPENTINE-JARRAHDALE

RESPONSIBLE AGENCY:

DEPARTMENT OF BIODIVERSITY, CONSERVATION AND
ATTRACTIONS (SCLM)

NOTE 1: M950769 CORRESPONDENCE FILE 00013-2014-01RO

WESTERN



AUSTRALIA

REGISTER NUMBER

77/P739

DUPLICATE
EDITION

2

DATE DUPLICATE ISSUED

21/6/2018

RECORD OF CERTIFICATE OF TITLE
UNDER THE TRANSFER OF LAND ACT 1893

VOLUME
1191FOLIO
779

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.



REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 77 ON PLAN 739

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

WESTERN AUSTRALIAN PLANNING COMMISSION OF 140 WILLIAMS STREET PERTH
(T N924580) REGISTERED 20/6/2018

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. TITLE EXCLUDES THE LAND SHOWN ON O.P. 7738.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

-----END OF CERTIFICATE OF TITLE-----

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: 1191-779 (77/P739)
PREVIOUS TITLE: 1046-383
PROPERTY STREET ADDRESS: 671 YANGEDI RD, KEYSBROOK.
LOCAL GOVERNMENT AUTHORITY: SHIRE OF SERPENTINE-JARRAHDALE
RESPONSIBLE AGENCY: WESTERN AUSTRALIAN PLANNING COMMISSION

Appendix C - Lowlands Environmental Values Assessment Report



Public Transport Authority
METRONET Potential Offset Sites
Lowlands Environmental Values Assessment

February 2020

Executive summary

METRONET is the State government's program of projects to increase the size of Perth's railway network, whilst also supporting the planning of integrated station precincts, to support growth of the Perth metropolitan region.

Where required, METRONET projects will be assessed by the Environmental Protection Authority (EPA) under Section 38 of the *Environmental Protection Act 1986* (EP Act) and/or by the Commonwealth Department of the Environment and Energy (DEE) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

As part of the State and Federal environmental approvals processes, the Public Transport Authority (PTA) is required to offset significant residual environmental impacts of assessed projects through the implementation of an Offsets Strategy. Through liaison with other State government agencies, a number of potential offset sites have been identified containing suitable environmental values to offset the potential METRONET project impacts.

GHD Pty Ltd (GHD) was engaged by the PTA to undertake Environmental Values Assessments (EVAs) for six potential offset sites. The purpose of the EVAs is to identify the key environmental values of each site, as well as opportunities for on-ground management works to enable an assessment of their suitability as land acquisition offset sites. This report presents an EVA of a potential offset site located in Mardella, Western Australia.

The potential offset site (the survey area) is approximately 1,140 hectares (ha) and is located at Lot 301 Lowlands Road in the suburb of Mardella within the Shire of Serpentine-Jarrahdale.

Key findings for vegetation

Ten broad vegetation types as well as dirt tracks were mapped by GHD within the survey area. Nine of the vegetation types were represented by remnant native vegetation, the eighth vegetation type, scattered natives over weeds, describes highly modified vegetation that has been altered by partial clearing, dieback and weeds.

The vegetation types were split into four upland vegetation types that predominately occurred on Bassendean sands and five lower lying vegetation types were mapped primarily on Pinjarra Plain soils. The vegetation types are considered to be representative of the Southern River, Guilford and Bassendean Complex-Central and South Complexes and Floristic Community Types (FTCs) 4, 5, 11, 21a, 21c, 22 and 23a.

The vegetation condition ranged from Excellent to Degraded across the survey area. Areas mapped in Degraded condition have been historically cleared/partially cleared to support grazing by livestock. Whilst there is no grazing of domestic animals today, native species such as kangaroos maintain grazing at a high level and contribute to weed spread (as well as keeping weed loads low). Dieback is present at localised spots throughout the survey area and has contributed to a decline in vegetation condition.

Based on the results of the desktop searches, previous literature, dominant species present, landform features and field observations, four conservation significant ecological communities were considered likely to occur within the survey area:

- *Banksia* woodlands of the Swan Coastal Plain, listed as a Threatened Ecological Community (TEC) under the EPBC Act.
- Low lying *Banksia attenuata* woodlands or shrublands (SCP21c), listed as a Priority 3 Priority Ecological Community (PEC) by the Department of Biodiversity, Conservation and Attractions (DBCA)

- *Banksia* dominated woodlands of the SCP IBRA region, listed as a Priority 3 PEC by the DBCA
- Tuart (*Eucalyptus gomphocephala*) woodlands of the SCP PEC, listed as a Priority 3 PEC by the DBCA.

Key findings for fauna and black cockatoos

Four broad fauna habitats were described within the survey area based on the mapped vegetation types, including Mixed Eucalyptus Banksia woodland, Flooded Gum Melaleuca woodlands, Riparian and pasture with scattered trees.

The survey area is an intact area of native vegetation mostly surrounded by cleared land with low density semi-rural residential properties and has limited connectivity to other areas of bushland. The Serpentine River intersects the central part of the survey area and there is some connectivity along this river.

During the one day field visit, Carnaby's Cockatoos were seen and heard calling over the survey area. Forest Red-tailed Black Cockatoos were also observed feeding at two locations during the subsequent two day field assessment. Foraging evidence (chewed Marri, Jarrah, Banksia and Allocasuarina nuts) was recorded extensively throughout the Mixed Eucalyptus Banksia and Scattered native tree habitat types with both Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo distinctive mandible marks evident. The survey area contains suitable foraging and potential breeding habitat for both Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo. No foraging evidence of Baudin's Cockatoo was located within the survey area, however the survey area is considered to contain suitable foraging and potential roosting habitat.

Other conservation significant fauna recorded from the site include Chuditch, Rakali, Pouched lamprey, Carter's Freshwater Mussel, Quenda and South-western Brush-tailed Phascogale.

This report is subject to, and must be read in conjunction with, the limitations set out in section 1.5 and the assumptions and qualifications contained throughout the Report.

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1. Introduction

1.1 Background

METRONET is the State government's program of projects to increase the size of Perth's railway network, whilst also supporting the planning of integrated station precincts, to support growth of the Perth metropolitan region.

METRONET projects will be assessed by the Environmental Protection Authority (EPA) under Section 38 of the *Environmental Protection Act 1986* (EP Act) and/or by the Commonwealth Department of the Environment and Energy (DEE) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) where required.

As part of the State and Federal environmental approvals processes, the Public Transport Authority (PTA) is required to offset significant residual environmental impacts of assessed projects through the implementation of an Offsets Strategy. Through liaison with other State government agencies, a number of potential offset sites have been identified containing suitable environmental values to offset the potential METRONET project impacts.

1.2 Purpose of this report

GHD Pty Ltd (GHD) was engaged by the PTA to undertake Environmental Values Assessments (EVAs) for a number of potential offset sites. The purpose of the EVAs are to identify the key environmental values of each site, as well as opportunities for on-ground management works to enable an assessment of their suitability as land acquisition offset sites. This report presents an EVA of a potential offset site located in Mardella, Western Australia.

1.3 Location

The potential offset site (the survey area) is located at Lot 301 Lowlands Road in the suburb of Mardella within the Shire of Serpentine-Jarrahdale Local Government Area (LGA). The survey area covers 1,139 hectares (ha) and is mapped in Figure 1, Appendix A

The survey area is part of the Department of Biodiversity, Conservation and Attractions (DBCA) managed Lowlands Nature Reserve (also known as Lowlands), which includes Lots 300 and 301 Lowlands Road.

1.4 Scope of works

The scope of works for this EVA includes:

- A desktop review of existing information relating to the survey area
- A one-day site visit to confirm access requirements, hygiene protocols and to meet with relevant stakeholders
- A two day reconnaissance vegetation and fauna survey with targeted assessment of values requiring offset
- The preparation of a report documenting the findings of the desktop assessment, anecdotal observations (from stakeholders), field survey and opportunities for on-ground management works
- The provision of all mapping and spatial data.

1.5 Limitations and assumptions

This report has been prepared by GHD for PTA and may only be used and relied on by PTA for the purpose agreed between GHD and the PTA as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than PTA arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

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Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the access, hygiene management and the location of vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

This report has assessed the flora, vegetation and fauna values within the survey area, as shown in Figure 1, Appendix A. Should the survey area location change or be refined, further assessment may be required.

2. Methodology

2.1 Desktop assessment

A desktop assessment was undertaken to identify relevant environmental information pertaining to the survey area. The desktop assessment included a review of:

- Previous flora and fauna surveys and mapping of the survey area, including:
 - Rivers 2 Ramsar: Connecting River Corridors for Landscape Resilience at Lowlands Nature Reserve (Sheenan et al. 2017)
 - Floristics of Lowlands (Keighery et al. 1995)
 - Vegetation association, condition and known threatened flora and ecological communities mapping provided by the DBCA (updated in 2017)
- The DBCA Threatened and Priority Ecological Communities (TECs and PECs), Threatened/Priority Flora and Threatened/Priority Fauna Database Searches (5 km buffer of the survey area)
- The DBCA *NatureMap* database for conservation significant flora and fauna species previously recorded within 5 km of the survey area (DBCA 2007–) (Appendix B)
- Regional vegetation complex mapping (e.g. Heddle *et al.* 1980, Webb *et al.* 2016)
- Bush Forever (Government of Western Australia (GoWA) 2000)
- Aerial imagery of the survey area.

2.2 Site visit and field survey

GHD ecologists completed a one day site visit on 26 June 2019. The purpose of the site visit was to meet with representatives from the DBCA, Shire of Jarrahdale Serpentine and landowners to discuss access, hygiene protocols and the biological values of survey area. During the site visit, GHD ecologists accessed the survey area via Lowlands Roads (accompanied by the DBCA) and the southern part of a north-south orientated track. From these roads/tracks limited observations on the vegetation and fauna habitat were recorded. All other access throughout the survey area was restricted due to the wet soil conditions and subsequent dieback risk at the time of the visit.

GHD ecologists completed a two day field survey of the survey area on 6 and 7 November 2019. The survey was completed in November due to rainfall across the survey area during winter and early spring that restricted access due to hygiene and dieback risk. The survey was completed in November during dry soil conditions in line with DBCA stipulated access requirements.

2.2.1 Vegetation and flora

The vegetation and flora component of the field survey was a reconnaissance level and was undertaken to verify the information obtained from the desktop assessment and assess and characterise the broad vegetation types and vegetation condition throughout the survey area. Preliminary assessment of occurrence and approximate extent of potential TEC/PECs (including indicative floristic community types (FCTs)) was also completed.

Field survey methods involved a combination of sampling relevés located in identified vegetation units and traversing the survey area by vehicle and foot. The survey methodology was undertaken with reference to the EPA Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016a).

Broad vegetation types

Broad vegetation types were identified and boundaries delineated using a combination of aerial photography, topographical features, field data/observations and mapping from Keighery *et al.* (1995) and the DBCA (2017). Data recorded at relevé sites included dominant flora taxa from each structural layer (i.e. upper, mid and ground) as well as other observable flora taxa (to assist with FCT identification); full floristics at each relevé site were not recorded. Vegetation data recorded from the survey area is provided in Appendix C.

The vegetation types were described based on structure, dominant taxa and cover characteristics. The broad vegetation type description is consistent with National Vegetation Information System (NVIS) Level IV or V, where the dominant species for the three traditional strata (upper, mid and ground) are used to describe the association (NVIS Technical Working Group 2017).

Vegetation condition

The vegetation condition mapping from Keighery *et al.* (1995) and the DBCA (2017) was reviewed in the field, and where applicable updated. The vegetation condition was mapped in accordance with the vegetation condition rating scale for the South West and Interzone Botanical Provinces of WA (devised by Keighery (1994) and adapted by EPA (2016)). The scale recognises the intactness of vegetation and consists of six rating levels. The vegetation condition rating scale is outlined in Table 1.

Table 1 Vegetation condition rating scale

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

Preliminary assessment of TECs and PECs

Preliminary identification of potential TECs and PECs within the survey area was based on vegetation association and condition mapping by Keighery *et al.* (1995) and DBCA (2017). Keighery *et al.* (1995) identified floristic community types (FCTs) for the mapped vegetation associations and this information was used to identify potential TECs and PECs within the survey area.

During the field survey, areas of vegetation representative of potential TECs and PECs were visited and preliminary identification confirmed or made based on vegetation structure, typical

and common species, and observations on soils, landforms etc. Where areas of potential TECs or PECs were identified, the occurrence was noted and the approximate extent mapped using a GPS enabled handheld tablet.

Flora nomenclature

Nomenclature used in this report follows that used by the WA Herbarium as reported on *FloraBase* (WA Herbarium 1998–). The conservation status of flora was compared against the current lists available on *FloraBase* and the EPBC Act Threatened species database provided by DEE (2019).

2.2.2 Fauna

The fauna component of the field survey was undertaken to verify the information obtained from the desktop assessment, describe the key fauna habitat values and identify suitable habitat for conservation significant fauna species. A black cockatoo habitat assessment was also completed.

Field methodology included traversing the survey area by vehicle and foot. The survey methodology was undertaken with reference to the EPA Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna Surveys (EPA 2016b) and EPA Technical Guidance – Terrestrial Fauna Surveys (EPA 2016c).

Broad fauna habitats

Broad fauna habitats were described and boundaries delineated using a combination of aerial photography, mapping from Keighery *et al.* (1995), DBCA (2017), and site visit observations. Site characteristics include vegetation type and structure, substrate, topography, and hydrology. Fauna habitats were also aligned with the vegetation types delineated during the vegetation and flora assessment of this current survey. Anecdotal observations from stakeholders were incorporated into the broad habitat type descriptions where possible.

Black cockatoo assessment

A desktop black cockatoo habitat assessment was undertaken and included an evaluation of presence and approximate extent of foraging, breeding and roosting habitat within the site. Habitat suitability was based on the mapping from Keighery *et al.* (1995) and DBCA (2017), and broad fauna habitats described by GHD. Foraging, breeding and roosting habitat was defined as per the EPBC Act referral guidelines for three threatened black cockatoo species: Carnaby's Cockatoo (endangered) *Calyptorhynchus latirostris*, Baudin's Cockatoo (vulnerable) *Calyptorhynchus baudinii*, Forest Red-tailed Black Cockatoo (vulnerable) *Calyptorhynchus banksii naso*, (Department of Sustainability, Environment, Water, Populations, and Communities (DSEWPac) 2012).

A black cockatoo habitat assessment was undertaken in conjunction with the broad habitat assessment. The black cockatoo habitat assessment included:

- Evaluation of presence and approximate extent of foraging, breeding and roosting habitat (individual mapping of potential breeding tree locations was not undertaken). Foraging, breeding and roosting habitat was defined as per the EPBC Act referral guidelines for three threatened black cockatoo species: Carnaby's Cockatoo (endangered) *Calyptorhynchus latirostris*, Baudin's Cockatoo (vulnerable) *Calyptorhynchus baudinii*, Forest Red-tailed Black Cockatoo (vulnerable) *Calyptorhynchus banksii naso*, (Department of Sustainability, Environment, Water, Populations, and Communities (DSEWPac) 2012)
- Characterisation of the broadly mapped vegetation types for suitability as black cockatoo foraging, breeding and roosting habitat

- Foraging habitat values were quantified and a rating assigned based on the type, approximate and relative density and variety of known food plant species for black cockatoos.
- Potential breeding habitat values were quantified based on the density of potential breeding trees of known Black Cockatoo breeding tree species. Potential breeding tree density was calculated within a series of 50 x 50 m plots randomly located within each broad habitat type. Within each plot the Diameter at Breast Height (DBH) measured for all trees having DBH greater than 50 cm. A list of all plots and locations is included in Appendix D.
- Roosting habitat values were assessed based on presence of potentially suitable emergent tall trees, proximity of freshwater bodies, and on the local occurrence of any known roost sites (BirdLife Australia, unpublished data).
- Recording and mapping black cockatoo observations of foraging evidence, breeding and roosting activity.

Fauna nomenclature

Fauna nomenclature used in this report follows that used by the WA Museum and the DBCA *NatureMap* database (DBCA 2007–) with the exception of birds, where by Christidis and Boles (2008) was used.

2.3 Limitations

2.3.1 Desktop limitations

The records from the DBCA searches and *NatureMap* database provide generally accurate information for the general area. However, some records of collections, sightings or trappings cannot be dated or have plain language locality descriptions and may misrepresent the current range of a species (flora and fauna).

2.3.2 Field limitations

The EPA technical guidance recommend flora and fauna survey reports for environmental impact assessment in WA should contain a section describing the limitations of the survey methods used. The limitations and constraints associated with this field component are discussed in Table 2. Based on this assessment, the field component has been subject to constraints that have affected the thoroughness of the assessment and the conclusions which have been formed.

Table 2 Field limitations

Aspect	Constraint	Comment
Sources of information and availability of contextual information.	Nil	Adequate information is available for the survey area including a previous vegetation and flora survey (Keighery <i>et al.</i> 1995) and vegetation association, condition and known threatened flora and ecological communities mapping provided by the DBCA (2017).
Scope (what life forms were sampled etc.)	Nil	Vascular flora and terrestrial vertebrate fauna were sampled during the survey. Non-vascular flora, invertebrate and aquatic fauna were not surveyed. This survey focused on dominant flora and conservation significant fauna species.
Proportion of flora collected and identified (based on sampling, timing and intensity) Proportion of fauna identified, recorded and/or collected	Nil	The reconnaissance vegetation survey was undertaken in November, which is within the recommended timing for flora surveys in the South West Botanical Province (September – November) (EPA (2016a)). The vegetation survey was focused on describing broad vegetation types and their condition. The survey timing was considered appropriate for the purpose of the assessment. The reconnaissance fauna survey was also undertaken in November 2019. The fauna assessment sampled those species that can be easily seen, heard or have distinctive signs, such as tracks, scats, diggings, etc. Many cryptic species would not have been identified during a reconnaissance survey and seasonal variation within species often requires targeted surveys at a particular time of the year. Of the fauna species recorded during the survey, all were identified to species level. The fauna assessment was aimed at identifying broad habitat types and conservation significant terrestrial vertebrate fauna utilising the survey area. The survey timing was considered appropriate for the purpose of the assessment
Flora determination	Minor	Flora determination was undertaken by the GHD botanist in the field and at the WA Herbarium. Two taxa could only be identified to family level only, eight taxa could be identified to genus level only, and three taxa could be tentatively identified to species level, due to lack of flowering and/or fruiting material required for identification. The collecting and identification of flora taxa was considered appropriate for the purpose of the assessment.
Completeness and further work which might be needed (e.g. was the relevant area fully surveyed)	Nil	The survey area was accessible via vehicle and foot (during dry soil conditions). All areas of the survey area were adequately surveyed for the purpose of the assessment.
Mapping reliability	Minor	The vegetation was mapped using high-resolution ESRI aerial imagery obtained from Landgate, topographical features, previous broad scale mapping (Keighery <i>et al.</i> (1995), (DBCA (2017)) and field data. Data was recorded in the field using hand-held GPS tools (e.g. Samsung tablet and Garmin GPS). Certain atmospheric factors and other sources of error can affect the accuracy of GPS receivers. The Garmin GPS units used for this survey are accurate to within ± 5 metres on average. Therefore the data points consisting of coordinates recorded from the GPS may contain inaccuracies.
Timing/weather/season/cycle	Nil	The field survey was conducted on 6 and 7 November 2019. In the three months prior to the flora survey (August to October), Serpentine weather station (Bureau of Meteorology (BoM) 2019) recorded a total of 208.8 mm of

Aspect	Constraint	Comment
		rainfall. This rainfall total is slightly lower than the long term average for the same period (August - October 285.4 mm) (BoM 2019). The weather conditions recorded during the survey are within the observed climatic conditions previously recorded for November 2019 (years 1899 to 2019) at the Serpentine weather station (BoM 2019). The weather conditions recorded during the survey were considered unlikely to have impacted the survey results. The survey timings were considered appropriate for the field survey.
Disturbances (e.g. fire, flood, accidental human intervention)	Nil	No significant sources of disturbance were present during the survey. There was no recent evidence of fire or flood throughout the survey area
Intensity (in retrospect, was the intensity adequate)	Nil	The survey area was sufficiently covered by the survey team during the survey. The purpose of the survey was a reconnaissance level survey with a focus on conservation significant vegetation and fauna. The survey intensity was sufficient for the survey purpose.
Resources	Nil	Adequate resources were employed during the field survey. Four person days were spent undertaking the survey using suitably qualified personnel.
Access restrictions	Minor	Access was restricted to the survey area during wet soil conditions. No access problems were encountered during the November survey which occurred during dry soils conditions.
Experience levels	Nil	The botanist and zoologist who executed the survey are practitioners suitably qualified and experienced in their respective fields. Botanist Angela Benkovic has over 13 years' experience in undertaking flora and vegetation surveys within WA. Zoologist Robert Browne-Cooper has over 15 years' experience undertaking fauna surveys in WA.

3. Desktop assessment

3.1 Literature review

A floristic assessment by Keighery et al. (1995) has been completed at Lowlands, which reported on environmental features, vegetation and flora. Mapping from this assessment has been reviewed and updated by the DBCA to provide maps of the vegetation associations, condition and conservation significant vegetation and flora (DBCA 2017). In addition an article produced by Sheenan et al. (2017) (from the Department of Parks and Wildlife, DPaW – now the DBCA) details the management works being undertaken at Lowlands as part of the Rivers 2 Ramsar: Connecting River Corridors for Landscape Resilience Project.

A summary of the results from Keighery et al. (1995) and Sheenan et al. (2017), as well as background on the Lowlands site compiled by the PTA is provided below.

Lowlands site background (provided by the PTA)

In 2014, Lots 300 and 301 Lowlands Road Mardella were purchased by the Western Australian Planning Commission (WAPC) through funding provided by both the WAPC and Main Roads Western Australia (Main Roads). The lots were purchased for the purposes of using the site to offset impacts from future government projects.

Lot 300 Lowlands Road Mardella was applied to Main Roads Gateway project in 2015. In 2015, initiated by the Main Roads Gateway project offset, both lots were ceded to the then DPaW, now DBCA for conservation and proposed protection as an 'A' Class conservation reserve. Lowlands Class 'A' conservation reserve status was also applied for urgent management reasons and to honour the agreement made with the former landowner.

In 2019, the balance of Lowlands, i.e. the entirety of Lot 301 Lowlands Road Mardella, 1,138 ha, was allocated to METRONET. Allocation of the remainder of Lowlands to offset residual significant environmental impacts of METRONET rail infrastructure projects aligns with the original intention and proposed future use of Lowlands as a State Government advanced offset, as agreed to in principle by the State and Commonwealth.

Floristics of Lowlands (Keighery et al. 1995)

The survey work at Lowlands covered two areas, Lot 300 and the Lot 301 and was completed over three flowering seasons in 1992, 1993 and 1994. Twenty-three 100 m² sites were used to sample the range of plant communities within the Lowlands with a further two sites located in the unmade road reserve south of Lowlands. Of the 25 sites, 23 were permanently located using steel pegs to enable resampling. Opportunistic plant collections were made during foot and vehicular transects of the bushland areas at various times of the three years of survey. It was considered that approximately 95% of the flora within Lowlands has been documented.

Nine vegetation associations were mapped by Keighery et al. (1995) which could be grouped into three broad units:

- *Banksia* Woodlands
 - *Banksia* Woodlands to Forests with scattered emergent eucalypts (ebW)
 - *Banksia*, Sheoak (*Allocasuarina fraseriana*) and/or Paperbark (*Melaleuca preissiana*) Woodlands to Forests (baW and bmW)

- Tuart Woodland (tW)
- *Jacksonia sternbergiana* Low Woodland (jLW)
- *Banksia* Woodland or scattered *Banksia* over Spearwood (*Kunzea ericifolia*) Closed Tall Shrubland (bkW)
- Ephemeral Wetlands
 - Freshwater Paperback (*Melaleuca raphiophylla*) Woodland to Shrubland (mrW)
 - Woodlands over Sedgeland (WS)
 - Claypans
 - Other Sumplands
- River – Creekline
 - Flooded Gum (*Eucalyptus rudis*) Forest to Woodland (rF).

The mapped vegetation associations were broadly related to floristic units mapped by Gibson et al. (1994) including 21a, 23a, 21c, 5, 11 and 4.

Keighery et al. (1995) reported that the majority of native vegetation at Lowlands was in Very Good to Good condition. There is considerable disturbance associated with the transitional areas between the pasture and the bushland. The most severe weed invasion is associated with wetland areas.

The survey recorded 438 flora taxa, of which 334 were native taxa and 104 were introduced (exotic) taxa. The most species diverse families included Orchidaceae (33 taxa), Cyperaceae (23 taxa) and Myrtaceae (22 taxa). Seven conservation or other significant flora taxa were recorded from Lowlands, these included *Caladenia huegelii* (Threatened), *Drakaea elastica* (Threatened), *Eryngium pinnatifidum* subsp. Palustre (G.J. Keighery 13459) (Priority 3), *Parsonsia diaphanophleba* (Priority 4), *Conostephium minus* (now delisted), *Stylidium longitubum* (Priority 4) and *Stylidium mimeticum* (now *S. calcaratum* and not listed). Other significant taxa recorded during the survey included: *Dillwynia dillwynioides* (now Priority 3), *Gnephosis angianthoides*, *Lagenophora huegelii*, *Johnsonia* aff. *pubescens* and *Eucalyptus gomphocephala*.

The assessment by Keighery et al. (1995) concluded that the bushland at Lowlands is of very high conservation value as it contains mature *Banksia* Woodlands, has a diversity of floristic community types (FCTs) in a unique combination, contains significant areas of *Banksia* Woodland FCTs 21a and 21c, is a rare example of intact riverine communities, and contains populations of conservation and other significant flora.

Rivers 2 Ramsar; Connecting River Corridors for Landscape Resilience at Lowlands Nature Reserve (Sheenan et al. 2017)

The DBCA has managed Lowlands (Lot 300 and 301) since 2015, which contains 1,310 ha of intact remnant bushland and a portion of the Serpentine River. According to Sheen et al. (2017), threats to Lowlands include Phytophthora dieback, altered hydrological regimes on the riverine system, introduced weeds, invasive animal species, unmanaged access and potential impacts of wildfire. Therefore on ground works at Lowlands for the Rivers 2 Ramsar: Connecting River Corridors for Landscape Resilience Project have focused on dieback mapping and control, weed and feral animal control, revegetation, fencing and collection and establishment of a seedbank for the reserve.

Sheen et al. (2017) reports that Lowlands contains significant areas of mature *Banksia* woodland as well as wetland vegetation. The wetland vegetation along the Serpentine River comprises herblands, sedgelands and shrublands and contains flora rarely found on the Swan Coastal Plain (SCP) including Lowlands creeper (*Parsonsia*

diaphanophleba) and Maidenhair fern (*Adiantum aethiopicum*). Weed mapping and control has focused on infestations along the Serpentine River and within revegetation sites targeting Arum lily (*Zantedeschia aethiopica*), Blackberry (*Rubus fruticosus*), Bridal creeper (*Asparagus asparagoides*), Cotton bush (*Gomphocarpus fruticosus*), Freesia (*Freesia alba x leichtinii*), Black flag (*Ferraria crispa*) and Watsonia (*Watsonia meriana*).

The riverine system at Lowlands retains a diversity of freshwater fish and provides spawning grounds for Carters freshwater mussel (*Westralunio carteri*) and Pouched lamprey (*Geotria australis*). The river also provides important habitat for threatened mammals including Rakali (*Hydromys chrysogather*) and Quenda (*Isodoodon obesulus fusciventer*). Sheen et al. (2017) reports introduced fauna including foxes and cats are a threat to native fauna at Lowlands and 1080 fox baiting has also been carried out.

Dieback interpretation shows that *Phytophthora cinnamomi* is present although most of the Reserve is dieback free. A Hygiene Management Plan has been developed and dieback vehicle wash-down bays and signage has been installed on the reserve along major access tracks.

3.2 Wetlands

There are eight wetlands as described by Hill et al. (1996), which are within or intersect the survey area (Table 3 and Figure 2, Appendix A). Of these, two are Conservation Category wetlands (CCWs).

Table 3 Geomorphic wetlands within or intersecting the survey area

Name	UFI	Classification	Evaluation
Unknown	7244	Palusplain	Resource Enhancement
Unknown	7296	Palusplain	Conservation
Unknown	14744	Sumpland	Resource Enhancement
Unknown	14749	Sumpland	Resource Enhancement
Unknown	14846	Palusplain	Resource Enhancement
Unknown	14848	Palusplain	Conservation
Unknown	15250	Palusplain	Multiple Use
Unknown	16021	Palusplain	Multiple Use

3.3 Land use

3.3.1 DBCA legislated lands

The survey area is part of a Nature Reserve (R 51784, Class A), which is known as Lowlands Nature Reserve (Figure 3, Appendix A).

3.3.2 Bush Forever

The majority of the survey area is covered by Bush Forever Site no. 368, Lowlands Bushland – Eastern Block Peel Estate. Bush Forever Site no. 371, Serpentine River, Peel Estate to Serpentine also intersects the eastern boundary of the survey area (Figure 3, Appendix A).

3.3.3 Environmentally Sensitive Areas

The majority of the survey area lies within an Environmentally Sensitive Area (ESA). This ESA likely aligns with the presence of Bush Forever sites, CCWs, TECs and their buffer zones (Figure 3, Appendix A).

3.4 Regional vegetation complexes

Regional vegetation has been mapped by Heddle et al. (1980) with updates from Webb et al. (2016) based on major geomorphic units on the SCP. The mapping indicates that four vegetation complexes are present within the survey area, the Dardanup Complex, the Guildford Complex, the Southern River Complex and the Bassendean Complex – Central and South (Figure 4, Appendix A). These complexes occur on the Pinjarra Plain and Bassendean Dunes landform units as well as combinations of both units. The vegetation complexes 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 raphiophylla*
- Southern River Complex: Open-woodland of *Corymbia calophylla*, *Eucalyptus marginata*, *Banksia* on the elevated areas and a fringing woodland of *E. rudis*, *Melaleuca raphiophylla* along the streams. South of the Murray River *Agonis flexuosa* occurs in association with the *E. rudis* and *Melaleuca raphiophylla*
- Bassendean Complex-Central and South: Vegetation ranges from woodland of *Eucalyptus marginata* - *Allocasuarina fraseriana* - *Banksia* species to low woodland of *Melaleuca* species, and sedgeland on the moister sites. This area includes the transition of *Eucalyptus marginata* to *E. todtiana* in the vicinity of Perth.

3.5 Conservation significant communities

A desktop search of the DBCA TEC and PEC database identified nine TECs and three PECs potentially occurring within the survey area. One additional TEC was also considered as potentially occurring within the survey area, the *Banksia* Woodlands of the SCP TEC. Details on all of these communities, based on a 5 km search buffer are provided in Table 4 and Figure 5, Appendix A.

Table 4 TECs and PECs identified in the desktop search that may occur within the survey area

Community	EPBC Act	BC Act/DBCA	Description
<i>Banksia</i> woodlands of the SCP TEC	Endangered		The ecological community is a woodland associated with the SCP. A key diagnostic feature is a prominent tree layer of <i>Banksia</i> , with scattered eucalypts and other tree species often present among or emerging above the <i>Banksia</i> canopy. The understorey is a species rich mix of sclerophyllous shrubs, graminoids and forbs. The ecological community is characterised by a high endemism and considerable localised variation in species composition across its range (TSSC 2016).
<i>Banksia</i> dominated woodlands of the SCP IBRA Region PEC	A component of the <i>Banksia</i> TEC	Priority 3	Canopy is most commonly dominated or co-dominated by <i>Banksia attenuata</i> and/or <i>B. menziesii</i> . Other <i>Banksia</i> species that can dominate in the community are <i>B. prionotes</i> or <i>B. ilicifolia</i> . It typically occurs on well drained, low nutrient soils on sandplain landforms, particularly deep Bassendean and Spearwood sands and occasionally on Quindalup sands; it is also common on sandy colluvium and aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau and can occur in other less common scenarios (DBCA 2019)
<i>Corymbia calophylla</i> – <i>Kingia australis</i> woodlands on heavy soils (SCP3a) TEC	Critically Endangered	Endangered	A woodland community located on heavy soils of the eastern side of the Swan Coastal Plain between Capel and Hazelmere. Typical and common native taxa in the community are: <i>Corymbia calophylla</i> ; the shrubs <i>Banksia nivea</i> , <i>Philotheca spicata</i> , <i>Kingia australis</i> and <i>Xanthorrhoea preissii</i> ; herbs, rushes and sedges, <i>Cyathochaeta avenacea</i> , <i>Dampiera linearis</i> , <i>Haemodorum laxum</i> , <i>Desmocladius fasciculatus</i> , <i>Mesomelaena tetragona</i> and <i>Tetraria octandra</i> . The introduced grass <i>Briza maxima</i> is also common in the community.
<i>Corymbia calophylla</i> - <i>Eucalyptus marginata</i> woodlands on sandy clay soils of the southern Swan Coastal Plain (SCP3b) TEC		Vulnerable	No description available.
<i>Corymbia calophylla</i> - <i>Xanthorrhoea preissii</i> woodlands and shrublands, Swan Coastal Plain (SCP3c) TEC	Critically Endangered	Endangered	The community is located on heavy soils of the eastern side of the SCP between Bullsbrook, and Waterloo near Bunbury. Dominant species in the community are the trees <i>Corymbia calophylla</i> and occasionally <i>Eucalyptus wandoo</i> ; the shrubs <i>Xanthorrhoea preissii</i> , <i>Acacia pulchella</i> , <i>Dryandra nivea</i> , <i>Gompholobium marginatum</i> , and <i>Hypocalymma angustifolia</i> and the herbs <i>Burchardia umbellata</i> , <i>Cyathochaeta avenacea</i> and <i>Neurachne alopecuroidea</i> .

Community	EPBC Act	BC Act/DBCA	Description
Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain) TEC		Endangered	The habitat of this community is characterised by continuous discharge of groundwater in raised areas of peat. The peat and surrounds provide a stable, permanently moist series of microhabitats. Intact vegetated tumulus springs are only found at four locations. Typical and common native vascular plant species associated with the tumulus springs are the trees <i>Banksia littoralis</i> , <i>Melaleuca preissiana</i> and <i>Eucalyptus rudis</i> , and the shrubs <i>Agonis linearifolia</i> , <i>Pteridium esculentum</i> , <i>Astartea fascicularis</i> and <i>Cyclosorus interruptus</i> .
<i>Banksia attenuata</i> and/or <i>Eucalyptus marginata</i> woodlands of the eastern side of the Swan Coastal Plain (SCP20b) TEC	Endangered	Endangered	Most of the occurrences of this community type are <i>Eucalyptus marginata</i> – <i>Banksia attenuata</i> woodlands but the community also occurs as <i>Banksia</i> woodlands and heaths. A diverse shrub layer comprising <i>Hakea stenocarpa</i> , <i>Conostylis setosa</i> , and <i>Johnsonia</i> aff. <i>pubescens</i> differentiates this community type from the other two subgroups. The community is found on a range of soils on the base of the Darling Scarp from Yarloop to Byford. Soils are mainly yellow orange and yellow sands.
Herb rich saline shrublands in clay pans (SCP07) TEC	Critically Endangered TEC (part)	Vulnerable	This vegetation community type occurs on heavy clay soils that are generally inundated from winter to mid-summer. Structurally this vegetation community type is quite variable ranging from woodlands to herblands, the most common overstorey taxa being <i>Melaleuca viminea</i> , <i>M. uncinata</i> , <i>M. cuticularis</i> or <i>Casuarina obesa</i> . Aquatic species are common in this vegetation community early in the growing season. Typical species in the understorey include the common herbs <i>Brachyscome bellidioides</i> , <i>Centrolepis polygyna</i> , <i>Pogonolepis stricta</i> and <i>Cotula coronopifolia</i> .
Herb rich shrublands in clay pans (SCP08) TEC	Critically Endangered TEC (part)	Vulnerable	Occurs in low lying flats with a clay impeding layer allowing seasonal inundation. Dominated by one or more of the shrubs: <i>Viminaria juncea</i> , <i>Melaleuca viminea</i> , <i>M. lateritia</i> , <i>Kunzea micrantha</i> or <i>K. recurva</i> with occasional emergents of <i>Eucalyptus wandoo</i> . Species such as <i>Hypocalymma angustifolium</i> , <i>Acacia lasiocarpa</i> var. <i>bracteolata</i> long peduncle variant (G. J. Keighery 5026) and <i>Verticordia huegellii</i> occur at moderate frequencies.
Dense shrublands on clay flats (SCP09) TEC	Critically Endangered TEC (part)	Vulnerable	This vegetation community type is shrublands or low open woodlands on clay flats that are inundated for long periods because it usually occurs very low in the landscape. Sedges are more apparent in this ecological community and include <i>Chorizandra enodis</i> , <i>Cyathochaeta avenacea</i> , <i>Lepidosperma longitudinale</i> and <i>Meeboldina coangustata</i> . Shrubs include <i>Hakea varia</i> and <i>Melaleuca viminea</i> and occasionally <i>Xanthorrhoea preissii</i> , <i>Xanthorrhoea drummondii</i> and <i>Kingia australis</i> .

Community	EPBC Act	BC Act/DBCA	Description
Shrublands on dry clay flats (SCP10a) TEC	Critically Endangered TEC (part)	Endangered	A distinctive feature of the particular clay pan wetlands that comprise the ecological community is the suite of geophytes and annual flora that germinates, grows and flowers sequentially as these areas dry over summer, producing a floral display for over three months. The clay pans have very high species richness, a number of local endemics and are the most floristically diverse of the SCP wetlands
Low lying <i>Banksia attenuata</i> woodlands or shrublands (SCP21c) PEC	A component of the <i>Banksia</i> TEC	Priority 3	This type occurs sporadically between Gingin and Bunbury, and is largely restricted to the Bassendean system. The type tends to occupy lower lying wetter sites and is variously dominated by <i>Melaleuca preissiana</i> , <i>Banksia attenuata</i> , <i>B. menziesii</i> , <i>Regelia ciliata</i> , <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i> . Structurally, this community type may be either a woodland or occasionally shrubland.
<i>Casuarina obesa</i> association PEC		Priority 1	Thomas Rd to Serpentine River, Swan Coastal Plain. No detailed information to assess if distinct community.

3.6 Conservation significant flora

The *NatureMap* database search identified the presence/potential presence of 15 conservation significant flora taxa within 5 km of the survey area. The search recorded:

- Five taxa listed under the EPBC Act and/or *Biodiversity Conservation Act 2016* (BC Act)
- One Priority 1 taxon
- One Priority 2 taxon
- Five Priority 3 taxa
- Three Priority 4 taxa.

The DBCA Threatened and Priority flora searches (TPFL and WAHERB) supplied by the PTA identified 72 records of conservation significant flora taxa within a 5 km buffer of the survey area (Figure 5, Appendix A). The DBCA database searches contained no species names or identifiers, therefore no comparisons with the *NatureMap* searches results could be made.

The DBCA database search results indicate 20 records of conservation significant flora occur within the survey area.

3.7 Conservation significant fauna

The *NatureMap* database search identified the presence/potential presence of nine conservation significant fauna species within 5 km of the survey area, excluding marine listed species as no marine habitat is present within the survey area. The search recorded:

- Four species listed under the EPBC Act and/or BC Act as Endangered or Vulnerable
- Four Priority 4 species
- One species of special conservation interest (conservation dependent fauna).

The DBCA Threatened and Priority fauna search supplied by the PTA identified 91 records of conservation significant fauna taxa within a 5 km buffer of the survey area (Figure 5, Appendix A). The DBCA database searches contained no species names or identifiers, therefore no comparisons with the *NatureMap* searches results could be made.

The DBCA database search results indicate six records of conservation significant fauna occur within the survey area.

Black cockatoos

Available Carnaby's Cockatoo mapping (GoWA 2019) provides locations of confirmed and possible breeding areas, confirmed, unconfirmed and buffered roosting areas, and feed areas (as outlined by Glossop et al. (2011)). This mapping indicates the survey area contains plant species which Carnaby's cockatoos show a preference for when feeding (mapped as feed area requiring investigation). There are no confirmed breeding or roosting locations occurring within 5 km of the survey area. However, the 2018 Great Cocky Count (Peck et al. 2018) reports a confirmed roost for Carnaby's Cockatoo in the Lowlands area.

4. Field survey

The results presented below are collated from desktop sources, the one day site visit and two day field survey.

4.1 Broad vegetation types

Ten broad vegetation types as well as dirt tracks were mapped by GHD within the survey area. Nine of the vegetation types were represented by remnant native vegetation, the eighth vegetation type, scattered natives over weeds, describes highly modified vegetation that has been altered by partial clearing, dieback and weeds. Vegetation types identified within the survey area are described in Table 5 and mapped in Figure 6, Appendix A.

The vegetation types mapped by GHD refined the boundaries of the 12 vegetation associations mapped by Keighery et al. (1995) and updated by DBCA (2017). Four vegetation associations have been merged into broader vegetation types. *Amphibromus nervosus* grasslands (anG) has been merged into scattered natives over weeds because this area is now represented by isolated sedges of *Juncus pallidus* over pasture weeds. Other sumplands has been merged into the *Melaleuca* woodland vegetation type due to similar dominant upper strata species.



Corymbia calophylla and *Melaleuca raphiophylla* woodland and *Eucalyptus rudis* *Melaleuca* woodland have also been merged into one vegetation type due to similarities in dominant upper strata species. Conversely vegetation association *Banksia*, *Allocasuarina fraseriana* and/or *Melaleuca preissiana* Woodlands to Forests has been split into two vegetation types; *Allocasuarina Banksia* woodland and a small isolated patch of *Banksia ilicifolia* woodland. This was due to the dominance of *Banksia ilicifolia* within the area and lack of other dominant/ co dominate upper strata *Banksia* spp., the dominance of *B. ilicifolia* in this area has implications when classifying the community as a conservation significant (see further detail in section 4.3).



The vegetation within the survey area represents a unique combination of upland and lowland vegetation communities that is influenced by landform and soil types. Whilst the survey area is bordered to the east and west by Pinjarra Plain, the soils within the survey area predominately Bassendean sands (Keighery et al. 1995). The Pinjarra Plain is exposed along the Serpentine River and in the seasonally waterlogged areas to the north of the survey area. There were four upland vegetation types mapped by GHD that predominately occurred on Bassendean sands. The two dominant vegetation types were *Banksia* woodland types that represented 68 % (775.8 ha) of the survey area. The lower lying vegetation types were mapped primarily on Pinjarra Plain soils, which is where the most isolated vegetation type was mapped, Tuart woodlands 0.05 % (0.6 ha) of the survey area.



The vegetation types are considered to be representative of the Southern River, Guilford and Bassendean Complex-Central and South Complexes. Based on landforms and previous literature (e.g. Keighery et al. 1995 and Gibson et al. 1994) the vegetation types identified within the survey area are considered to align with the following FCT's:



- FCT4 – *Melaleuca preissiana* damplands
- FCT5 – Mixed shrub damplands
- FCT11 – Wet forests and woodlands
- FCT21a – Central *Banksia attenuata* – *Eucalyptus marginata* woodlands
- FCT21c – Low lying *Banksia attenuata* woodlands or shrublands
- FCT22 – *Banksia ilicifolia* woodlands
- FCT23a – Central *Banksia attenuata* – *B. menziesii* woodlands.



Table 5 Vegetation types described within the survey area

Vegetation type and description	Extent (ha)	FCT alignment	Photograph
Upland vegetation types			
<p><i>Eucalyptus Banksia</i> woodland (EBw) <i>Eucalyptus marginata</i> and <i>Allocasuarina fraseriana</i> isolated trees over <i>Banksia menziesii</i>, <i>B. attenuata</i> and <i>Xylomelum occidentale</i> low woodland over <i>Kunzea glabrescens</i> tall sparse shrubland over <i>Stirlingia latifolia</i>, <i>Dasypogon bromeliifolius</i> and <i>Desmocladius flexuosus</i> herbland.</p> <p>This is the most dominant vegetation type within the survey area</p>	712.6	21a and 23	
<p><i>Allocasuarina Banksia</i> woodland (ABw) <i>Allocasuarina fraseriana</i> and/or <i>Melaleuca preissiana</i> mid open woodland over <i>Banksia menziesii</i> and <i>B. attenuata</i> low woodland over <i>Kunzea glabrescens</i> tall shrubland over <i>Dasypogon bromeliifolius</i> and <i>Desmocladius flexuosus</i> herbland.</p> <p>Higher densities of <i>A. fraseriana</i> were recorded within this vegetation type along with occasional stands of <i>M. preissiana</i>, when compared to EBw</p>	63.2	21c	

Vegetation type and description	Extent (ha)	FCT alignment	Photograph
<p><i>Banksia ilicifolia</i> woodland (Biw) <i>Banksia ilicifolia</i> low woodland over <i>Xanthorrhoea preissii</i> low open shrubland over <i>Dasypogon bromeliifolius</i> and <i>Patersonia occidentalis</i> herbland</p> <p>This type was recorded from a small pocket located in the north western extent of the survey area</p>	3.3	22	
<p><i>Corymbia calophylla</i> open woodland (Cw) <i>Corymbia calophylla</i> tall open woodland over <i>Melaleuca preissiana</i> and/ or <i>Eucalyptus rudis</i> isolated trees over <i>Kunzea glabrescens</i> tall shrubland over weeds</p> <p>Located within the south eastern extent and part of the southern tributary of the Serpentine River.</p>	14.4	-	

Vegetation type and description	Extent (ha)	FCT alignment	Photograph
Lowland vegetation types			
<p><i>Banksia Kunzea</i> woodland (BKw) <i>Banksia attenuata</i> and <i>B. ilicifolia</i> woodland over <i>Kunzea glabrescens</i> tall shrubland over <i>Calytrix angulata</i> low open shrubland over <i>Patersonia occidentalis</i> and <i>Desmocladius flexuosus</i> open herbland.</p> <p>It should be noted that when Keighery et al. (1995) surveyed the site <i>K. glabrescens</i> had not been recognised and was considered the same as <i>K. ericifolia</i>. <i>Kunzea glabrescens</i> was identified as a new taxon separate from <i>K. ericifolia</i> by Toelken (1996). Specimens collected by GHD within the survey area were identified as <i>K. glabrescens</i>.</p>	146.9	21c	
<p><i>Eucalyptus Melaleuca</i> woodland (EMw) <i>Eucalyptus rudis</i> tall woodland over <i>Melaleuca preissiana</i> and <i>M. raphiophylla</i> low woodland over <i>Dielsia stenostachya</i> and <i>Juncus pallidus</i> closed sedgeland</p> <p>Mapped within the north and south western extents of the survey area</p>	19.7	4	

Vegetation type and description	Extent (ha)	FCT alignment	Photograph
<p><i>Eucalyptus rudis</i> forest (Ef) <i>Eucalyptus rudis</i> tall closed forest over <i>Astartea</i> sp. tall sparse shrubland over <i>Pteridium esculentum</i> closed fernland and <i>Lepidosperma longitudinale</i> open sedgeland.</p> <p>This vegetation type follows the Serpentine River. The density of <i>E. rudis</i> decreases with increasing distance from the river.</p>	36.0	11	
<p><i>Melaleuca</i> woodland (Mw) <i>Melaleuca preissiana</i> with occasional <i>M. raphiophylla</i> low open woodland over tall open shrubland <i>Kunzea glabrescens</i> tall open shrubland over <i>Astartea</i> sp. isolated shrubs over <i>Lyginia imberbis</i> and <i>Dasyopogon bromeliifolius</i> open herbland Mapped in areas of poor drainage within the survey area.</p>	4.8	5	

Vegetation type and description	Extent (ha)	FCT alignment	Photograph
<p>Tuart woodland (Tw) <i>Eucalyptus gomphocephala</i> open forest over <i>Kunzea glabrescens</i> tall isolated shrubs over <i>Pteridium esculentum</i> sparse fernland and <i>Desmocladius flexuosus</i> open sedgeland.</p> <p>Restricted to one small patch on the northern side of the River.</p>	0.6	-	
<p>Scattered natives over weeds (Sn) <i>Eucalyptus marginata</i>, <i>Corymbia calophylla</i>, <i>Melaleuca preissiana</i> and /or <i>Banksia</i> spp. other weedy grasses and herbs.</p> <p>Characterised as highly modified areas of vegetation where weedy species dominate.</p>	120.6	N/A	
<p>Track Gravel and/ or dirt vehicle tracks</p>	16.9	N/A	

4.2 Vegetation condition

The vegetation condition ranged from Excellent to Degraded across the survey area. The majority of the survey area was in Excellent or Very Good condition. In these areas the vegetation structure is intact and there are minimal disturbances. Areas mapped as scattered natives over weeds (Sn) are Degraded in condition as they have been historically cleared/partially cleared to support grazing by livestock. Whilst there is no grazing of livestock today, native species such as kangaroos maintain grazing at high level and contribute to weed spread (as well as keeping weed loads low) (Keighery et al. 1995).

Dieback is present at localised spots throughout the survey area and has contributed to a decline in vegetation condition. A number of patches of *Banksia* Woodland have been impacted by Dieback, which has resulted in death of *Banksia* individuals; these patches have been mapped as Good in condition and occur in the southern part of the survey area. A large patch of *Eucalyptus Banksia* woodland in the north of the survey area was also mapped in Good condition due to sparse occurrences of natives within the mid and lower stratum.

Banksia Kunzea woodland vegetation type, is synonymous to *Banksia* Woodland over *Kunzea ericifolia* Closed Tall Shrubland vegetation association mapped by Keighery et al. (1995). Keighery et al. (1995) reported that this association may be linked with regrowth after dieback infection, however, noted that *Kunzea ericifolia* (now recognised as *K. glabrescens* within the survey area) occurs naturally across the SCP in low lying areas. Dieback does appear to have been introduced along the southern boundary from drainage associates with roadworks. (Keighery et al. 1995) noted that in these areas the *Banksia* trees appeared dead or dying, GHD also observed *Banksia* deaths in this area during the field survey.

The north western corner of the survey area was mapped by Keighery et al. (1995) as part of the *Banksia*, *Allocasuarina fraseriana*, and/or *Melaleuca preissiana* Woodlands to Forests association in Very Good condition. The area has since been subjected to fire and possibly Dieback. As a result the canopy cover is dominated by *B. ilicifolia* amongst stags of what may have historically been other *Banksia* spp. and/or *Allocasuarina*. This area was mapped as Good in condition and separated out from Keighery et al. (1995) original vegetation association due to its modification in species dominance.

The extents of the vegetation condition ratings within the survey area are presented in Table 6 and mapped in Figure 7, Appendix A

Table 6 Vegetation condition and extent

Vegetation condition	Extent (ha)
Excellent	354.8
Very Good	441.9
Good	202.7
Degraded	122.7
Tracks	16.9
Total	1,139.0

4.3 Conservation significant communities

Based on the results of the desktop searches, previous literature (e.g. Keighery et al. 1995 and Gibson et al. 1994) dominant species, landform features and field observations four conservation significant ecological communities were considered likely to occur within the survey area:

- *Banksia* woodlands of the SCP TEC
- Low lying *Banksia attenuata* woodlands or shrublands (SCP21c) PEC

- *Banksia* dominated woodlands of the SCP IBRA region PEC
- Tuart (*Eucalyptus gomphocephala*) woodlands of the SCP PEC.

All conservation significant communities considered likely to occur within the survey area are described in detail below and mapped in Figure 8, Appendix A.

***Banksia* Woodlands of the SCP TEC**

The *Banksia* Woodlands of the SCP was listed in September 2016 as an Endangered TEC under the EPBC Act. The Commonwealth TEC encompasses a number of FCTs, some of which are also listed as State TECs/PECs. The low lying *Banksia attenuata* woodland or shrublands (FCT21c) and the Central *Banksia attenuata* – *B. menziesii* woodlands (FCT23a) are both listed as sub-communities of the *Banksia* Woodlands of the SCP TEC.

The Threatened Species Scientific Community (TSSC) (2016) provides criteria and guidance for determining whether the TEC is present, such as:

- A prominent tree layer of *Banksia*, with scattered eucalypts and other tree species often present among, or emerging above, the canopy
- The understorey is a species rich mix of sclerophyllous shrubs, graminoides and forbs
- High endemism and considerable localised variation in species composition across its range
- Minimum patch size and condition requirements.

Based on the vegetation association and condition mapping by Keighery et al. (1995), updates from DBCA and field survey results the *Eucalyptus Banksia* woodland (EBw), *Allocasuarina Banksia* woodland (ABw) and *Banksia Kunzea* woodland (BKw) vegetation types are considered likely to meet the key diagnostic characteristics for the *Banksia* Woodlands of the SCP TEC. There are five separate patches present within the survey area which are considered representative of the *Banksia* TEC (Table 7). These patches also encompass the Low lying *Banksia attenuata* woodland or shrublands (FCT21c) PEC and *Banksia* dominated woodlands of the SCP IBRA region PEC areas.

Table 7 Approximate extent of *Banksia* Woodlands of the SCP TEC within the survey area

Patch ID	Vegetation type	Extent (ha)
1	EBw	48.0
	Patch total	48.0
2	ABw	63.2
	BKw	41.9
	EBw	459.2
	Patch total	564.3
3	EBw	6.5
	Patch total	6.5
4	BKw	37.7
	EBw	127.6
	Patch total	165.3
5	BKw	67.3
	EBw	71.3
	Patch total	138.6
Total		922.7

Low lying *Banksia attenuata* woodland or shrublands (FCT21c) PEC

FCT21c is described as a low lying *Banksia attenuata* woodland or shrublands that occurs sporadically between Gingin and Bunbury. This community is largely restricted to the Bassendean dune system and tends to occupy low lying sites. The *Allocasuarina Banksia* woodland (ABw) and *Banksia Kunzea* woodland (BKw) vegetation types mapped within the survey area are considered representative of FCT21c. These vegetation types included species such as *Banksia attenuata*, *B. menziesii*, *Melaleuca preissiana*, *Eucalyptus marginata*, *Kunzea glabrescens*, *Patersonia occidentalis* and *Desmocladius flexuosus*, which are all typical and common species of FCT21c. There is approximately 210.1 ha of FCT21c present in the survey area.

***Banksia* dominated woodlands of the SCP IBRA region PEC**

Banksia dominated woodlands of the SCP IBRA region is a Priority 3 PEC listed by DBCA. DBCA (2019) describes the *Banksia* PEC as having a canopy that is most commonly dominated or co-dominated by *Banksia attenuata* and/or *B. menziesii*. Other *Banksia* species that can dominate in the community are *B. prionotes* or *B. ilicifolia*. The PEC differs from the EPBC Act listed *Banksia* woodlands of the SCP TEC in that it has no minimum condition and patch size thresholds.

The Central *Banksia attenuata* – *Eucalyptus marginata* woodlands (FCT21a) and Central *Banksia attenuata* – *B. menziesii* woodlands (FCT23a) were identified within the survey area. These FCTs are not listed as conservation significant communities under the BC Act or by the DBCA. However both FCT21a and FCT23a are considered a component of the *Banksia* dominated woodlands of the SCP IBRA region PEC due to key structural features.

Vegetation type *Eucalyptus Banksia* woodland (EBw) is considered representative of the *Banksia* dominated woodlands of the SCP IBRA region (PEC). There is 712.6 ha of the *Banksia* dominated woodlands of the SCP IBRA region (PEC) within the survey area

Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain (PEC)

Vegetation type Tuart woodland is considered to align with the Tuart (*Eucalyptus gomphocephala*) woodlands of the SCP PEC, listed as Priority 3 PEC by DBCA. This PEC differs from the TEC in that it has no minimum condition or patch size thresholds. There is 0.6 ha of the PEC present within the survey area.

4.4 Conservation significant flora

Four conservation significant flora have historically been recorded within the survey area:

- *Caladenia huegelii* (listed as EN under the EPBC Act and CR under the BC Act)
- *Drakaea elastica* (listed as EN under the EPBC Act and CR under the BC Act)
- *Johnsonia pubescens* subsp. *cygnorum* (P2) listed by DBCA
- *Dillwynia dillwynioides* (P3) listed by DBCA

During the field survey a new location of *Johnsonia pubescens* subsp. *cygnorum* (P2) was recorded. The location of this conservation significant species is illustrated on Figure 8, Appendix A.

4.5 Significant weeds

During the field survey four Declared Pests as listed under the *Biosecurity and Management Act 2007* were recorded in multiple locations throughout the survey area. One taxon is also listed as Weeds of National Significance (WoNS):

- **Gomphocarpus fruticosus* (Narrowleaf Cottonbush) – Declared Pest
- **Echium plantagineum* (Paterson's Curse) – Declared Pest
- **Zantedeschia aethiopica* (Arum lily) – Declared Pest
- **Asparagus asparagoides* (Bridal Creeper) – Declared Pest and WoNS


Locations of the Declared Pests and WoNS recorded during the field survey are shown in Figure 7, Appendix A


4.6 Broad fauna habitats


Four broad habitats were identified within the survey area based on the mapped vegetation types. The fauna habitats are described in Table 8 and mapped in Figure 9, Appendix A.


The survey area is an intact area of native vegetation dominated by mixed Eucalyptus and Banksia woodlands interspersed with partial clearings and lower elevation areas with associated damp land vegetation associations. The survey area is mostly surrounded by cleared land with low density semi-rural residential properties and has limited connectivity to other areas of bushland. The Serpentine River intersects the central part of the survey area and there is some connectivity along this river via riparian woodland, and remnant patches of scattered trees in the surrounding setting provide some canopy connectivity. Access to the survey area is via a private road and locked gate which has minimised vehicle and bike activity as well as illegal dumping.

Table 8 Broad fauna habitats within the survey area

Habitat type and description	Value	Extent (ha)	Photographs
<p>Mixed Eucalyptus Banksia Woodland</p> <p>Corresponding vegetation associations: EBW, ABw, BiW, BKw</p> <p>The habitat comprises Bassendean sand plain supporting emergent Marri and Jarrah trees over a mature canopy of <i>Banksia</i> with Sheoaks and Paperbarks in lower lying areas. The midstorey varies from open, moderately dense, or scattered patches of Bassendean derived mixed shrubs such as <i>Jacksonia</i>, <i>Acacia</i> and <i>Kunzea</i>. Lower strata vegetation consists of a diverse mix of low shrubs and forbs including <i>Xanthorrhoea</i> and <i>Loxocarya</i>. This habitat type contains good structural diversity and is likely to provide a variety of micro-habitat types including logs, soft sand, leaf litter and woody debris for a range of small to medium sized terrestrial vertebrate mammals and reptiles. The mid strata shrubs and trees support a range of small insectivorous and nectar feeding birds. Emergent mature Jarrah and Marri trees are present and provide potential breeding habitat for black cockatoos.</p> <p><u>Conservation Significant Fauna</u></p> <p>This habitat provides resources for conservation significant fauna including:</p> <ul style="list-style-type: none"> • Carnaby's Cockatoo (<i>Calyptorhynchus latirostris</i>) (foraging, and potential breeding and roosting) • Forest Red-tailed Black Cockatoo (<i>Calyptorhynchus banksii naso</i>) (foraging, and potential breeding and roosting) • Baudin's Cockatoo (<i>Calyptorhynchus baudinii</i>) (foraging and potential roosting) • Quenda (<i>Isodoon fusciventer</i>) (foraging) • South-western Brush-tailed Phascogale (<i>Phascogale tapoatafa wambenger</i>) (foraging, shelter/refuge) • Coastal Plains Skink (<i>Ctenotus ora</i>) (foraging/shelter). • Chuditch (<i>Dasyurus geoffroi</i>) (foraging) 	High	940.3	

Habitat type and description	Value	Extent (ha)	Photographs
<p>Flooded Gum Melaleuca woodlands</p> <p>Corresponding vegetation associations: Mw, Cw</p> <p>This habitat comprised an overstorey of Paperbarks with occasional emergent Marri and Flooded gum over sparse to dense shrublands and mixed herbs and sedges, and introduced species such as Arum Lily. This habitat type occurs in lower elevation poor retainage damplands and ephemeral swamp areas, There is moderate structural diversity and is likely to be seasonally inundated. The midstorey and understorey may be dense enough to support small ground dwelling mammals and reptiles, however, the waterlogged soils may prevent soil living fauna from utilizing the area. The Quenda would not utilise areas that are seasonally inundated, but would utilise habitat on the margins that are dense and accessible.</p> <p><u>Conservation Significant Fauna</u></p> <p>This habitat provides resources for conservation significant fauna including:</p> <ul style="list-style-type: none"> • Carnaby's Cockatoo (potential breeding and roosting) • Forest Red-tailed Black Cockatoo (potential breeding and roosting) • Baudin's Cockatoo (potential roosting) • Southern Brown Bandicoot (foraging) • Quenda (resident, foraging) • Chuditch (<i>Dasyurus geoffroi</i>) (foraging) 	Moderate	24.5	

Habitat type and description	Value	Extent (ha)	Photographs
<p>Riparian</p> <p>Corresponding vegetation associations: Ef, Emw, Tw</p> <p>Riparian habitat includes banks of the Serpentine River, the waterway and associated tributaries, and sumpland areas. This habitat type comprises dense and very tall stands of Flooded gum forest with occasional Tuart and Paperbarks over Bracken and sedges. This habitat type contains good structural diversity and is likely to provide a variety of micro-habitat types including large logs and other fallen timber, dense patches of ferns and thick litter. This habitat is likely to provide excellent cover and foraging opportunities for birds and reptiles, and there is extensive signs of Quenda foraging activity. The understorey vegetation also provides refuge and foraging opportunities for mammals such as the Quenda and habitat on the river margins for Rakali.</p> <p>The Serpentine River provides habitat for aquatic species such as fish, crustaceans and amphibians.</p> <p><u>Conservation Significant Fauna</u></p> <p>This habitat provides resources for conservation significant fauna including:</p> <ul style="list-style-type: none"> • Carnaby's Cockatoo (potential breeding and roosting) • Forest Red-tailed Black Cockatoo (potential breeding and roosting) • Baudin's Cockatoo (potential roosting) • Rakali (<i>Hydromys chrysogaster</i>) (feeding and shelter) • Quenda (resident, foraging) • Carter's Freshwater Mussel (<i>Westralunio carteri</i>) (resident) • Pouched lamprey (<i>Geotria australia</i>) • Chuditch (<i>Dasyurus geoffroi</i>) (foraging, movement corridor regionally) 	High	36.6	

Habitat type and description	Value	Extent (ha)	Photographs
<p>Pasture with scattered trees</p> <p>Corresponding vegetation associations: Sn</p> <p>This habitat type is largely cleared except for remnant trees and few shrubs. It contains poor structural diversity with a scattered overstorey, limited mid-storey and understorey of pasture weeds. The scattered trees include mainly Jarrah, Marri and occasional Flooded gum and or <i>Banksia</i> species. Tree density varies from very sparse to small clusters. A lack of low strata native vegetation coverage (native understorey and ground layer) is replaced by pasture and weed grasses and exotic herbaceous species which makes the area largely unsuitable for most small mammals, and reptiles. The mature trees provide opportunistic foraging, and potential breeding and may provide potential roosting habitat (dependant on size of each tree) for black cockatoo species. This habitat type includes patches of highly degraded clay pan supporting weed species.</p> <p><u>Conservation Significant Fauna</u></p> <p>The habitat within the survey area provides resources for conservation significant fauna including:</p> <ul style="list-style-type: none"> • Carnaby's Cockatoo (foraging, potential breeding and roosting) • Forest Red-tailed Black Cockatoo (foraging, potential breeding and roosting) • Baudin's Cockatoo (foraging and potential roosting) • South-western Brush-tailed Phascogale (foraging, shelter/refuge) 	Moderate	120.6	
Tracks		16.9	

4.7 Black cockatoo habitat assessment

4.7.1 Foraging habitat

During the one day field visit, Carnaby's Cockatoos were seen and heard calling over the survey area. Forest Red-tailed Black Cockatoos were also observed feeding at two locations during the subsequent two day field assessment. Foraging evidence (chewed Marri, Jarrah, Banksia and Allocasuarina nuts) was recorded extensively throughout the Mixed Eucalyptus Banksia Sheoak, and Scattered native tree habitat types with both Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo distinctive mandible marks evident.

The type and quality of plant species provides extensive and high quality food resources for both Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo. The survey area is also considered to contain foraging and potential roosting habitat for Baudin's Cockatoo, however no evidence of feeding or roosting was observed. A summary of potential black cockatoo habitat available within the survey area is provided in Table 9. Foraging, potential breeding and roosting habitat for Black Cockatoos is mapped in Figure 9, Appendix A. Foraging evidence recorded during the survey is mapped in Figure 10, Appendix A

4.7.2 Breeding habitat

From tree density plots the potential breeding trees (DBH greater than 50 cm) were recorded within all four of the major habitat types. Potential breeding trees were recorded at greatest density within the Riparian habitat and lowest density recorded in the Scattered native tree habitat (Table 10). The presence of extensive and high quality foraging resource throughout the survey area enhances the value potential breeding trees.

4.7.3 Roosting habitat

The survey area does not support any known roosts, however the 2018 Great Cocky Count (Peck et al. 2018) reports multiple confirmed roost sites for Carnaby's Cockatoo within a 12 km radius of the Lowlands survey area.

Table 9 Black cockatoo habitat within the survey area

Habitat type	Extent (ha)	Foraging	Potential breeding	Potential roosting
Mixed Eucalyptus Banksia Sheoak woodland	940.3	high	yes	no
Scattered native trees	120.6	low/ mod	yes	no
Flooded Gum Melaleuca woodland	24.5	low/mod	yes	no
Riparian	36.6	low/mod	yes	yes

Table 10 Potential breeding tree density

Habitat type	No. of plots sampled	Density range (trees/ha)	Mean (trees/ha)	Estimated trees in habitat type
Mixed Eucalyptus Banksia Sheoak woodland	23	0 - 16	6.3	5,923
Scattered native trees	5	0 - 8	2.4	289
Flooded Gum Melaleuca woodland	5	0 - 8	4.0	98
Riparian	5	32 - 76	48.8	1,786

4.8 Conservation significant fauna

The DBCA are currently using camera traps within the survey area to detect fauna species present. During the site visit, GHD ecologists were shown photographs of some of the conservation significant fauna species recorded within the site, these included:

- Chuditch (*Dasyurus geoffroi*) (a single male individual)
- Rakali (*Hydromys chrysogaster*)
- Pouched lamprey (*Geotria australia*)
- Carters Freshwater Mussel (*Westralunio carteri*)
- Quenda (*Isodoodon fusciventer*)
- Brush-tailed Phascogale (*Phascogale tapoatafa wambenger*).

Property owner and resident Margaret Richardson provided anecdotal evidence on the conservation significant fauna within the reserve:

- Quenda are frequently observed around the immediate homestead where they shelter from foxes and are also seen throughout much of the reserve
- Tammar Wallabies (*Notamacropus eugenii derbianus*) have been recorded historically on the reserve but not seen for many years
- Brush-tailed Phascogales have been recorded in the woodland areas
- Carter's Freshwater Mussels were collected upstream of the reserve in a study and are thought to spawn in the Serpentine River within the reserve; Pouched lamprey were also captured in this study
- Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo are both frequent visitors and residents at the reserve.

Sheenan et al. (2017) reported that the riverine system within the site provides spawning grounds for Carters Freshwater Mussels and Pouched lamprey. Carter's Freshwater Mussels were recorded within the Serpentine River in the survey area during the survey. The river also provides important habitat for threatened mammals including Rakali and Quenda. Signs of presence, and direct observation of all conservation significant fauna recorded during the survey are presented in Figure 10, Appendix A.

Likelihood of occurrence assessment

An assessment of the likelihood of occurrence for conservation significant fauna in the survey area was conducted. This assessment was based on species biology, habitat requirements, the quality and connectivity of available habitat, and local and regional occurrence of species records. The assessment identified eight species that are known to occur within the survey area. A summary of the assessment is provided in Table 11.

Table 11 Summary of conservation significant fauna likelihood of occurrence assessment

Species	Common Name	BC Act / DBCA	EPBC	Likelihood of occurrence
<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black Cockatoo	VU	VU	Known Confirmed present. Extensive signs of foraging on Marri, Jarrah and <i>Allocasuarina</i> nuts was recorded, as well as small flocks of active cockatoos observed. The survey area has foraging, potential breeding and roosting habitat.
<i>Calyptorhynchus latirostris</i>	Carnaby's Cockatoo	EN	EN	Known Confirmed present. Extensive signs of foraging of <i>Banksia attenuata</i> , <i>B. grandis</i> , <i>B. menziesii</i> and <i>B. ilicifolia</i> . The survey area has foraging, potential breeding and roosting habitat.
<i>Calyptorhynchus baudinii</i>	Baudin's Cockatoo	VU	VU	Likely The survey area has foraging and potential roosting habitat
<i>Oxyura australis</i>	Blue-billed Duck	P4		Unlikely This species prefers large deep lakes and wetlands which the site does not provide. The Serpentine River represents limited and sub-optimal habitat.
<i>Dasyurus geoffroii</i>	Chuditch, Western Quoll	VU	VU	Known Confirmed present
<i>Hydromys chrysogaster</i>	Water-rat, Rakali	P4		Known Confirmed present. This species is likely to be a resident along the Serpentine Rv.
<i>Isoodon fusciventer</i>	Quenda, South-western Brown Bandicoot	P4		Known Confirmed present. Foraging signs (diggings) recorded during the field survey.
<i>Notamacropus eugenii derbianus</i>	Tammar Wallaby	P4		Unlikely Historically recorded on site. The site lacks suitable and/or connected habitat for the Tammar Wallaby.
<i>Phascogale tapoatafa wambenger</i>	South-western Brush-tailed Phascogale	CD		Known Confirmed present.
<i>Westralunio carteri</i>	Carter's Freshwater Mussel	VU	VU	Known Confirmed present. This species recorded within Serpentine River during the field survey.
<i>Geotria australia</i>	Pouched lamprey	P3		Known Confirmed present

5. Opportunities for on ground management work

Based on discussions with stakeholders and the two-day field survey the following on ground maintenance will need to be considered:

- Maintenance of existing fences and gates, fencing upgrade/replacement in the southern part of the survey area
- Weed management and targeted control for significant weeds including but not limited to Arum lily (*Zantedeschia aethiopica*), Bridal creeper (*Asparagus asparagoides*), Cotton bush (*Gomphocarpus fruticosus*) and **Echium plantagineum* (Paterson's Curse)
- Feral animal control including rabbits, foxes, pigs, goats, dogs and possibly cats
- Potential control of native fauna such as kangaroos to minimise weed invasion into area of Banksia Woodlands
- Revegetation of areas along the Serpentine River and in patches of degraded Banksia Woodland. Revegetation will improve fauna habitats by increasing foraging, breeding and shelter values, particularly for the eight conservation significant fauna species
- Continued dieback management through implementation of the existing Hygiene Management Plan maintenance of dieback vehicle wash-down bays and signage throughout the reserve.
- Consider installation of artificial nest tubes for Carnaby's and Forest Red-tailed Black Cockatoos, and nest boxes for Brush-tailed Phascogale
- Consider including the survey area in the Great Cocky Count autumn roost survey, which is coordinated by Birdlife Australia. This may establish whether the survey area is being used as a Black Cockatoo roost survey area.

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Appendices

Appendix A – Figures

Figure 1 Location

Figure 2 Hydrological constraints

Figure 3 Land use constraints

Figure 4 Vegetation complexes

Figure 5 Biological constraints

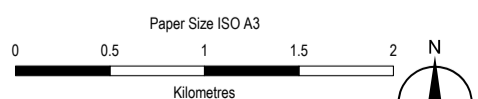
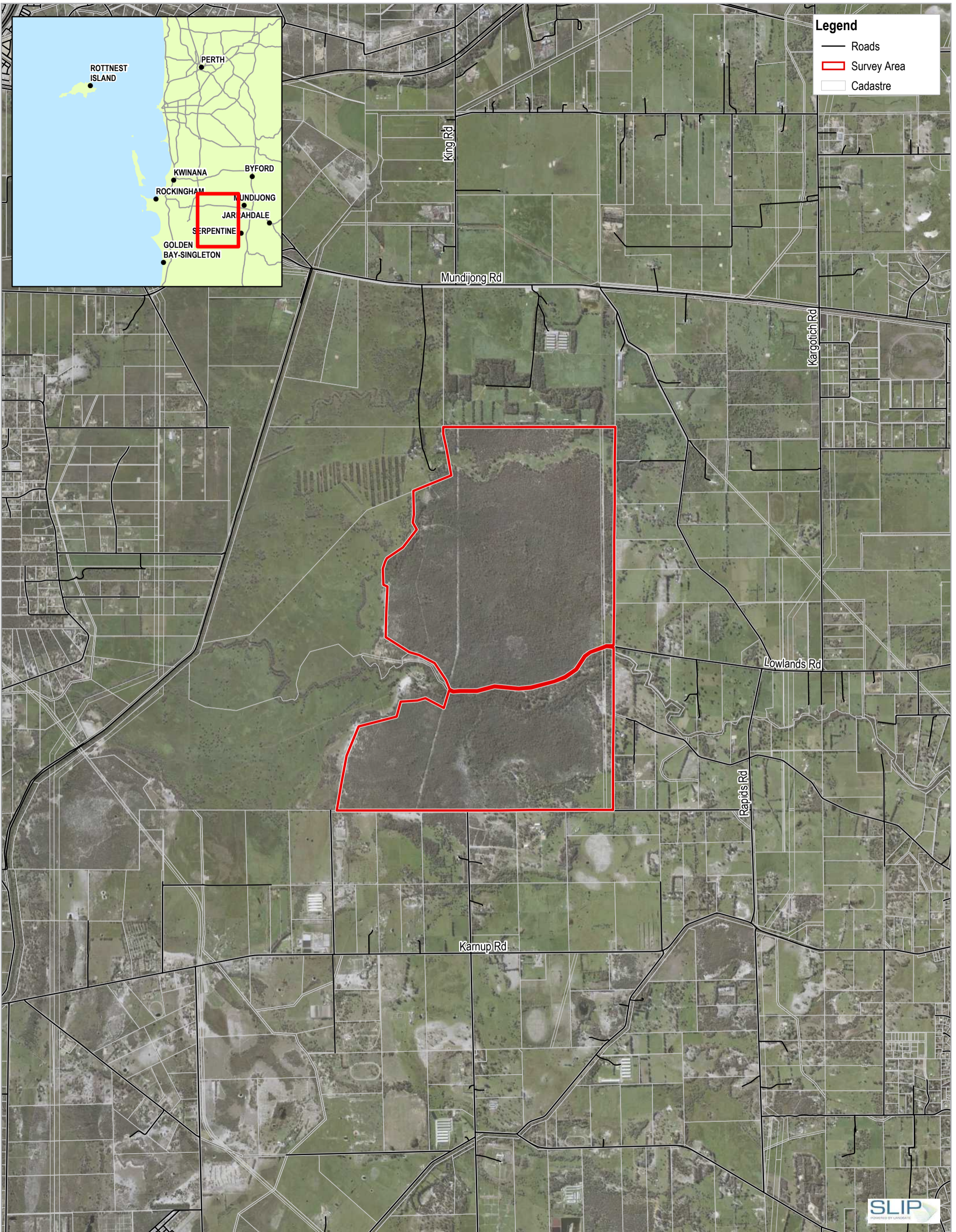
Figure 6 Vegetation types

Figure 7 Vegetation condition

Figure 8 Conservation significant communities

Figure 9 Fauna habitats and Black Cockatoo values

Figure 10 Significant fauna observations



Map Projection: Transverse Mercator
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 Grid: GDA 1994 Perth Coastal Grid 1994

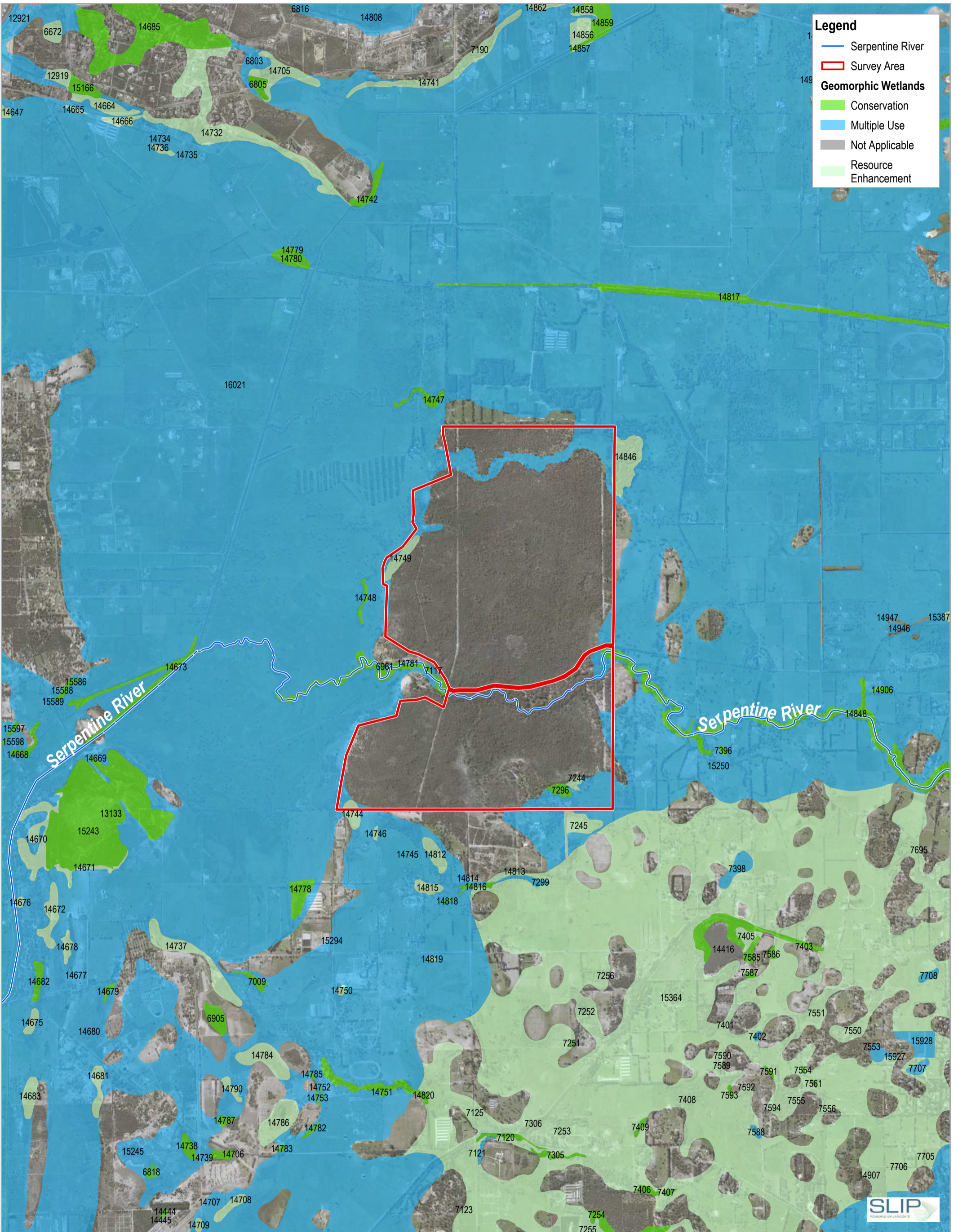


PTA
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 Assessment Lowlands

Lowlands Site Location

Project No. 61-38451-03
 Revision No. 0
 Date 25/11/2019

FIGURE 1



Legend

- Serpentine River
- Survey Area
- Geomorphic Wetlands**
- Conservation
- Multiple Use
- Not Applicable
- Resource Enhancement

Paper Size ISO A3

Kilometres

Map Projection: Transverse Mercator
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Grid: GDA 1994 Perth Coastal Grid 1994

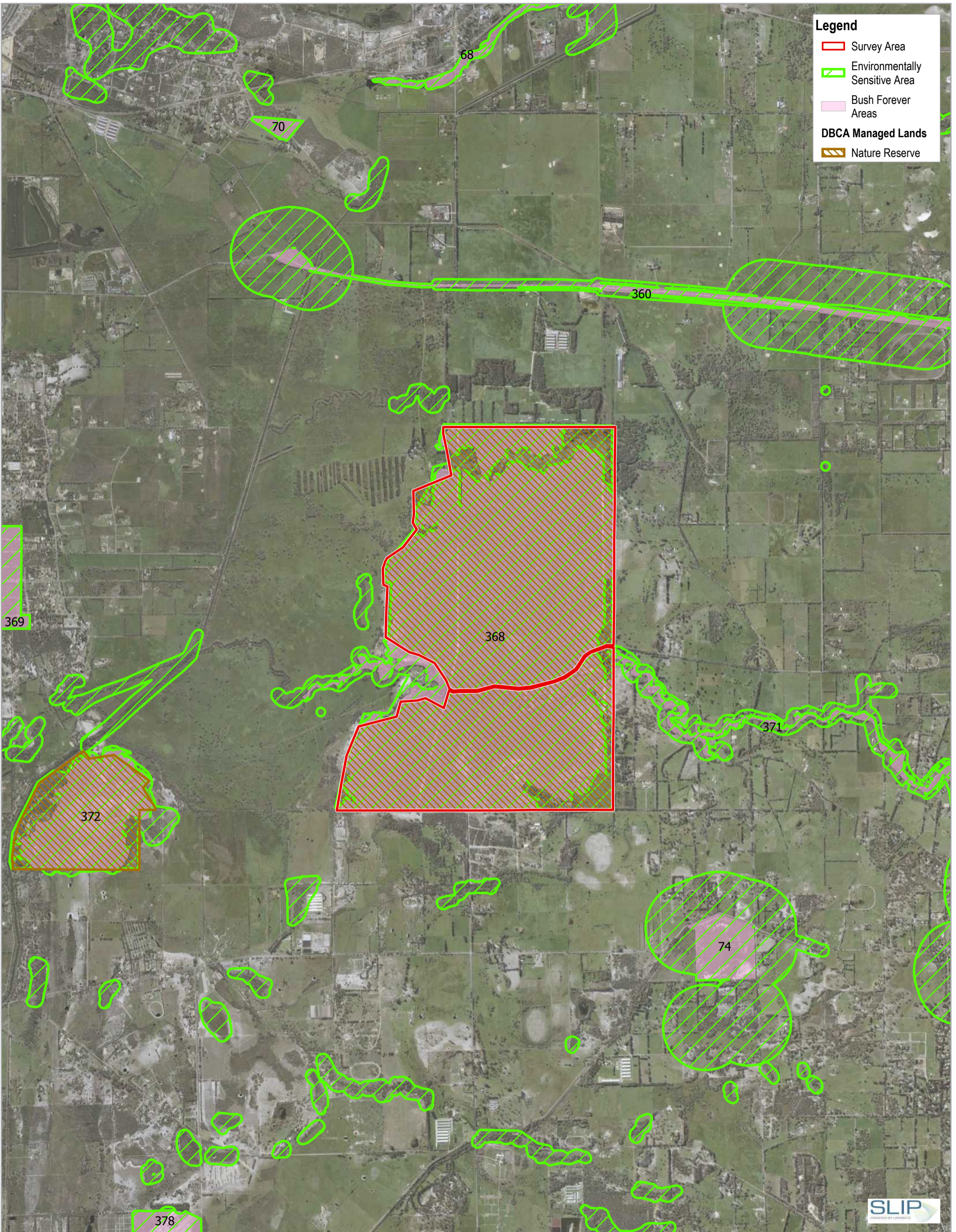


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Hydrological constraints

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FIGURE 2



Legend

- Survey Area
- Environmentally Sensitive Area
- Bush Forever Areas

DBCA Managed Lands

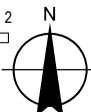
- Nature Reserve

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Kilometres

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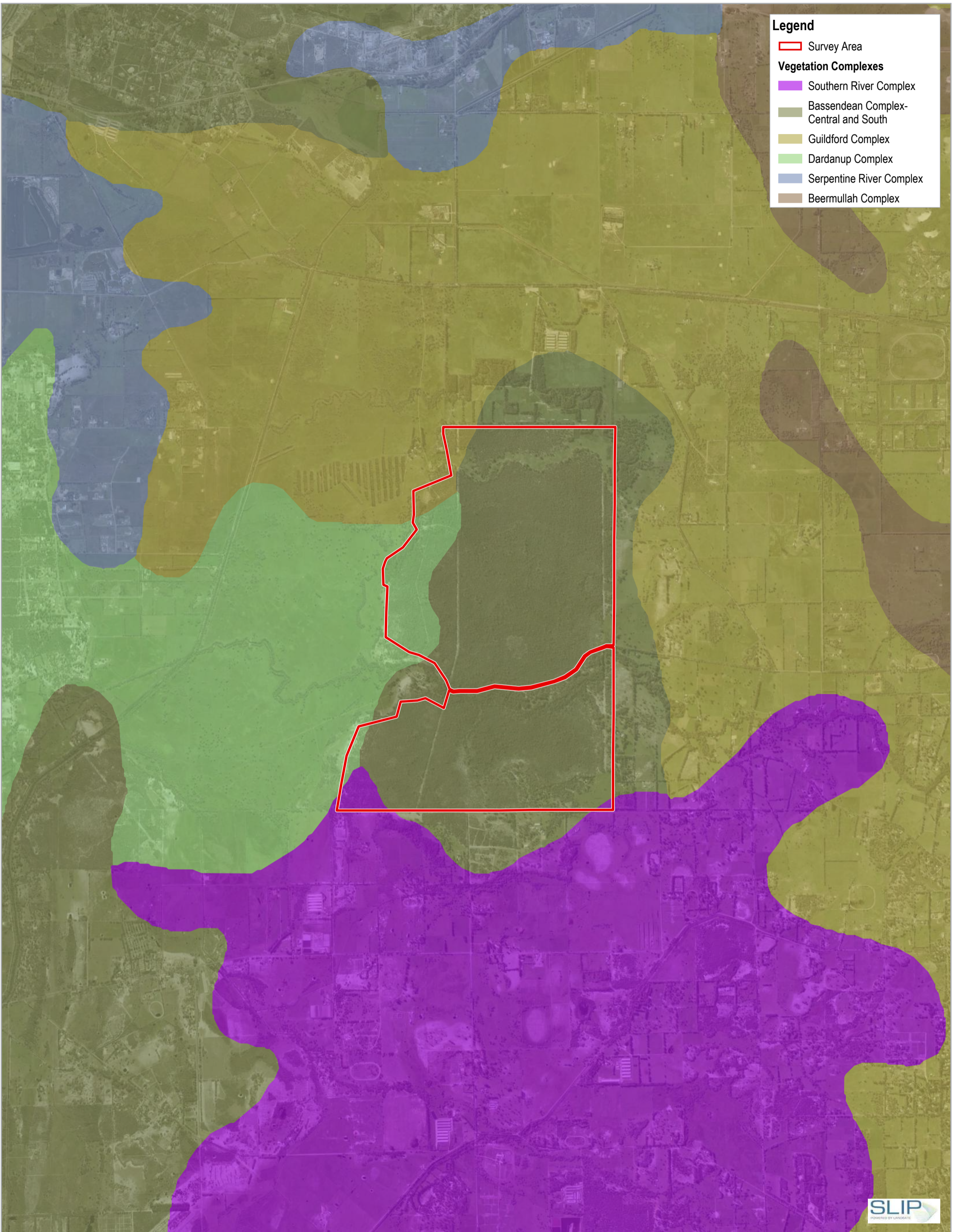



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Land use constraints

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FIGURE 3



Legend

- Survey Area
- Vegetation Complexes**
- Southern River Complex
- Bassendean Complex-Central and South
- Guildford Complex
- Dardanup Complex
- Serpentine River Complex
- Beermullah Complex



Paper Size ISO A3

Kilometres

Map Projection: Transverse Mercator
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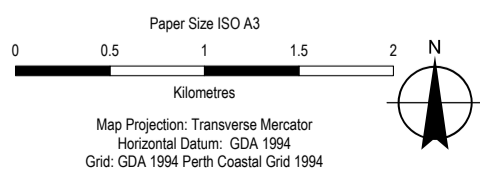
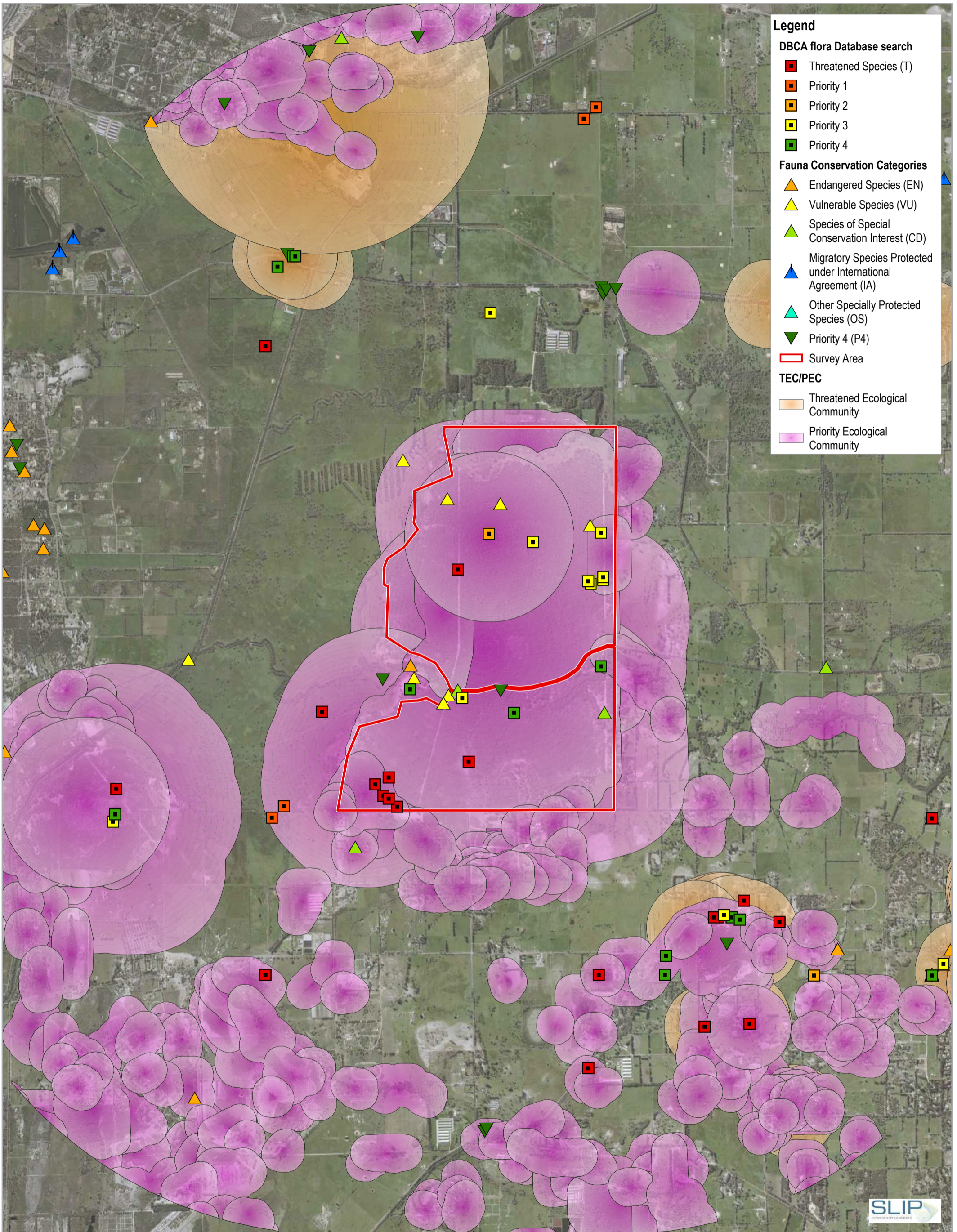


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Vegetation Complexes

FIGURE 4

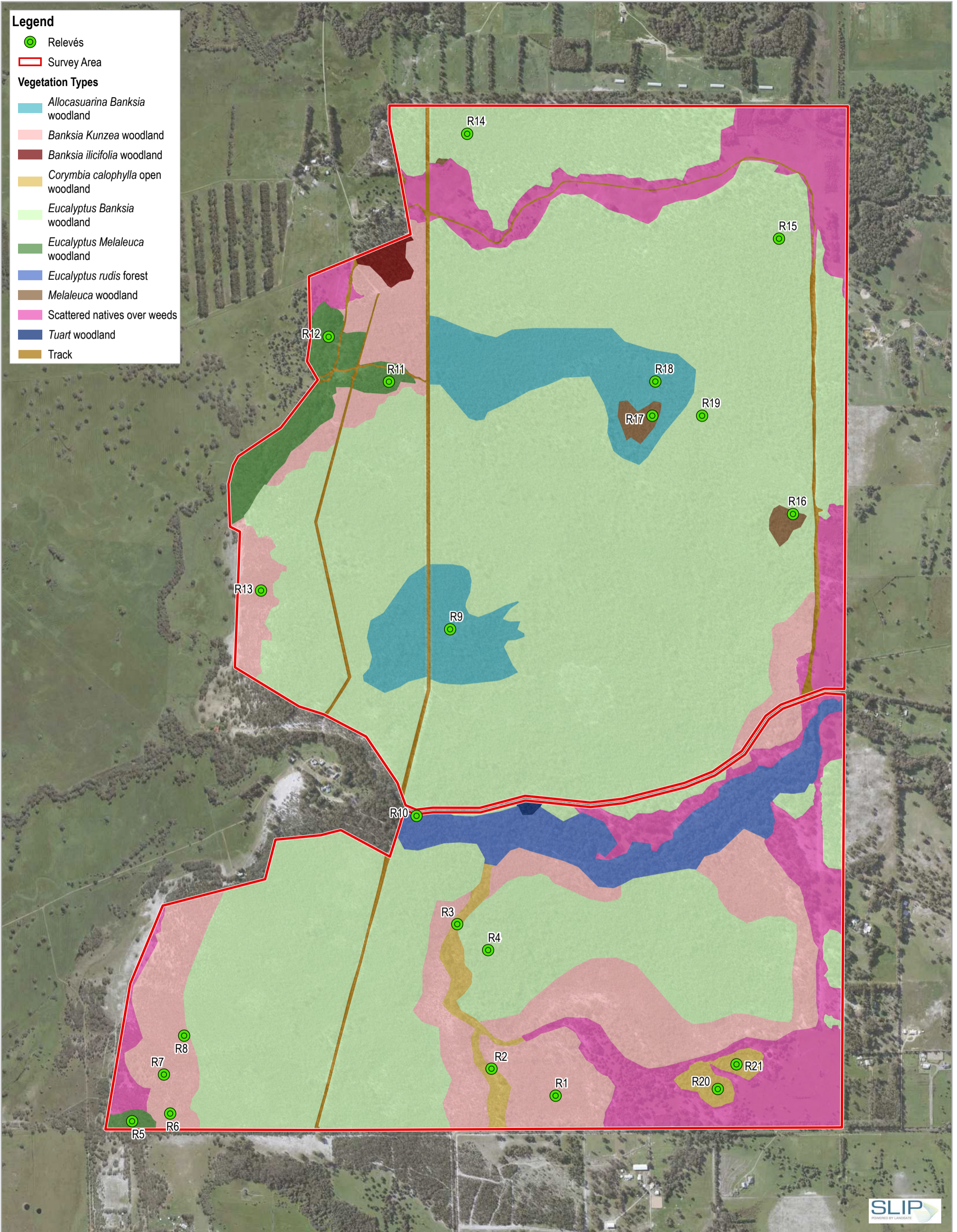


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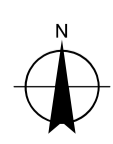
Biological Constraints

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Date 25/11/2019

FIGURE 5



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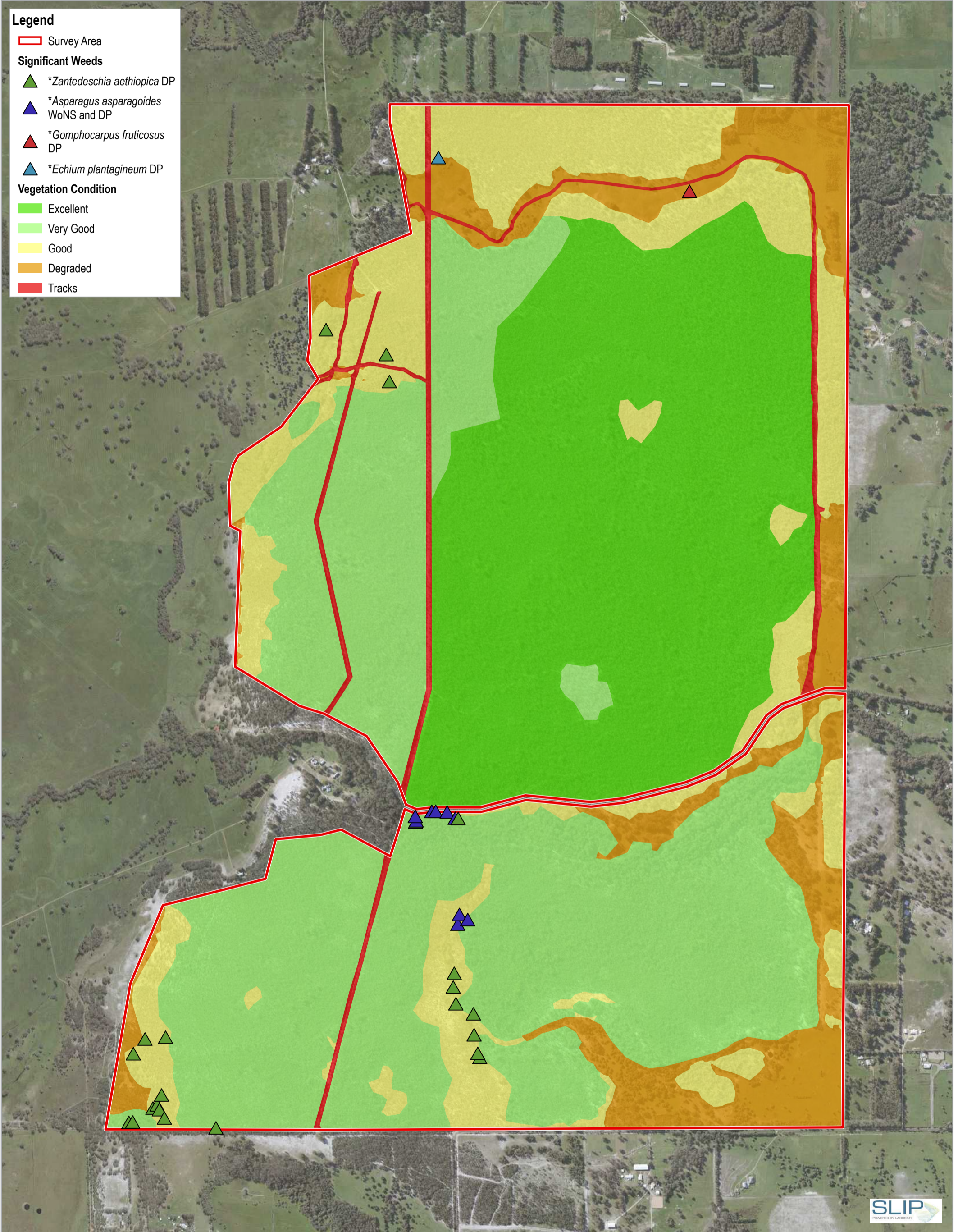


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**Vegetation types and
 sample sites**

FIGURE 6



Legend

- Survey Area
- Significant Weeds**
- ▲ **Zantedeschia aethiopica* DP
- ▲ **Asparagus asparagoides* WoNS and DP
- ▲ **Gomphocarpus fruticosus* DP
- ▲ **Echium plantagineum* DP
- Vegetation Condition**
- Excellent
- Very Good
- Good
- Degraded
- Tracks

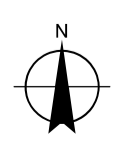


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Assessment Lowlands

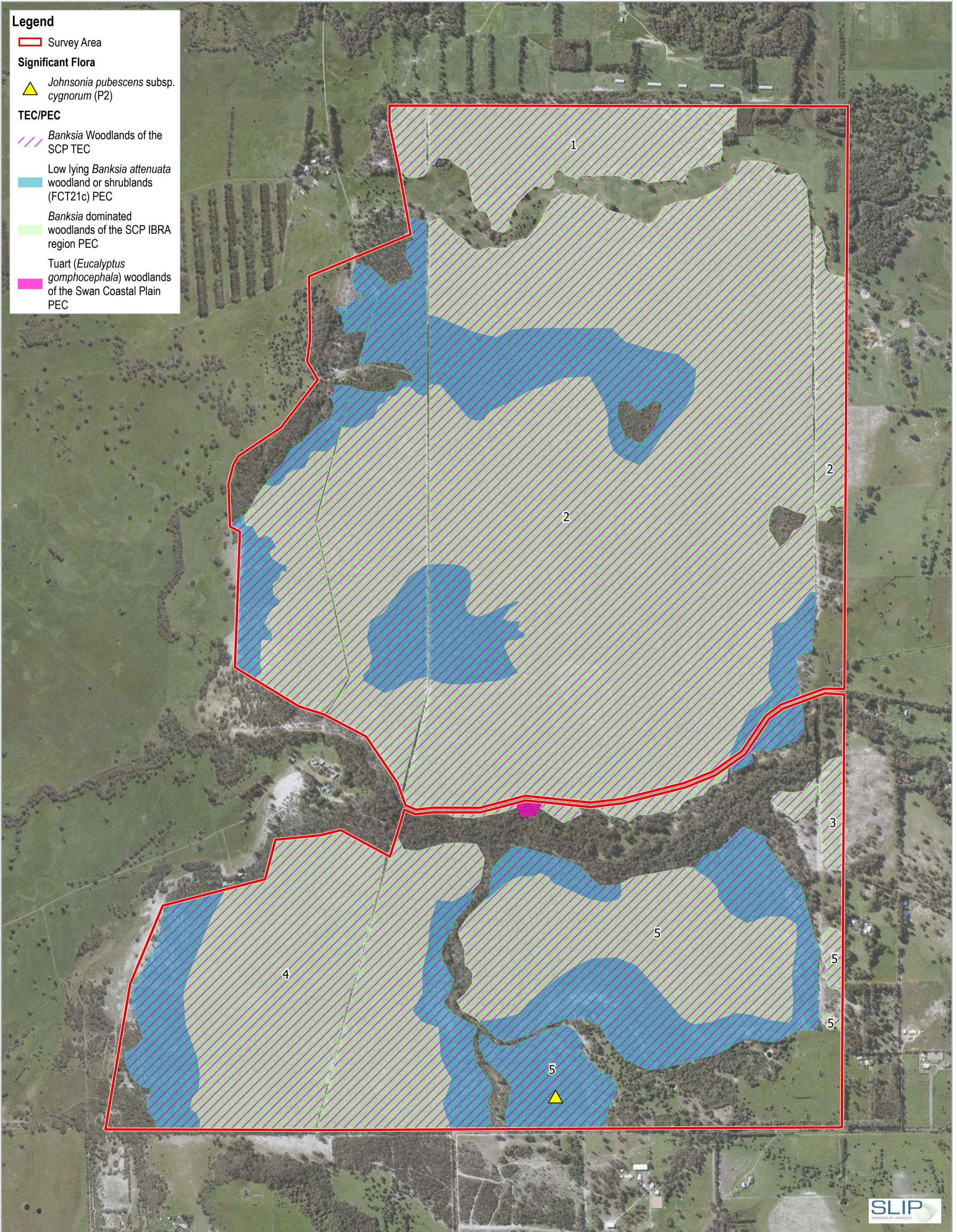
**Vegetation condition and
significant weeds**

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FIGURE 7

Legend

- Survey Area
- Significant Flora**
- ▲ *Johnsonia pubescens* subsp. *cygnorum* (P2)
- TEC/PEC**
- Banksia* Woodlands of the SCP TEC
- Low lying *Banksia attenuata* woodland or shrublands (FCT21c) PEC
- Banksia* dominated woodlands of the SCP IBRA region PEC
- Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain PEC

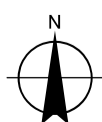


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Grid: GDA 1994 Perth Coastal Grid 1994



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**Conservation significant communities
and significant flora**

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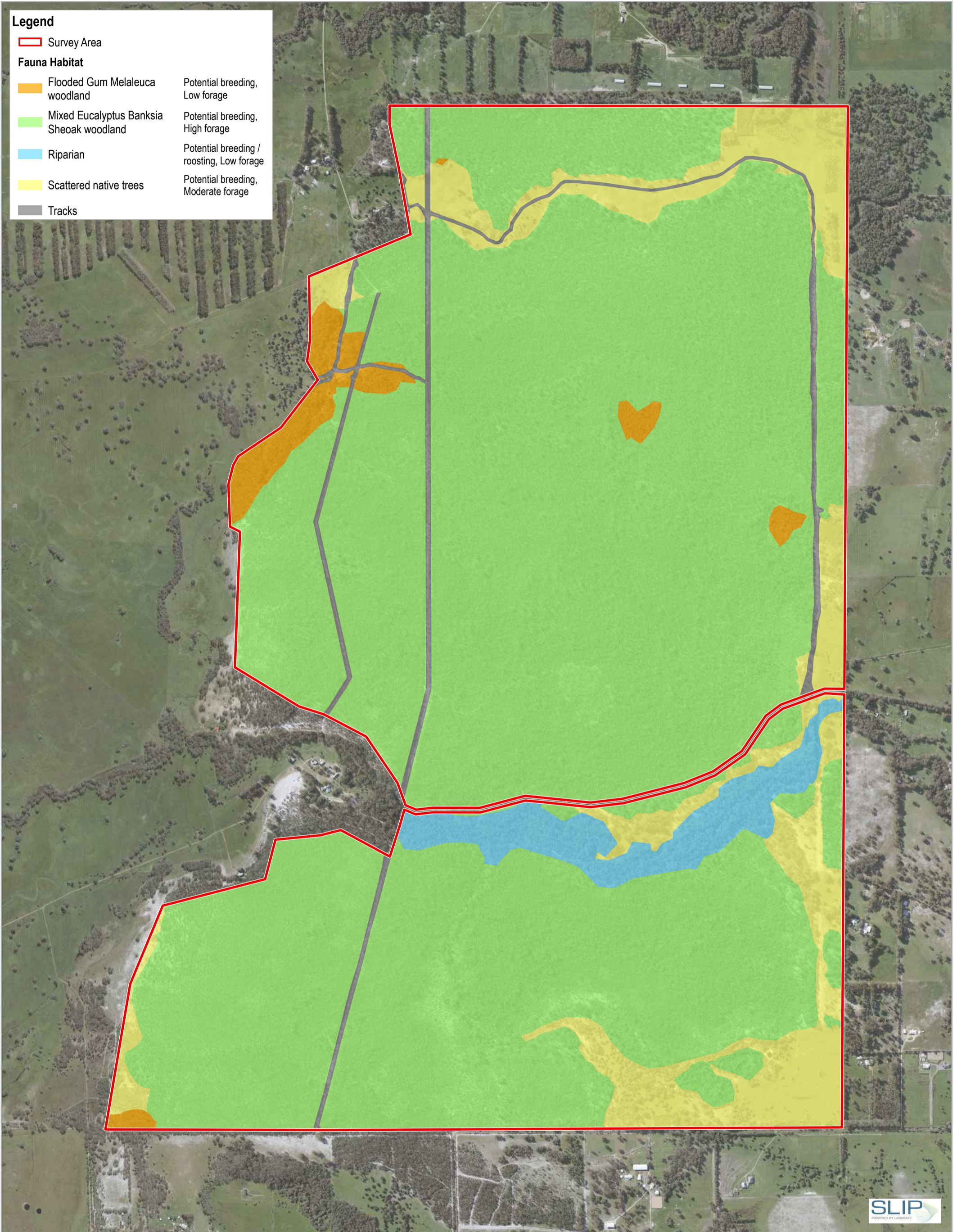
FIGURE 8

Legend

- Survey Area

Fauna Habitat

 Flooded Gum Melaleuca woodland	Potential breeding, Low forage
 Mixed Eucalyptus Banksia Sheoak woodland	Potential breeding, High forage
 Riparian	Potential breeding / roosting, Low forage
 Scattered native trees	Potential breeding, Moderate forage
 Tracks	

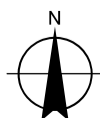


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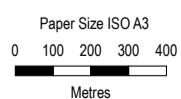
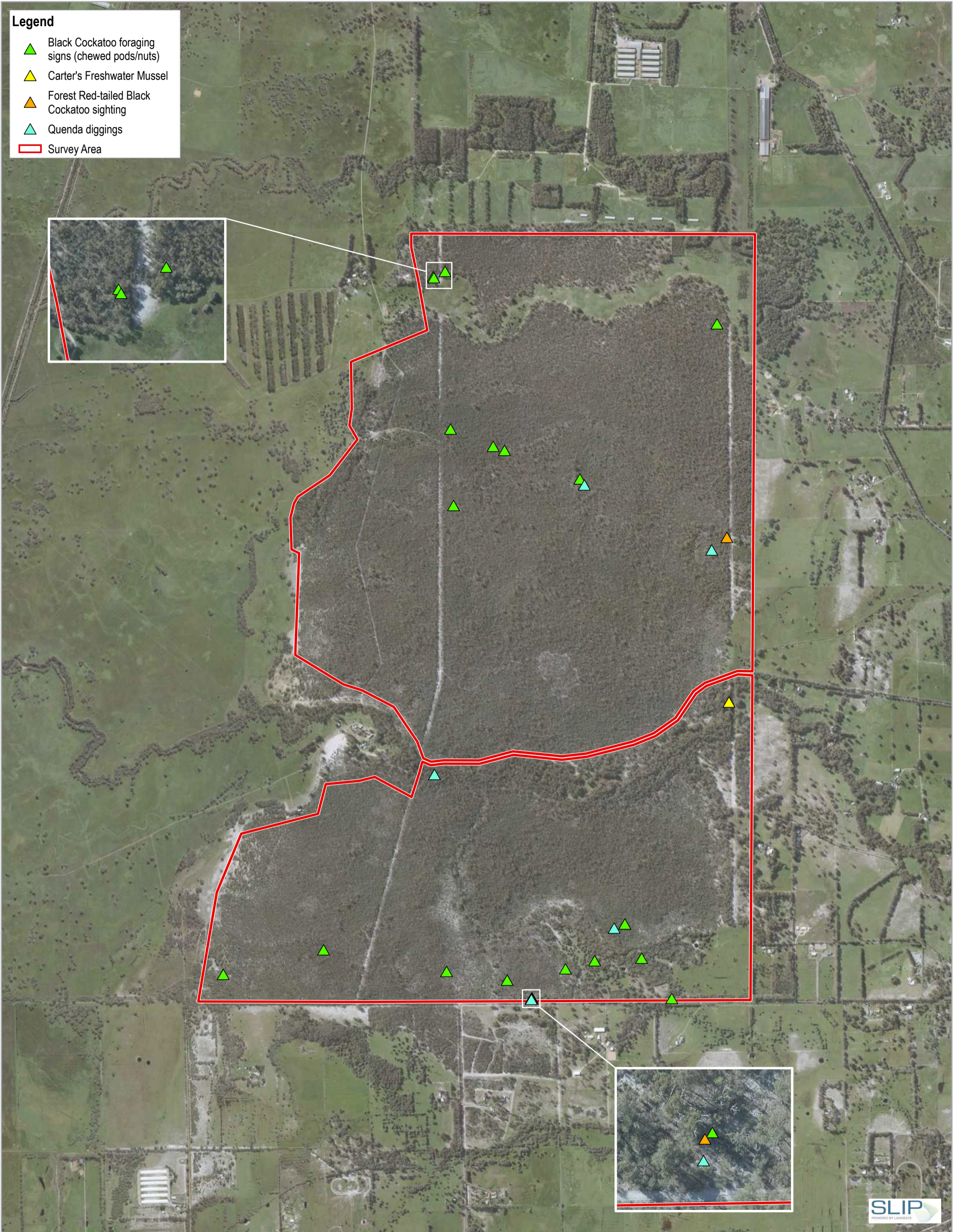


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Assessment Lowlands

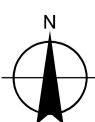
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Revision No. 0
Date 7/02/2020

**Fauna habitats and
Black Cockatoo values**

FIGURE 9



Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 Perth Coastal Grid 1994



PTA
PTA Potential Offset Site Environmental
Assessment Lowlands

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Significant fauna observations

FIGURE 10

Appendix B – Desktop searches

NatureMap Flora (5 km buffer)

NatureMap fauna (5 km buffer)

Mardella CS flora report

Created By Guest user on 17/07/2019

Kingdom Plantae
Conservation Status Conservation Taxon (T, X, IA, S, P1-P5)
Current Names Only Yes
Core Datasets Only Yes
Method 'By Circle'
Centre 115° 54' 50" E, 32° 19' 50" S
Buffer 5km
Group By Family

Family	Species	Records
Apiaceae	1	1
Apocynaceae	1	2
Asteraceae	1	1
Cyperaceae	2	2
Fabaceae	3	10
Hemerocallidaceae	1	4
Myrtaceae	2	5
Orchidaceae	2	9
Proteaceae	2	7
TOTAL	15	41

Name ID	Species Name	Naturalised	Conservation Code	Endemic To Query Area
Apiaceae				
1.	41801 <i>Eryngium pinnatifidum</i> subsp. <i>Palustre</i> (G.J. Keighery 13459)		P3	
Apocynaceae				
2.	6573 <i>Parsonia diaphanophleba</i>		P4	
Asteraceae				
3.	7829 <i>Angianthus drummondii</i>		P3	
Cyperaceae				
4.	759 <i>Carex tereticaulis</i>		P3	
5.	1033 <i>Tetragia australiensis</i>		T	
Fabaceae				
6.	14932 <i>Acacia lasiocarpa</i> var. <i>bracteolata</i> long peduncle variant (G.J. Keighery 5026)		P1	
7.	3863 <i>Dillwynia dillwynioides</i>		P3	
8.	20462 <i>Jacksonia gracillima</i>		P3	
Hemerocallidaceae				
9.	19272 <i>Johnsonia pubescens</i> subsp. <i>cygnorum</i>		P2	
Myrtaceae				
10.	13512 <i>Eucalyptus rudis</i> subsp. <i>cratyantha</i>		P4	
11.	14714 <i>Verticordia lindleyi</i> subsp. <i>lindleyi</i>		P4	
Orchidaceae				
12.	1596 <i>Caladenia huegelii</i> (Grand Spider Orchid)		T	
13.	1639 <i>Drakaea elastica</i> (Glossy-leaved Hammer Orchid)		T	
Proteaceae				
14.	30751 <i>Synaphea</i> sp. <i>Pinjarra Plain</i> (A.S. George 17182)		T	
15.	28354 <i>Synaphea</i> sp. <i>Serpentine</i> (G.R. Brand 103)		T	

Conservation Codes

T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

¹ For NatureMap's purposes, species flagged as endemic are those whose records are wholly contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

Mardella CS fauna report

Created By Guest user on 17/07/2019

Kingdom Animalia
Conservation Status Conservation Taxon (T, X, IA, S, P1-P5)
Current Names Only Yes
Core Datasets Only Yes
Method 'By Circle'
Centre 115° 54' 50" E, 32° 19' 50" S
Buffer 5km
Group By Species Group

Species Group	Species	Records
Bird	4	9
Invertebrate	1	2
Mammal	6	20
TOTAL	11	31

Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
Bird				
1.	24731 <i>Calyptorhynchus banksii</i> subsp. <i>naso</i> (Forest Red-tailed Black Cockatoo)		T	
2.	24734 <i>Calyptorhynchus latirostris</i> (Carnaby's Cockatoo, White-tailed Short-billed Black Cockatoo)		T	
3.	48400 <i>Calyptorhynchus</i> sp. (white-tailed black cockatoo)		T	
4.	24328 <i>Oxyura australis</i> (Blue-billed Duck)		P4	
Invertebrate				
5.	34113 <i>Westralunio carteri</i> (Carter's Freshwater Mussel)		T	
Mammal				
6.	24092 <i>Dasyurus geoffroi</i> (Chuditch, Western Quoll)		T	
7.	24215 <i>Hydromys chrysogaster</i> (Water-rat, Rakali)		P4	
8.	48588 <i>Isodon fusciventer</i> (Quenda, southwestern brown bandicoot)		P4	
9.	48024 <i>Notamacropus eugenii</i> subsp. <i>derbianus</i> (Tammar Wallaby, Tammar)		P4	
10.	25508 <i>Phascogale tapoatafa</i> (Brush-tailed Phascogale)		S	
11.	48070 <i>Phascogale tapoatafa</i> subsp. <i>wambenger</i> (South-western Brush-tailed Phascogale, Wambenger)		S	

Conservation Codes

T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

¹ For NatureMap's purposes, species flagged as endemic are those whose records are wholly contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

Appendix C – Vegetation Data

Relevé Data

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R1	Proteaceae	<i>Banksia attenuata</i>		Upper	30_10	10
R1	Proteaceae	<i>Banksia ilicifolia</i>		Upper	30_10	10
R1	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	70_30	8
R1	Loranthaceae	<i>Nuytsia floribunda</i>		Upper	<2T10	10
R1	Iridaceae	<i>Patersonia occidentalis</i>		Lower	<10	0.5
R1	Restionaceae	<i>Desmocladius flexuosus</i>		Lower	70_30	0.3
R1	Dilleniaceae	<i>Hibbertia hypericoides</i>		Lower	<2N	0.5
R1	Fabaceae	<i>Hovea trisperma</i>		Lower	<2T10	0.2
R1	Poaceae	<i>Briza maxima</i>	*	Lower	<2N	0.2
R1	Fabaceae	<i>Gompholobium tomentosum</i>		Lower	<2T10	0.2
R1	Proteaceae	<i>Petrophile linearis</i>		Lower	<2T10	0.3
R1	Anarthriaceae	<i>Lyginia barbata</i>		Lower	<10	0.3
R1	Zamiaceae	<i>Macrozamia riedlei</i>		Lower	<10	0.5
R1	Myrtaceae	<i>Calytrix angulata</i>		Lower	<10	0.1
R1	Myrtaceae	<i>Melaleuca thymoides</i>		Mid	<10	1.5
R1	Colchicaceae	<i>Burchardia congesta</i>		Lower	<2T10	0.5
R1	Asparagaceae	<i>Lomandra caespitosa</i>		Lower	<2N	0.3
R1	Stylidiaceae	<i>Stylidium brunonianum</i>		Lower	<10	0.3
R1	Ericaceae	<i>Leucopogon parviflorus</i>		Lower	<2T10	0.2
R1	Proteaceae	<i>Banksia menziesii</i>		Upper	30_10	8
R1 opp	Casuarinaceae	<i>Allocasuarina fraseriana</i>		Upper	opp	15
R1 opp	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Lower	opp	0.5
R1 opp	Hemerocallidaceae	<i>Johnsonia pubescens</i> subsp. <i>cygnorum</i>	P2	Lower	opp	0.3
R1 opp	Dilleniaceae	<i>Hibbertia vaginata</i>		Lower	opp	0.3
R1 opp	Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>		Mid	opp	1
R1 opp	Hemerocallidaceae	<i>Tricoryne elatior</i>		Lower	opp	0.3
R2	Myrtaceae	<i>Corymbia calophylla</i>		Upper	<10	20

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R2	Loranthaceae	<i>Nuytsia floribunda</i>		Upper	<2T10	15
R2	Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>		Mid	<10	1.5
R2	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	70_30	3
R2	Orobanchaceae	<i>Orobanche minor</i>	*	Lower	<2N	0.3
R2	Asteraceae	<i>Ursinia anthemoides</i>	*	Lower	<10	0.1
R2	Poaceae	<i>Ehrharta calycina</i>	*	Lower	<2N	0.3
R2	Dilleniaceae	<i>Hibbertia hypericoides</i>		Lower	<2N	0.5
R2	Commelinaceae	<i>Cartonema philyroides</i>		Lower	<2N	0.3
R2	Poaceae	<i>Rytidosperma</i> sp.		Lower	<2N	0.3
R2	Restionaceae	<i>Desmocladius flexuosus</i>		Lower	<2N	0.1
R2	Poaceae	<i>Aira caryophyllea</i>	*	Lower	<2N	0.1
R2 opp	Asteraceae	<i>Sonchus oleraceus</i>	*	Lower	opp	0.2
R2 opp	Solanaceae	<i>Solanum nigrum</i>	*	Lower	opp	0.2
R2 opp	Proteaceae	<i>Stirlingia latifolia</i>		Lower	opp	0.5
R2 opp	Asteraceae	<i>Podotheca angustifolia</i>		Lower	opp	0.2
R2 opp	Asteraceae	<i>Hyalosperma cotula</i>		Lower	opp	0.1
R2 opp	Primulaceae	<i>Lysimachia arvensis</i>	*	Lower	opp	0.1
R2 opp	Araceae	<i>Zantedeschia aethiopica</i>	*DP	Lower	opp	0.5
R2 opp	Asparagaceae	<i>Dichopogon capillaris</i>		Lower	opp	0.3
R2 opp	Asteraceae	<i>Lagenophora huegelii</i>		Lower	opp	0.1
R2 opp	Fabaceae	<i>Hardenbergia comptoniana</i>		Lower	opp	cr
R2 opp	Asteraceae	<i>Arctotheca calendula</i>	*	Lower	opp	0.1
R2 opp	Geraniaceae	<i>Pelargonium capitatum</i>	*	Lower	opp	0.2
R3	Myrtaceae	<i>Eucalyptus rudis</i>		Upper	30_10	20
R3	Myrtaceae	<i>Melaleuca preissiana</i>		Upper	30_10	10
R3	Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>		Mid	30_10	1.5
R3	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	70_30	8

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R3	Iridaceae	<i>Patersonia occidentalis</i>		Lower	<10	0.5
R3	Cyperaceae	<i>Lepidosperma</i> sp.		Lower	30_10	0.5
R3	Restionaceae	<i>Leptocarpus coangustatus</i>		Lower	<10	0.5
R3	Juncaceae	<i>Juncus pallidus</i>		Lower	<10	0.5
R3	Asteraceae	<i>Ursinia anthemoides</i>	*	Lower	<2N	0.2
R3	Dilleniaceae	<i>Hibbertia hypericoides</i>		Lower	<2N	0.2
R3	Commelinaceae	<i>Cartonema philydroides</i>		Lower	<2N	0.2
R3	Fabaceae	<i>Acacia saligna</i>		Mid	<2T10	1
R3	Araliaceae	<i>Trachymene pilosa</i>		Lower	<2N	0.1
R3	Poaceae	<i>Ehrharta calycina</i>	*	Lower	<2N	0.2
R3	Dennstaedtiaceae	<i>Pteridium esculentum</i>		Lower	<10	0.5
R3	Cyperaceae	<i>Mesomelaena pseudostygia</i>		Lower	<2T10	0.5
R3	Orchidaceae	<i>Pyrorchis nigricans</i>		Lower	<2T10	0.1
R3	Asparagaceae	<i>Laxmannia squarrosa</i>		Lower	<2T10	0.1
R3	Violaceae	<i>Hybanthus calycinus</i>		Lower	<2T10	0.2
R3 opps	Asparagaceae	<i>Asparagus asparagoides</i>	*DP & WoNS	Lower	opp	cr
R3 opps	Casuarinaceae	<i>Allocasuarina fraseriana</i>		Upper	opp	15
R3 opps	Myrtaceae	<i>Corymbia calophylla</i>		Upper	opp	20
R4	Myrtaceae	<i>Eucalyptus marginata</i>		Upper	<10	20
R4	Casuarinaceae	<i>Allocasuarina fraseriana</i>		Upper	30_10	15
R4	Proteaceae	<i>Banksia menziesii</i>		Upper	30_10	10
R4	Proteaceae	<i>Banksia ilicifolia</i>		Upper	<10	10
R4	Proteaceae	<i>Banksia attenuata</i>		Upper	30_10	10
R4	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	30_10	3
R4	Proteaceae	<i>Stirlingia latifolia</i>		Lower	30_10	0.5
R4	Proteaceae	<i>Petrophile linearis</i>		Lower	<10	0.2
R4	Restionaceae	<i>Desmocladius flexuosus</i>		Lower	30_10	0.1

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R4	Dasygogonaceae	<i>Dasygogon bromeliifolius</i>		Lower	30_10	0.2
R4	Dilleniaceae	<i>Hibbertia vaginata</i>		Lower	<2N	0.3
R4	Asteraceae	<i>Hyalosperma cotula</i>		Lower	<2T10	0.1
R4	Iridaceae	<i>Patersonia occidentalis</i>		Lower	<10	0.3
R4 opp	Hemerocallidaceae	<i>Tricoryne elatior</i>		Lower	opp	0.1
R4 opp	Droseraceae	<i>Drosera</i> sp.		Lower	opp	0.1
R4 opp	Xanthorrhoeaceae	<i>Chamaescilla corymbosa</i>		Lower	opp	0.1
R4 opp	Orchidaceae	<i>Prasophyllum</i> sp.		Lower	opp	0.1
R4 opp	Stylidiaceae	<i>Stylidium</i> sp.		Lower	opp	0.1
R4 opp	Asteraceae	<i>Ursinia anthemoides</i>	*	Lower	opp	0.1
R4 opp	Colchicaceae	<i>Burchardia congesta</i>		Lower	opp	0.2
R4 opp	Proteaceae	<i>Xylomelum occidentale</i>		Upper	opp	8
R4 opp	Haemodoraceae	<i>Conostylis juncea</i>		Lower	opp	0.2
R4 opp	Asparagaceae	<i>Thysanotus ?arenarius</i>		Lower	opp	0.2
R4 opp	Restionaceae	<i>Desmocladius fasciculatus</i>		Lower	opp	0.1
R4 opp	Poaceae	<i>Austrostipa compressa</i>		Lower	opp	0.2
R4 opp	Polygalaceae	<i>Comesperma calymega</i>		Lower	opp	0.2
R5	Myrtaceae	<i>Corymbia calophylla</i>		Upper	<2T10	15
R5	Myrtaceae	<i>Melaleuca preissiana</i>		Upper	30_10	10
R5	Cyperaceae	<i>Lepidosperma</i> sp.		Lower	<10	0.5
R5	Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>		Mid	<10	1.5
R5	Poaceae	<i>Briza maxima</i>	*	Lower	<2N	0.3
R5	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	<2T10	5
R5	Poaceae	<i>Ehrharta calycina</i>	*	Lower	<2T10	0.3
R5	Poaceae	<i>Hordeum leporinum</i>	*	Lower	<2N	0.3
R5	Poaceae	<i>Lolium</i> sp.	*	Lower	<2N	0.3
R5	Restionaceae	<i>Dielsia stenostachya</i>		Lower	70_30	0.2

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R5	Asteraceae	<i>Ursinia anthemoides</i>	*	Lower	<2N	0.2
R5	Orobanchaceae	<i>Orobanche minor</i>	*	Lower	<2N	0.3
R5	Myrtaceae	<i>Astartea</i> sp.		Mid	30_10	1.5
R5	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Lower	<10	0.3
R6	Proteaceae	<i>Banksia attenuata</i>		Upper	<10	12
R6	Proteaceae	<i>Banksia ilicifolia</i>		Upper	30_10	10
R6	Myrtaceae	<i>Melaleuca preissiana</i>		Upper	<10	10
R6	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	70_30	5
R6	Asteraceae	<i>Zantedeschia aethiopica</i>	*DP	Lower	<10	0.5
R6	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Lower	30_10	0.3
R6	Poaceae	<i>Ehrharta calycina</i>	*	Lower	<2N	0.3
R6	Asteraceae	<i>Ursinia anthemoides</i>	*	Lower	<2N	0.2
R6	Poaceae	<i>Bromus diandrus</i>	*	Lower	<2N	0.2
R6	Hemerocallidaceae	<i>Tricoryne elatior</i>		Lower	<2T10	0.2
R6	Myrtaceae	<i>Eucalyptus marginata</i>		Upper	<2T10	10
R6	Restionaceae	<i>Desmocladius fasciculatus</i>		Lower	<2N	0.2
R7	Proteaceae	<i>Banksia ilicifolia</i>		Upper	<10	15
R7	Proteaceae	<i>Banksia menziesii</i>		Upper	<2N	10
R7	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	70_30	5
R7	Poaceae	<i>Briza maxima</i>	*	Lower	<2N	0.2
R7	Asteraceae	<i>Ursinia anthemoides</i>	*	Lower	<2N	0.2
R7	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Lower	<10	0.3
R7	Restionaceae	<i>Desmocladius flexuosus</i>		Lower	30_10	0.2
R7	Proteaceae	<i>Banksia attenuata</i>		Upper	<2T10	10
R7	Araceae	<i>Zantedeschia aethiopica</i>	*DP	Lower	<2N	0.5
R8	Proteaceae	<i>Banksia ilicifolia</i>		Upper	30_10	12
R8	Proteaceae	<i>Banksia menziesii</i>		Upper	<10	10

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R8	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	70_30	5
R8	Restionaceae	<i>Desmocladius flexuosus</i>		Lower	30_10	0.3
R8	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Lower	30_10	0.3
R8	Araliaceae	<i>Trachymene pilosa</i>		Lower	<2N	0.1
R8	Myrtaceae	<i>Melaleuca thymoides</i>		Mid	<2N	1.5
R8	Proteaceae	<i>Banksia attenuata</i>		Upper	<2N	8
R8	Hemerocallidaceae	<i>Corynotheca micrantha</i>		Lower	30_10	0.2
R8	Violaceae	<i>Hybanthus calycinus</i>		Lower	<10	0.2
R9	Proteaceae	<i>Banksia menziesii</i>		Upper	<10	8
R9	Casuarinaceae	<i>Allocasuarina fraseriana</i>		Upper	30_10	10
R9	Myrtaceae	<i>Eucalyptus marginata</i>		Upper	30_10	20
R9	Proteaceae	<i>Banksia attenuata</i>		Upper	<10	10
R9	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	30_10	4
R9	Proteaceae	<i>Adenanthos cygnorum</i>		Mid	<10	2
R9	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Lower	<10	0.5
R9	Iridaceae	<i>Patersonia occidentalis</i>		Lower	30_10	0.5
R9	Myrtaceae	<i>Calytrix angulata</i>		Lower	30_10	0.2
R9	Asparagaceae	<i>Thysanotus ?arenarius</i>		Lower	<10	0.1
R9	Restionaceae	<i>Desmocladius flexuosus</i>		Lower	30_10	0.2
R9	Fabaceae	<i>Gompholobium tomentosum</i>		Lower	30_10	0.2
R9	Xanthorrhoeaceae	<i>Chamaescilla corymbosa</i>		Lower	<10	0.1
R9	Dilleniaceae	<i>Hibbertia hypericoides</i>		Lower	<2N	0.5
R9	Proteaceae	<i>Petrophile linearis</i>		Lower	<2N	0.3
R9	Droseraceae	<i>Drosera</i> sp.		Lower	<2T10	0.1
R9	Ericaceae	Ericaceae sp.		Lower	<2T10	0.3
R9	Proteaceae	<i>Stirlingia latifolia</i>		Mid	<2T10	1
R9	Myrtaceae	<i>Melaleuca thymoides</i>		Mid	<2T10	1.5

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R9	Dilleniaceae	<i>Hibbertia vaginata</i>		Lower	<2T10	0.3
R9	Hemerocallidaceae	<i>Tricoryne elatior</i>		Lower	<2T10	0.1
R9	Haemodoraceae	<i>Conostylis aculeata</i>		Lower	<2T10	0.1
R10	Myrtaceae	<i>Eucalyptus rudis</i>		Upper	70_30	25
R10	Myrtaceae	<i>Astartea</i> sp.		Mid	30_10	2
R10	Cyperaceae	<i>Lepidosperma longitudinale</i>		Mid	<10	2
R10	Dennstaedtiaceae	<i>Pteridium esculentum</i>		Mid	100_70	1.5
R10	Papaveraceae	<i>Fumaria capreolata</i>	*	Lower	<10	0.3
R10	Fabaceae	<i>Acacia saligna</i>		Mid	<2T10	1.5
R10	Oxalidaceae	<i>Oxalis pes-caprae</i>	*	Lower	<2T10	0.1
R10	Juncaginaceae	<i>Triglochin</i> sp.		Lower	<10	0.3
R10 opp	Proteaceae	<i>Banksia grandis</i>		Upper	opp	10
R10 opp	Cyperaceae	<i>Ficinia nodosa</i>		Mid	opp	1.5
R11	Myrtaceae	<i>Melaleuca preissiana</i>		Upper	30_10	10
R11	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	<2N	5
R11	Restionaceae	<i>Dielsia stenostachya</i>		Lower	100_70	0.2
R11	Restionaceae	<i>Hypolaena exsulca</i>		Lower	30_10	0.2
R11	Poaceae	<i>Bromus diandrus</i>	*	Lower	<10	0.2
R11	Poaceae	<i>Ehrharta calycina</i>	*	Lower	<10	0.2
R11	Asteraceae	<i>Hypochaeris glabra</i>	*	Lower	<10	0.1
R11	Poaceae	<i>Briza maxima</i>	*	Lower	<10	0.2
R11	Araceae	<i>Zantedeschia aethiopica</i>	*DP	Lower	<2T10	0.5
R11	Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>		Lower	<2T10	0.5
R11	Poaceae	<i>Lolium</i> sp.		Lower	<2N	0.3
R11	Caryophyllaceae	<i>Cerastium glomeratum</i>	*	Lower	<2N	0.2
R11	Poaceae	<i>Briza minor</i>	*	Lower	<2N	0.2
R11	Iridaceae	<i>Patersonia occidentalis</i>		Lower	<2N	0.5

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R11	Asteraceae	<i>Arctotheca calendula</i>	*	Lower	<2N	0.2
R12	Myrtaceae	<i>Eucalyptus rudis</i>		Upper	30_10	20
R12	Myrtaceae	<i>Melaleuca preissiana</i>		Upper	30_10	10
R12	Myrtaceae	<i>Melaleuca raphiophylla</i>		Upper	30_10	8
R12	Restionaceae	<i>Dielsia stenostachya</i>		Lower	100_70	0.2
R12	Restionaceae	<i>Hypolaena exsulca</i>		Lower	30_10	0.2
R12	Cyperaceae	<i>Lepidosperma</i> sp.		Lower	<10	0.5
R12	Orchidaceae	Orchidaceae sp.		Lower	<10	0.5
R12	Araceae	<i>Zantedeschia aethiopica</i>	*DP	Lower	<2N	0.3
R12	Poaceae	<i>Lolium</i> sp.	*	Lower	<2N	0.3
R12	Poaceae	<i>Briza maxima</i>	*	Lower	<2N	0.3
R12	Poaceae	<i>Bromus diandrus</i>	*	Lower	<2N	0.5
R12	Asteraceae	<i>Conyza sumatrensis</i>	*	Lower	<2N	0.3
R12	Violaceae	<i>Hybanthus calycinus</i>		Lower	<2N	0.3
R12	Poaceae	<i>Briza minor</i>	*	Mid	<10	1.5
R12	Juncaceae	<i>Juncus pallidus</i>		Mid	<2T10	1.5
R12	Asparagaceae	<i>Thysanotus ?arenarius</i>		Lower	<2T10	0.3
R12	Hemerocallidaceae	<i>Caesia occidentalis/micrantha</i>		Lower	<2T10	0.3
R12	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	<2T10	4
R13	Proteaceae	<i>Banksia ilicifolia</i>		Upper	30_10	15
R13	Proteaceae	<i>Banksia menziesii</i>		Upper	<10	12
R13	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	70_30	5
R13	Dennstaedtiaceae	<i>Pteridium esculentum</i>		Mid	70_30	1.5
R13	Poaceae	<i>Briza maxima</i>	*	Lower	<2N	0.3
R13	Araceae	<i>Zantedeschia aethiopica</i>	*DP	Lower	<2N	0.5
R13	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Lower	<2N	0.5
R13	Proteaceae	<i>Banksia attenuata</i>		Upper	<10	8

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R14	Casuarinaceae	<i>Allocasuarina fraseriana</i>		Upper	<10	15
R14	Proteaceae	<i>Banksia attenuata</i>		Upper	30_10	10
R14	Proteaceae	<i>Banksia menziesii</i>		Upper	30_10	10
R14	Proteaceae	<i>Xylomelum occidentale</i>		Upper	<10	10
R14	Myrtaceae	<i>Eucalyptus marginata</i>		Upper	30_10	15
R14	Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>		Mid	<10	1.5
R14	Proteaceae	<i>Stirlingia latifolia</i>		Lower	30_10	0.5
R14	Ericaceae	<i>Leucopogon propinquus</i>		Lower	<2T10	0.5
R14	Araceae	<i>Zantedeschia aethiopica</i>	*DP	Lower	<2N	0.5
R14	Asteraceae	<i>Hypochaeris glabra</i>	*	Lower	<10	0.1
R14	Asteraceae	<i>Ursinia anthemoides</i>	*	Lower	<10	0.2
R14	Poaceae	<i>Briza maxima</i>	*	Lower	<10	0.2
R14	Restionaceae	<i>Desmocladius flexuosus</i>		Lower	<10	0.2
R14	Hemerocallidaceae	<i>Tricoryne elatior</i>		Lower	<2T10	0.2
R14	Poaceae	<i>Ehrharta calycina</i>	*	Lower	<2N	0.3
R14	Asparagaceae	<i>Thysanotus patersonii/manglesianus</i>		Lower	<2T10	CR
R15	Proteaceae	<i>Banksia menziesii</i>		Upper	30_10	8
R15	Proteaceae	<i>Xylomelum occidentale</i>		Upper	30_10	8
R15	Myrtaceae	<i>Eucalyptus marginata</i>		Upper	30_10	20
R15	Proteaceae	<i>Banksia attenuata</i>		Upper	30_10	10
R15	Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>		Mid	<10	1.5
R15	Casuarinaceae	<i>Allocasuarina fraseriana</i>		Upper	30_10	10
R15	Asteraceae	<i>Hypochaeris glabra</i>	*	Lower	<2N	0.1
R15	Araliaceae	<i>Trachymene pilosa</i>		Lower	<2N	0.1
R15	Asteraceae	<i>Ursinia anthemoides</i>	*	Lower	<2N	0.1
R15	Restionaceae	<i>Desmocladius fasciculatus</i>		Lower	<2N	0.2
R15	Iridaceae	<i>Romulea rosea</i>	*	Lower	<2N	0.1

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R15	Dilleniaceae	<i>Hibbertia hypericoides</i>		Lower	<2T10	0.3
R15	Asteraceae	<i>Hyalosperma cotula</i>		Lower	<2N	0.1
R15	Asteraceae	<i>Lagenophora huegelii</i>		Lower	<2T10	0.1
R15	Restionaceae	<i>Desmocladius flexuosus</i>		Lower	<2T10	0.2
R15	Proteaceae	<i>Briza maxima</i>	*	Lower	<2T10	0.1
R15	Fabaceae	<i>Kennedia prostrata</i>		Lower	<2T10	cr
R16	Myrtaceae	<i>Melaleuca preissiana</i>		Upper	30_10	10
R16	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	70_30	4
R16	Proteaceae	<i>Xylomelum occidentale</i>		Upper	<2T10	10
R16	Casuarinaceae	<i>Allocasuarina fraseriana</i>		Upper	<2T10	15
R16	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Lower	30_10	0.5
R16	Myrtaceae	<i>Calytrix angulata</i>		Lower	30_10	0.2
R16	Anarthriaceae	<i>Lyginia imberbis</i>		Lower	30_10	0.3
R17	Myrtaceae	<i>Melaleuca preissiana</i>		Upper	30_10	12
R17	Proteaceae	<i>Banksia menziesii</i>		Upper	30_10	10
R17	Proteaceae	<i>Banksia attenuata</i>		Upper	<10	10
R17	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	70_30	5
R17	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Lower	<10	0.5
R17	Myrtaceae	<i>Astartea</i> sp.		Mid	<10	1
R17	Anarthriaceae	<i>Lyginia imberbis</i>		Lower	<2T10	0.5
R17	Loranthaceae	<i>Nuytsia floribunda</i>		Upper	<2T10	15
R18	Myrtaceae	<i>Corymbia calophylla</i>		Upper	<10	20
R18	Casuarinaceae	<i>Allocasuarina fraseriana</i>		Upper	<10	15
R18	Myrtaceae	<i>Eucalyptus marginata</i>		Upper	<2T10	20
R18	Proteaceae	<i>Banksia menziesii</i>		Upper	30_10	15
R18	Proteaceae	<i>Banksia attenuata</i>		Upper	30_10	15
R18	Proteaceae	<i>Xylomelum occidentale</i>		Upper	<10	10

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R18	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	70_30	5
R18	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Lower	<10	0.3
R18	Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>		Mid	<2T10	1.5
R18	Anarthriaceae	<i>Lyginia imberbis</i>		Lower	<2T10	0.3
R18	Proteaceae	<i>Banksia grandis</i>		Upper	<2T10	8
R18	Restionaceae	<i>Desmocladius flexuosus</i>		Lower	<2T10	0.3
R18	Iridaceae	<i>Patersonia occidentalis</i>		Lower	<2T10	0.3
R19	Casuarinaceae	<i>Allocasuarina fraseriana</i>		Upper	<10	15
R19	Proteaceae	<i>Banksia menziesii</i>		Upper	30_10	15
R19	Myrtaceae	<i>Eucalyptus marginata</i>		Upper	<10	20
R19	Proteaceae	<i>Banksia attenuata</i>		Upper	30_10	10
R19	Proteaceae	<i>Xylomelum occidentale</i>		Upper	<10	10
R19	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	30_10	5
R19	Iridaceae	<i>Patersonia occidentalis</i>		Lower	70_30	0.5
R19	Proteaceae	<i>Stirlingia latifolia</i>		Lower	30_10	0.5
R19	Restionaceae	<i>Desmocladius flexuosus</i>		Lower	30_10	0.3
R19	Zamiaceae	<i>Macrozamia riedlei</i>		Lower	<10	0.3
R19	Violaceae	<i>Hybanthus calycinus</i>		Lower	<10	0.2
R19	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Lower	<10	0.5
R19	Dilleniaceae	<i>Hibbertia hypericoides</i>		Lower	<10	0.5
R19	Proteaceae	<i>Petrophile linearis</i>		Lower	<2T10	0.2
R19	Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>		Lower	<2T10	0.5
R20	Myrtaceae	<i>Corymbia calophylla</i>		Upper	30_10	20
R20	Myrtaceae	<i>Eucalyptus marginata</i>		Upper	30_10	20
R20	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	70_30	5
R20	Fabaceae	<i>Acacia floribunda</i>	*	Upper	<2T10	5
R20	Proteaceae	<i>Banksia ilicifolia</i>		Upper	<2T10	10

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R20	Poaceae	<i>Briza maxima</i>	*	Lower	30_10	0.2
R20	Fabaceae	<i>Hardenbergia comptoniana</i>		Lower	<2T10	CR
R21	Myrtaceae	<i>Melaleuca preissiana</i>		Upper	30_10	10
R21	Myrtaceae	<i>Eucalyptus marginata</i>		Upper	<2T10	20
R21	Myrtaceae	<i>Corymbia calophylla</i>		Upper	30_10	20
R21	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	100_70	5
R21	Fabaceae	<i>Acacia saligna</i>		Upper	<10	3
R21	Dennstaedtiaceae	<i>Pteridium esculentum</i>		Lower	100_70	0.5
R21	Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>		Mid	<2T10	2

Appendix D – Fauna data

Black Cockatoo potential breeding tree and foraging data

Conservation significant fauna evidence

Black Cockatoo potential breeding tree and foraging data

Tree Density Plot No.	Tree species	DBH (cm)	Tree density (trees/ hectare)	Black Cockatoo Foraging value	Fauna habitat type	Easting	Northing
1	Jarrah	100	8	high	Mixed Eucalyptus Banksia Sheoak woodland	397199	6420593
	Jarrah	80					
2	Marri	65	4	moderate	Mixed Eucalyptus Banksia Sheoak woodland	397514	6420550
3	Marri	60	16	moderate	Mixed Eucalyptus Banksia Sheoak woodland	397545	6420466
	Marri	70					
	Marri	80					
	Marri	80					
4	nil		0	high	Mixed Eucalyptus Banksia Sheoak woodland	397770	6420480
5	Marri	55	8	moderate	Scattered native trees	398087	6420567
	Marri	80					
6	Jarrah	80	12	high	Mixed Eucalyptus Banksia Sheoak woodland	398251	6420797
	Jarrah	70					
	Jarrah	80					
7	Marri	80	8	high	Mixed Eucalyptus Banksia Sheoak woodland	398412	6420558
	Marri	90					
8	Marri	51	8	high	Mixed Eucalyptus Banksia Sheoak woodland	398575	6420641
	Marri	55					
9	nil		0	low	Scattered native trees	398618	6420436
10	Flooded Gum	60	4	low	Flooded Gum Melaleuca woodland	395936	6420373
11	nil		0	moderate	Flooded Gum Melaleuca woodland	395923	6420463
12	Jarrah	51	4	low	Mixed Eucalyptus Banksia Sheoak woodland	396077	6420601
13	Jarrah	90	12	moderate	Mixed Eucalyptus Banksia Sheoak woodland	396478	6420642
	Jarrah	60					
	Jarrah	65					

Tree Density Plot No.	Tree species	DBH (cm)	Tree density (trees/ hectare)	Black Cockatoo Foraging value	Fauna habitat type	Easting	Northing
15	Flooded Gum	51	76	low	Riparian	397143	6421690
	Flooded Gum	65					
	Flooded Gum	60					
	Flooded Gum	65					
	Flooded Gum	60					
	Flooded Gum	55					
	Flooded Gum	60					
	Flooded Gum	65					
	Flooded Gum	55					
	Flooded Gum	55					
	Flooded Gum	51					
	Flooded Gum	55					
	Flooded Gum	51					
	Flooded Gum	51					
	Flooded Gum	55					
	Flooded Gum	70					
	Flooded Gum	65					
	Flooded Gum	55					
	Flooded Gum	65					
16	Flooded Gum	75	56	low	Riparian	397523	6421709
	Flooded Gum	75					
	Flooded Gum	65					
	Flooded Gum	51					
	Flooded Gum	60					
	Flooded Gum	51					
	Flooded Gum	65					

Tree Density Plot No.	Tree species	DBH (cm)	Tree density (trees/ hectare)	Black Cockatoo Foraging value	Fauna habitat type	Easting	Northing
	Flooded Gum	70					
	Flooded Gum	51					
	Flooded Gum	65					
	Flooded Gum	60					
	Flooded Gum	65					
	Flooded Gum	51					
	Flooded Gum	51					
17	Tuart	65	32	moderate	Riparian	397615	6421774
	Tuart	85					
	Tuart	85					
	Tuart	90					
	Tuart	60					
	Tuart	65					
	Tuart	80					
	Tuart	65					
18	nil		0	high	Mixed Eucalyptus Banksia Sheoak woodland	397203	6423466
20	nil		0	high	Mixed Eucalyptus Banksia Sheoak woodland	396968	6423393
21	Flooded Gum	90	8	low	Flooded Gum Melaleuca woodland	396657	6423471
	Flooded Gum	60					
22	Marri	75	4	low	Flooded Gum Melaleuca woodland	396951	6423630
23	nil		0	high	Mixed Eucalyptus Banksia Sheoak woodland	397359	6423660
24	Jarrah	65	8	high	Mixed Eucalyptus Banksia Sheoak woodland	397609	6423551
	Jarrah	75					
25	nil		0	moderate	Mixed Eucalyptus Banksia Sheoak woodland	398074	6423458
26	Jarrah	70	12	high	Mixed Eucalyptus Banksia Sheoak woodland	397508	6423324

Tree Density Plot No.	Tree species	DBH (cm)	Tree density (trees/ hectare)	Black Cockatoo Foraging value	Fauna habitat type	Easting	Northing
	Jarrah	90					
	Jarrah	75					
27	Marri	150	4	moderate	Scattered native trees	397267	6424465
28	nil		0	nil	Scattered native trees	397155	6424517
29	Jarrah	65	8	high	Mixed Eucalyptus Banksia Sheoak woodland	397187	6424615
	Jarrah	51					
30	Jarrah	65	8	high	Mixed Eucalyptus Banksia Sheoak woodland	397400	6424740
	Jarrah	100					
31	Jarrah	55	4	high	Mixed Eucalyptus Banksia Sheoak woodland	397075	6424703
32	Jarrah	110	16	high	Mixed Eucalyptus Banksia Sheoak woodland	398743	6424313
	Jarrah	51					
	Jarrah	70					
	Jarrah	65					
33	Flooded Gum	51	4	low	Flooded Gum Melaleuca woodland	398728	6423013
34	Marri	100	8	high	Mixed Eucalyptus Banksia Sheoak woodland	398935	6423056
	Marri	90					
35	nil		0	nil	Scattered native trees	398953	6422505
36	nil		0	nil	Mixed Eucalyptus Banksia Sheoak woodland	398714	6422327
37	Flooded Gum	90	40	low	Riparian	398871	6422134
	Flooded Gum	85					
	Flooded Gum	65					
	Flooded Gum	70					
	Marri	65					
	Flooded Gum	70					
	Flooded Gum	60					
	Flooded Gum	80					

Tree Density Plot No.	Tree species	DBH (cm)	Tree density (trees/ hectare)	Black Cockatoo Foraging value	Fauna habitat type	Easting	Northing
	Flooded Gum	100					
	Flooded Gum	65					
38	Flooded Gum	51	40	low	Riparian	398815	6422153
	Flooded Gum	65					
	Flooded Gum	55					
	Flooded Gum	51					
	Flooded Gum	55					
	Flooded Gum	55					
	Flooded Gum	60					
	Flooded Gum	55					
	Flooded Gum	60					
	Flooded Gum	51					

Conservation significant fauna evidence



Chewed Jarrah - Forest Red-tailed Black Cockatoo



Chewed Allocasuarina fraseriana - Forest Red-tailed Black Cockatoo



Chewed Banksia attenuata – Carnaby's Cockatoo



Chewed Banksia ilicifolia – Carnaby's Cockatoo



Quenda diggings



Carter's Freshwater Mussel

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Appendix D - Lowlands Weed Survey Report

LOWLANDS RESERVE WEED SURVEY - 2019



FINAL

06 February 2020

PREPARED FOR

PREPARED BY





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Midge Richardson Lowlands Homestead Resident (and former owner of reserve)
Mark Angeloni Serpentine-Jarrahdale Shire Environmental Officer

ACRONYMS AND ABBREVIATIONS

The following acronyms and abbreviations are used in this report for succinctness:

DBCA (Western Australian) Department of Biodiversity, Conservation and Attractions
ha hectare
PTA (Western Australian) Public Transport Authority

COVER PHOTO

Photo of *Gladiolus angustus* in Lowlands Reserve

EXECUTIVE SUMMARY

The Public Transport Authority requires offsets to counterbalance significant residual environmental impacts associated with the Yanchep Rail Extension and Thornlie-Cockburn Link projects. One of the offset sites is 'Lowlands Reserve', a 1138 ha Class 'A' Nature Reserve (R 51784) managed by the Department of Biodiversity, Conservation and Attractions for the purpose of 'Conservation of Flora and Fauna', approximately 15 kilometres east of Rockingham.

A weed baseline of Lowlands Reserve was required to inform on-ground management works that will constitute offsets. Field surveys were undertaken over 8 field days from 30 November to 10 December 2019 inclusive. Traverses covered approximately 90 km, with approximately 1,700 observations recorded. Despite the limitations of timing, the mapping appropriately reflects the distribution and abundance of 32 weed species likely to be subject to management (43 weeds recorded onsite were not mapped).

Weed maps were generated of:

- approximately 9 hectares of tree lot plantings, including local and non-local species
- 21 tree and shrub species
 - 1 abundant and widespread
 - 3 widespread
 - 14 in low abundance and/or restricted extent
 - 3 suspected of being weeds onsite as they naturally occur in the region but appear to have established in the reserve as a result of activities such as plantings in nearby areas.
- 9 herb species
 - 1 abundant and widespread
 - 3 widespread
 - 5 low abundance and/or restricted extent
- 2 grasses
 - 2 widespread

The most abundant and widespread weed was *Zantedeschia aethiopica* (Arum Lily), which occurs over more than 135 hectares based on combined data from 2019 low intensity traverses across the entire reserve and 2012 high intensity mapping of the portion of the reserve along the Serpentine River.

Following the 2019 reconnaissance survey, management objectives should be established. Future weed data collection should be developed in the context of these objectives and take the two discrete but complementary forms of surveillance (to detect new occurrences of weeds in an area), and monitoring (to measure changes in abundance and/or extents).

Other datasets should be used in conjunction with the weed mapping in developing a weed management program, and additional associated data collection is recommended.

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1. INTRODUCTION

1.1. BACKGROUND

The Public Transport Authority (PTA) requires offsets to counterbalance the significant residual environmental impacts associated with the Yanchep Rail Extension and Thornlie-Cockburn Link projects that form part of the METRONET Program. One of the offset sites is Lot 301 Lowlands Road Mardella, referred to in this report as the ‘Lowlands Reserve’.

A weed baseline of Lowlands Reserve was required to inform on-ground management works that will constitute offsets.

1.2. LOCATION

The Lowlands Reserve is a 1138 ha Class ‘A’ Nature Reserve (R 51784) managed by the Department of Biodiversity, Conservation and Attractions (DBCA) for the purpose of ‘Conservation Of Flora And Fauna’, approximately 15 kilometres east of Rockingham, as shown in Figure 1.



Figure 1: Location of Survey Area

Basemap © Geoscience Australia – National Mapping Division (2002)

The reserve was historically privately-owned freehold land. The majority of Lots 300 and 301 Lowlands Road were purchased by the Government of Western Australia in 2014, with the remainder (adjoining cleared areas) purchased in 2019 to consolidate and rationalise boundaries.

1.3. SCOPE

The scope of work was:

- Conduct a desktop assessment of background information including:
 - Lowlands Weed Action Calendar (2015-16-17).
 - Lowlands Arum Lily mapping (DEC, 2012).
 - Lowlands Blackberry and Bridal Creeper mapping (DEC, 2012)
 - Lowlands Castor Oil Cottonbush and Freesia mapping (DEC, 2012)
 - Lowlands Access and Dieback Interpretation Map (DPAW, 2016).
 - Scope of Work Guidelines for Weed Mapping Lowlands Nature Reserve 2019 (DBCA, 2019).
 - Lowlands Draft Hygiene Management Plan (DPAW, 2013)
 - Management of Phytophthora dieback in Lowlands Nature Reserve (Government of Western Australia, 2018).
 - Lowlands Nature Reserve Access Management Information (Government of Western Australia, no date).
- Conduct weed mapping of the entire Lowlands Site (refer to Figure 1, attached) in accordance with the following guidance documents:
 - Techniques for mapping weed distribution and cover in bushlands and wetlands Standard Operating Procedure (SOP) No: 22.1 (Department of Environment and Conservation, 2011).
 - Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (Government of Western Australia, 2016).
 - Site specific dieback management procedures including the Lowlands Access and Dieback Interpretation Map (DPAW, 2016), Lowlands Draft Hygiene Management Plan (DPAW, 2013) and Management of Phytophthora dieback in Lowlands Nature Reserve (Government of Western Australia, 2018).
- Prepare a short report summarising the results of the weed mapping with references to weed maps prepared in accordance with the Techniques for mapping weed distribution and cover in bushlands and wetlands Standard Operating Procedure (SOP) No: 22.1 (Department of Environment and Conservation, 2011)
- Liaison with officers from the DBCA as required.
- Provision of all spatial data (compatible with ArcGIS in MGA Zone 50).

The survey methodology, refined through consultation with, and approved by, DBCA and PTA, was a reconnaissance survey:

- focused on weeds likely to be subject to management, DBCA indicated Perennial Veldt Grass was the only grass to be targeted;
- based on traverses:
 - along tracks/firebreaks, clearings, reserve perimeter and the Serpentine River;
 - in the reserve's interior at approximately 500 metres spacing;
- with initial fieldwork (excluding woody weeds) completed by 30 December; and
- with fieldwork ceasing if wet soil conditions occurred, to limit spread of *Phytophthora cinnamomi* (Dieback).

2. METHODS

2.1. TIMING

Field surveys were undertaken over 8 field days from 30 November to 10 December 2019 inclusive. Whilst field surveys were commenced within 3 days of finalising contractual and access arrangements, the timing was sub-optimum given Perth experienced its earliest recorded 40-degree December day on December 3, after having its first ever 40-degree November day on record on 16 November (Ceranic, 2019).

Fieldwork was not interrupted by wet soil conditions, as would have been required if it had occurred, to limit spread of *Phytophthora cinnamomi* (Dieback).

During the survey, some species were only detectable on the basis of dead material (e.g. *Moraea flaccida* (One-Leaf Cape Tulip) shown in Photo 1).

Identification of *Ehrharta calycina* (Perennial Veldt Grass) was problematic given none of the terrestrial grasses retained seed or colour at the time of the survey, the similar *Ehrharta longiflora* (Annual Veldt Grass) was also present, where observed *Ehrharta* species tended to occur in very low density (Photo 2), grass species tended to intermingle. At the time of the survey, both *Ehrharta* species' inflorescences had shed seed, and were yellow. Height was not used diagnostically, although many plants appeared less robust than would usually be expected of *Ehrharta calycina* (Perennial Veldt Grass) on the Swan Coastal Plain.

The detectability of some weeds declined significantly during the survey period (e.g. *Zantedeschia aethiopica* (Arum Lily) shown in Photo 3 and Photo 4).

To address detectability issues most traverses were walked, regardless of whether vehicle access was available, or tracks had already been driven. Additional walking was undertaken to limit fire risk associated with driving vehicles over dead grasses on very hot days.

Despite the limitations of timing, it is considered the weed mapping appropriately reflects the situation, and the scope was fulfilled in identifying key species and their broad distribution onsite.



Photo 1: Remnants of *Moraea flaccida* (One-Leaf Cape Tulip)



Photo 2: Remnants of *Ehrharta species* (Veldt Grass)



Photo 3: Dying Back of *Zantedeschia aethiopica* (Arum Lily)



Photo 4: Remnants of *Zantedeschia aethiopica* (Arum Lily)

2.1. TRAVERSES

Traverses, excluding multiple trips along tracks, covered approximately 90 km (Figure 2). Midge Richardson allowed traverses to extend into her adjacent property.

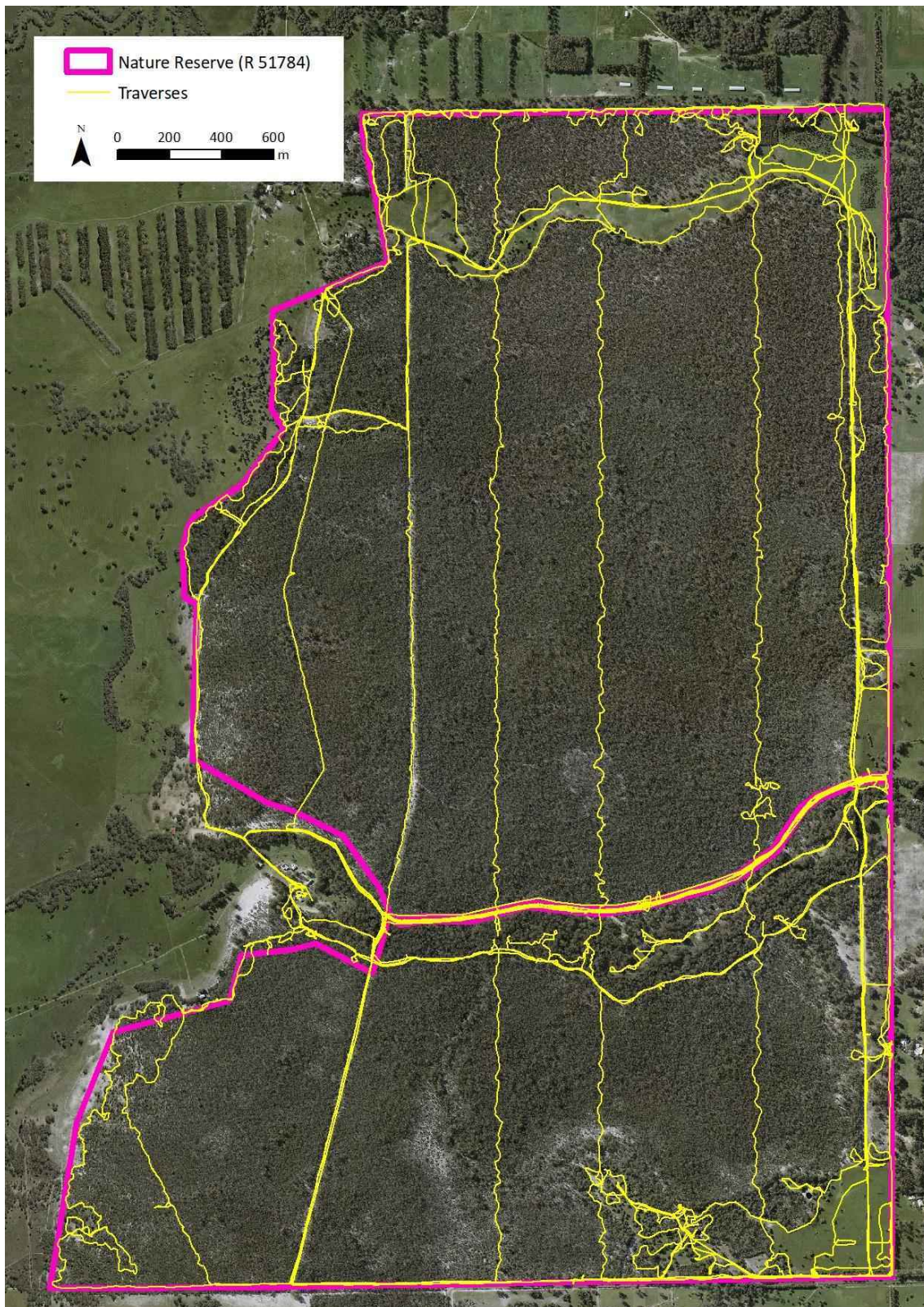


Figure 2: Survey Traverses

Approximately 1,700 observations with GPS locations were recorded. The objective of the reconnaissance was to provide an indication of patterns across the reserve and whilst every record represents an observation of a plant, not every individual of every weed was recorded.

Visibility and access was highly variable across the reserve (Photo 5 to Photo 10).



Photo 5: Limited Access/Visibility in *Banksia attenuata*/*Banksia menziesii* Woodland



Photo 6: Limited Access/Visibility in *Kunzea ericifolia* Shrubland



Photo 7: Limited Access/Visibility in *Eucalyptus gomphocephala* Woodland



Photo 8: Extensive Access/Visibility in *Banksia attenuata*/*Banksia menziesii* Woodland



Photo 9: Extensive Access/Visibility in *Banksia ilicifolia* Woodland



Photo 10: Extensive Access/Visibility in *Melaleuca preissiana* Woodland

Most traverses were walked, regardless of whether vehicle access was available given the suboptimum timing for detecting weeds.

The length and intensity of traverses were considered sufficient to generate weed maps that appropriately reflect the situation, and the scope was fulfilled in identifying the broad distribution of key species onsite.

2.2. INCORPORATION OF PREVIOUS HISTORIC DATA

Previous high intensity weed surveys of the portion of the reserve along the Serpentine River undertaken by DBCA (as the then Department of Environment and Conservation) included:

- *Asparagus asparagoides* (Bridal Creeper) 2007 and 2015
- *Freesia alba* × *leichtlinii* (Freesia) 2012 and 2015
- *Gomphocarpus fruticosus* (Narrow-Leaf Cottonbush) 2012
- *Leptospermum laevigatum* (Coast Teatree) 2016
- *Pinus species* (Pine Trees) 2015
- *Ricinus communis* (Castor Oil Plant) 2012
- *Rubus species* (Blackberry) 2007 and 2017
- *Zantedeschia aethiopica* (Arum Lily) 2005 and 2012

Previous weed data collected just outside the reserve by DBCA (as the then Department of Environment and Conservation) included:

- *Agapanthus species* (Agapanthus) 2015
- *Carpobrotus edulis* (Pigface) 2015
- *Ehrharta calycina* (Perennial Veldt Grass) 2015
- *Ferraria crispa* (Black Flag) 2015

These earlier datasets should not be compared with the 2019 data to measure change due to differences in survey method and boundaries. The multiple datasets are shown in figures where they provide an indication of a broader distribution than that shown by the 2019 dataset alone (where data largely overlaps only the 2019 is shown for clarity).

2.3. PERSONNEL

Andrew Waters, who undertook all parts of the fieldwork and report writing, is appropriately qualified as a Certified Environmental Practitioner with the Environment Institute of Australia and New Zealand and holding:

- Graduate Certificate GIS (with distinction), Curtin University;
- Bachelor of Science (Environmental Science), Murdoch University;
- Advanced Certificate of Horticulture, Challenger TAFE;
- *Phytophthora* Interpretation, Glevan Consulting; and
- *Phytophthora* Management, CALM, 1999.

Since 1997, Andrew has worked in the following 10 bioregions:

- Avon Wheatbelt
- Esperance Plains
- Geraldton Sandplains
- Great Sandy Desert
- Jarrah Forest
- Little Sandy Desert
- Mallee
- Murchison
- Pilbara
- Swan Coastal Plain

3. RESULTS

3.1. WEEDS

3.1.1. PLANTINGS

A number of formerly cleared sites within the reserve have been planted as tree lots, as indicated in Table 1 and Figure 3, and shown in Photo 11 and Photo 12:

- Prior to 2014, Lots 300 and 301 Lowlands Road were privately owned and mixed plantings of local and non-local Australian trees was undertaken; and
- DBCA subsequently planted lots of only *Corymbia calophylla* (Marri).

Table 1: Tree Lot Plantings

Site	Area (ha)	Species include but not limited to (Angeloni, 2019)	Recorded in Native Flora Inventory (Keighery, Keighery, & Gibson, 1995)
1	0.3	<i>Casuarina obesa</i> (Swamp Sheoak)	Yes
+	+	<i>Eucalyptus rudis</i> (Flooded Gum)	Yes
2	0.2	<i>Melaleuca lateritia</i> (Robin Redbreast Bush)	Yes
		<i>Melaleuca cuticularis</i> (Saltwater Paperbark)	No
		<i>Melaleuca viminea</i> (Mohan)	No
3	1.3	<i>Eucalyptus gomphocephala</i> (Tuart)	Yes
		<i>Eucalyptus dundasii</i> (Dundas Blackbutt)	No
		<i>Eucalyptus melliodora</i> (Yellow Box)	No
		<i>Eucalyptus sideroxylon</i> (Red Ironbark)	No
		<i>Eucalyptus platypus</i> (Moort)	No
4	1.5	<i>Eucalyptus marginata</i> (Jarrah) – dieback resistant variety	Yes
		<i>Eucalyptus patens</i> (Swan River Blackbutt)	No
		<i>Eucalyptus melliodora</i> (Yellow Box)	No
		<i>Eucalyptus lane-poolei</i> (Salmon White Gum)	No
		<i>Eucalyptus occidentalis</i> (Flat-topped Yate)	No
5	1.2	<i>Eucalyptus marginata</i> (Jarrah) – dieback resistant variety	Yes
		<i>Eucalyptus patens</i> (Swan River Blackbutt)	No
		<i>Eucalyptus melliodora</i> (Yellow Box)	No
6	0.9	<i>Corymbia calophylla</i> (Marri)	Yes
7	1.6	<i>Corymbia calophylla</i> (Marri)	Yes
8	0.6	<i>Corymbia calophylla</i> (Marri)	Yes
9	1.4	<i>Corymbia calophylla</i> (Marri)	Yes

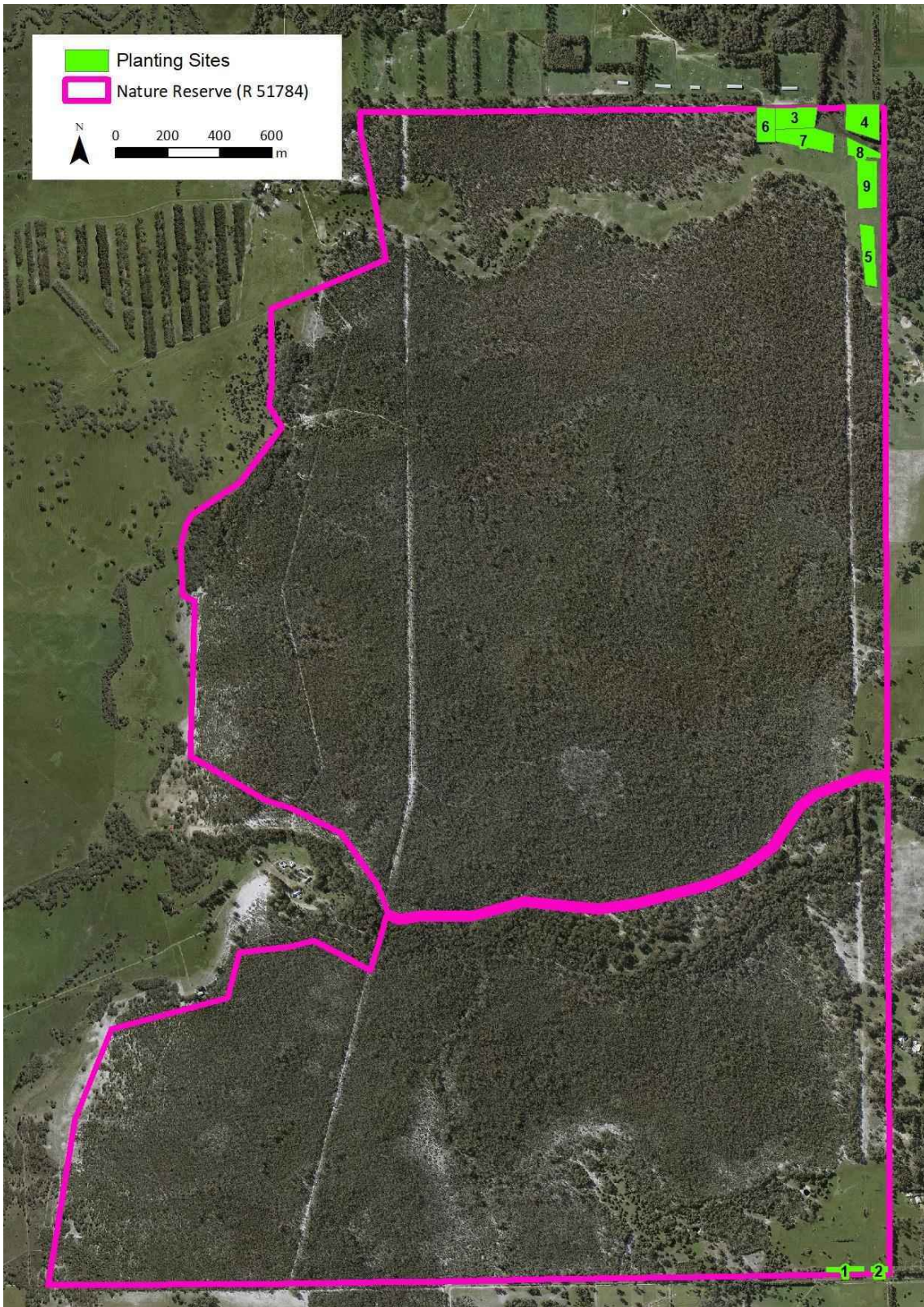


Figure 3: Location of Tree Lot Planting Sites



Photo 11: Plantings at Site 3



Photo 12: Plantings at Site 5

3.1.2. SUSPECTED WEEDS

The three species in Table 2 (with photos included in Appendix 1) are suspected of being weeds onsite as they naturally occur in the Perth Metropolitan Region but have been recorded as having the potential to become ‘weedy’ outside their natural distribution by Keighery (2013) and:

- do not appear to be naturally occurring onsite, although Keighery, Keighery, & Gibson (1995) noted several species onsite more typical of other parts of the Swan Coastal Plain/Ridge Hill Shelf;
- were only observed around periphery of reserve (and on nearby properties/roads);
- have not been planted in the reserve (Richardson, 2019);
- appear to have established in the reserve as a result of activities such as plantings in nearby areas.

Table 2: Suspected Weeds

Weed	Comments
<i>Agonis flexuosa</i> (Peppermint)	<ul style="list-style-type: none"> • 9 plants recorded – not initially targeted and likely more plants • Grows on a variety of soils, but restricted in the Perth Region to calcareous dunes (Dixon, 2011). • Naturally occur along the Swan Estuary downstream from Freshwater Bay (Powell, 2009) with Blackwall Reach possibly being one of the most easterly occurrences (Government of Western Australia, 2000). • May become weedy if fire and soil disturbance is not controlled (Dixon, 2011). • Has the ability to completely alter the structure of communities it invades, and it is currently being removed from Kings Park (Keighery G., 2013)
<i>Callistemon phoeniceus</i> (Lesser Bottlebrush)	<ul style="list-style-type: none"> • 9 plants recorded – not initially targeted and likely more plants • Perth Metropolitan Region is at the western edge of its distribution (Powell, 2009) • In the Perth Metropolitan Region, it grows in the Helena and Avon Valleys (Powell, 2009)
<i>Calothamnus rupestris</i> (Mouse Ears)	<ul style="list-style-type: none"> • 9 plants recorded – not initially targeted and likely more plants • In reserve not growing in typical habitat (usually associated with granite, and to a lesser degree laterite) (Powell, 2009)

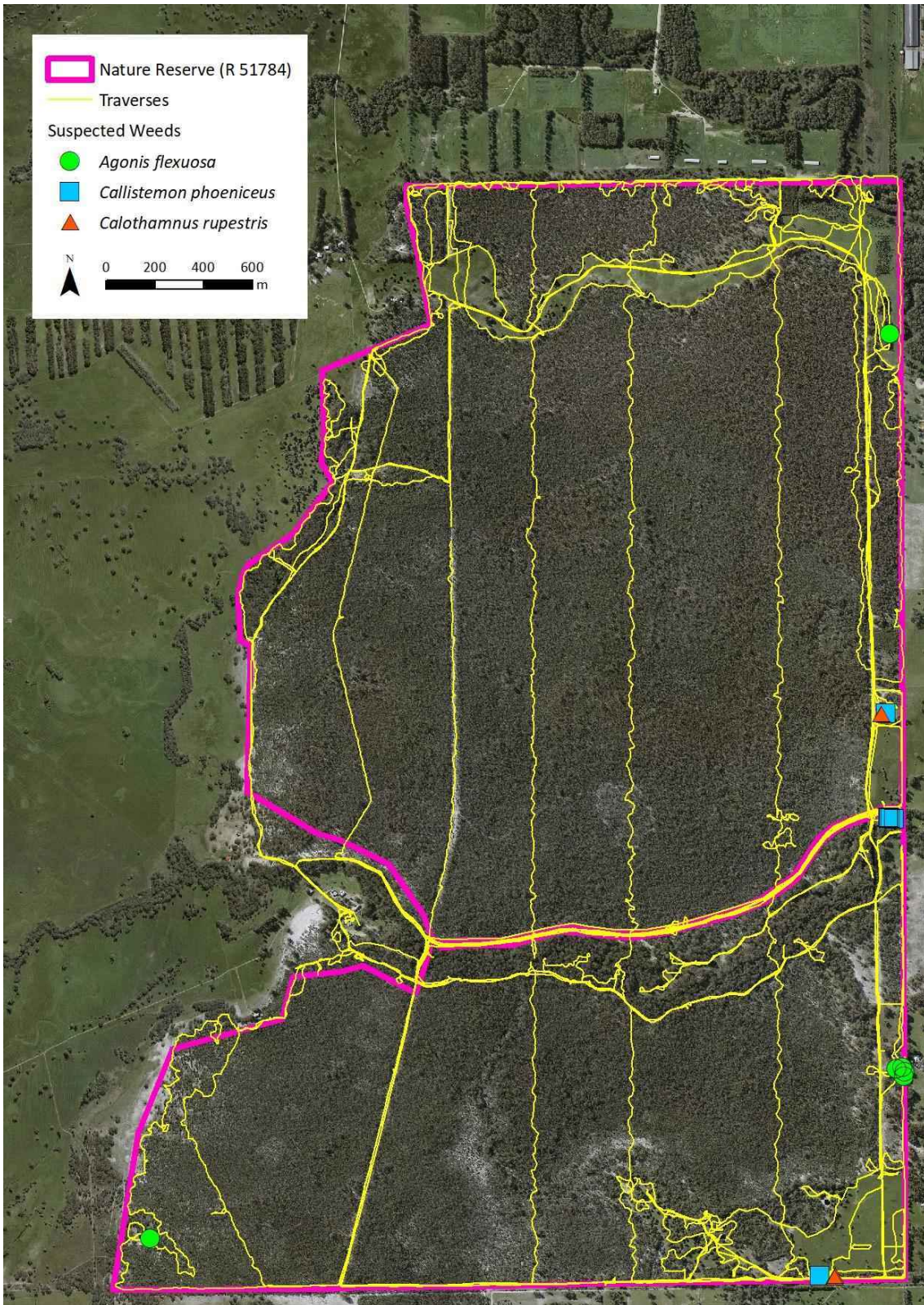


Figure 4: Location of Suspected Weeds

3.1.1. TREE AND SHRUB WEEDS MAPPED

The 21 tree/shrub weed species mapped are listed in Table 3, with photos included in Appendix 2.

Table 3: Tree/Shrub Observations

Abundance / Extent	Weed	Comments (counts and areas* limited to reserve)
Abundant and Widespread Figure 5	<i>Gomphocarpus fruticosus</i> (Narrow-Leaf Cottonbush)	20.5 ha based on 206 observations on traverses 39.5 ha based on traverses and 2012 map
Widespread Figure 6	<i>Corymbia</i> and <i>Eucalyptus</i> species (Gum Trees)	114 plants excluding tree lots All very tall trees with smooth white trunks, no species naturally occurring onsite have these characteristics. At least 4 species, predominately: <ul style="list-style-type: none"> • <i>Corymbia citriodora</i> (eastern boundary) • <i>Eucalyptus saligna</i> (northern boundary)
	<i>Ricinus communis</i> (Castor Oil Plant)	2.25 ha based on 23 observations on traverses 11.25 ha based on traverses and 2012 map
Low Abundance and/or Restricted Extent Figure 7 Figure 8	<i>Acacia longifolia</i> (Sydney Golden Wattle)	2 plants
	<i>Brachychiton populneus</i> (Kurrajong)	1 plant near Serpentine River
	<i>Casuarina cunninghamiana</i> (River Sheoak)	1 site on eastern fenceline estimated less than 10 plants
	<i>Chamaecytisus palmensis</i> (Tagasate)	6 plants on eastern fenceline
	<i>Ficus carica</i> (Edible Fig)	5 plants
	<i>Lavandula stoechas</i> (Italian Lavender)	1 site near Serpentine River estimated less than 10 plants
	<i>Leptospermum laevigatum</i> (Coast Teatree)	18 seedlings in vicinity of parent plant which has been cut-down, near Lowlands private road <ul style="list-style-type: none"> • 17 seedlings north of road (around parent) • 1 seedling nearby just south of road
	<i>Melaleuca quinquenervia</i> (Broad-leaved Paperbark)	1 plant on eastern fenceline
	<i>Pelargonium capitatum</i> (Rose Pelargonium)	3 sites estimated less than 10 plants
	<i>Phytolacca octandra</i> (Red Ink Plant)	2 plants
	<i>Pinus pinea</i> (Stone Pine)	8 plants Leaves in pairs – consistent with identification of <i>Pinus pinea</i> supplied by Midge Richardson (2019)
	<i>Salix matsunda</i> (Chinese Willow)	1 plant
<i>Schinus terebinthifolia</i> (Brazilian Pepper)	5 plants	
<i>Solanum linnaeanum</i> (Apple of Sodom)	19 plants	

*Area based on 50 m x 50 m squares in grid intersected by records

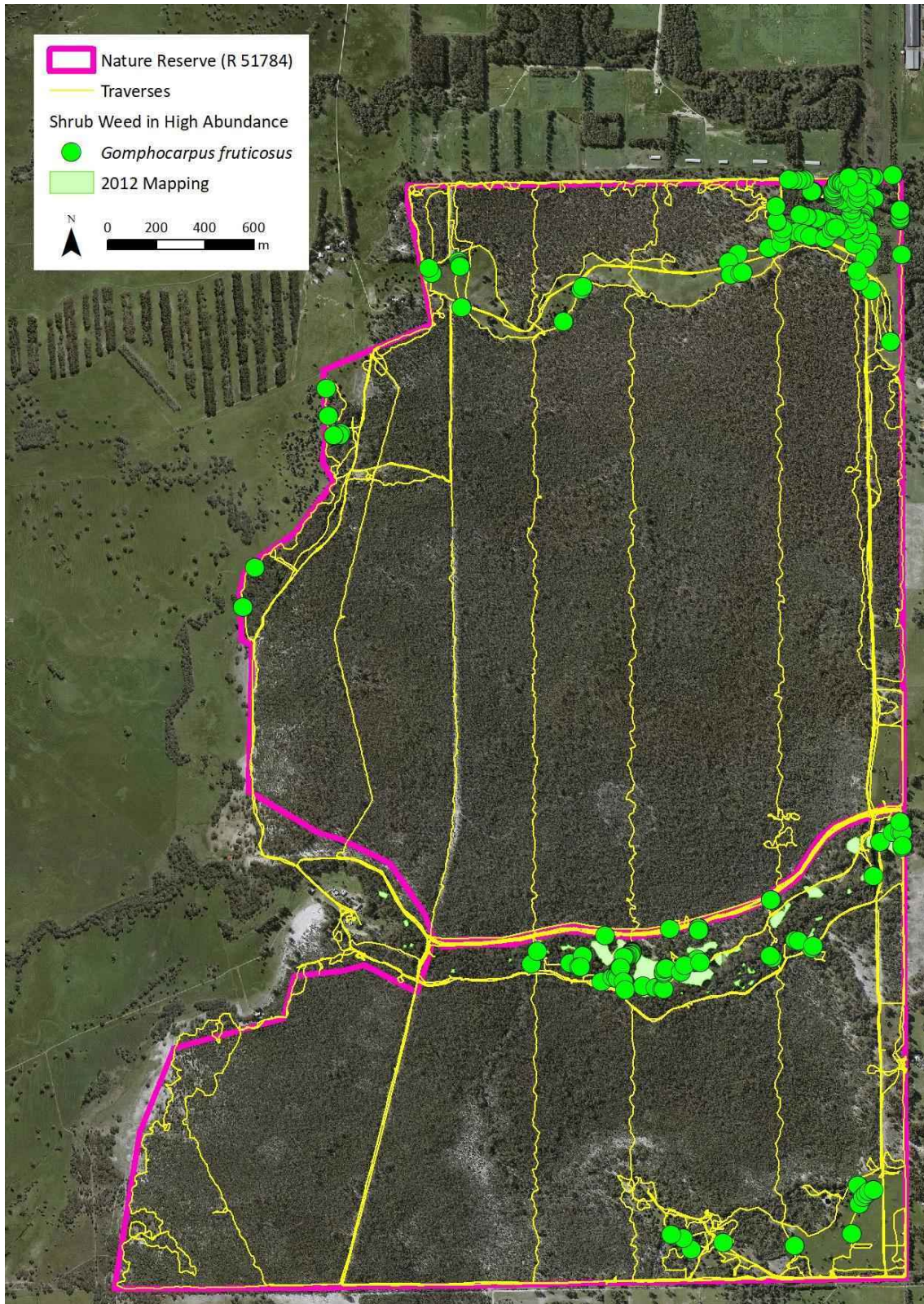


Figure 5: Location of Shrub (*Gomphocarpus fruticosus*) in High Abundance

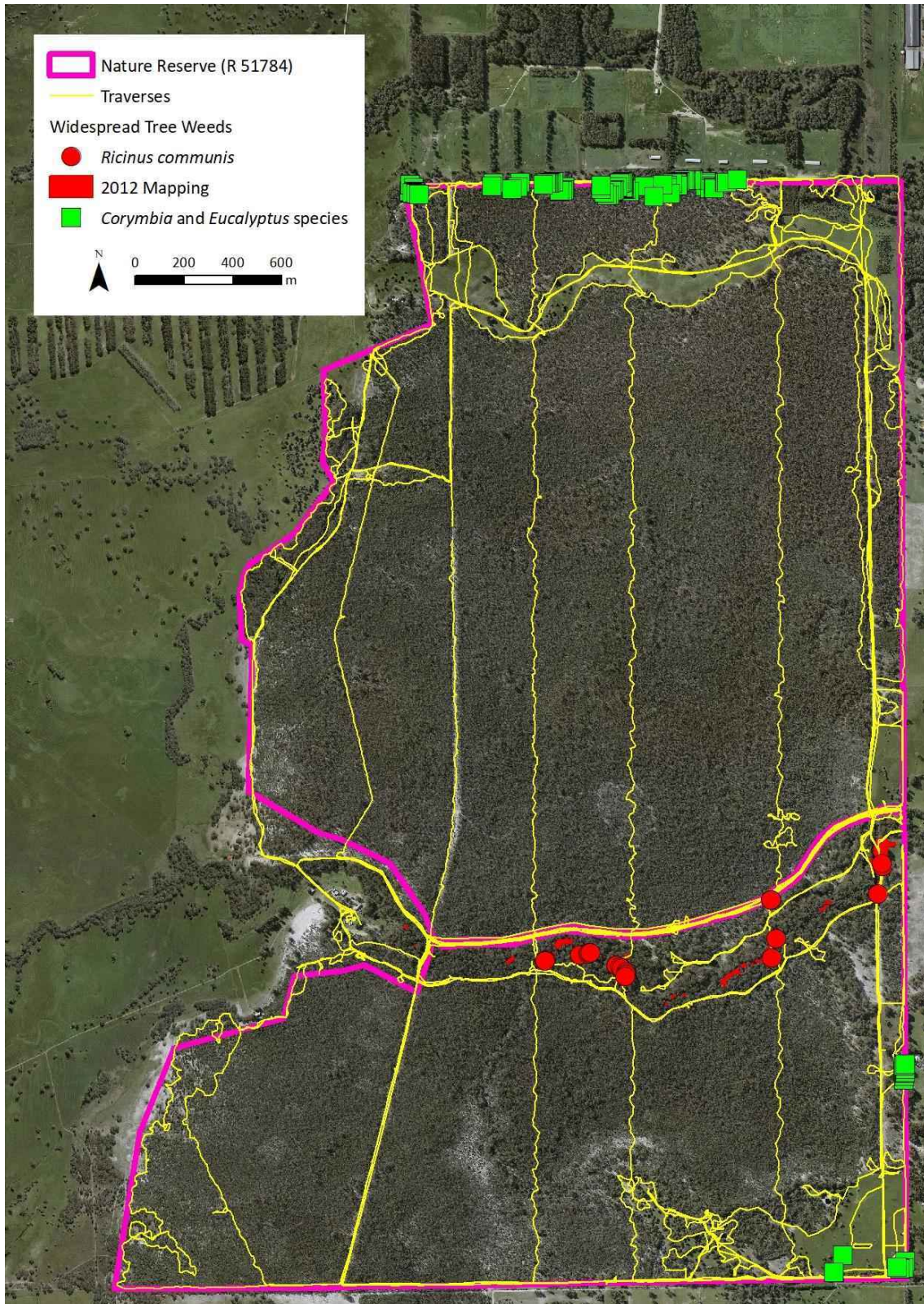


Figure 6: Location of Widespread (*Ricinus communis* and *Corymbia/Eucalyptus*) Trees

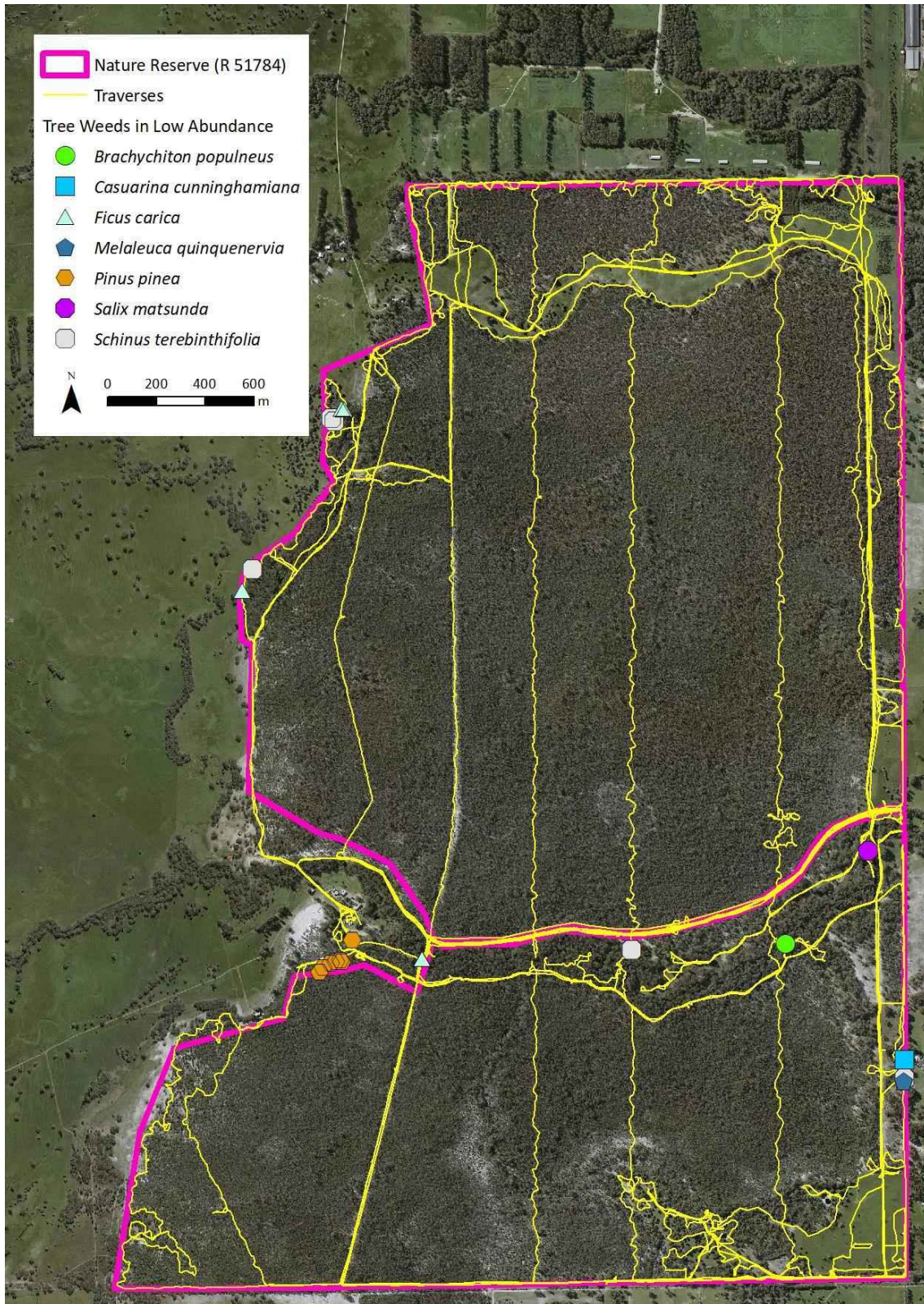


Figure 7: Location of Trees in Low Abundance

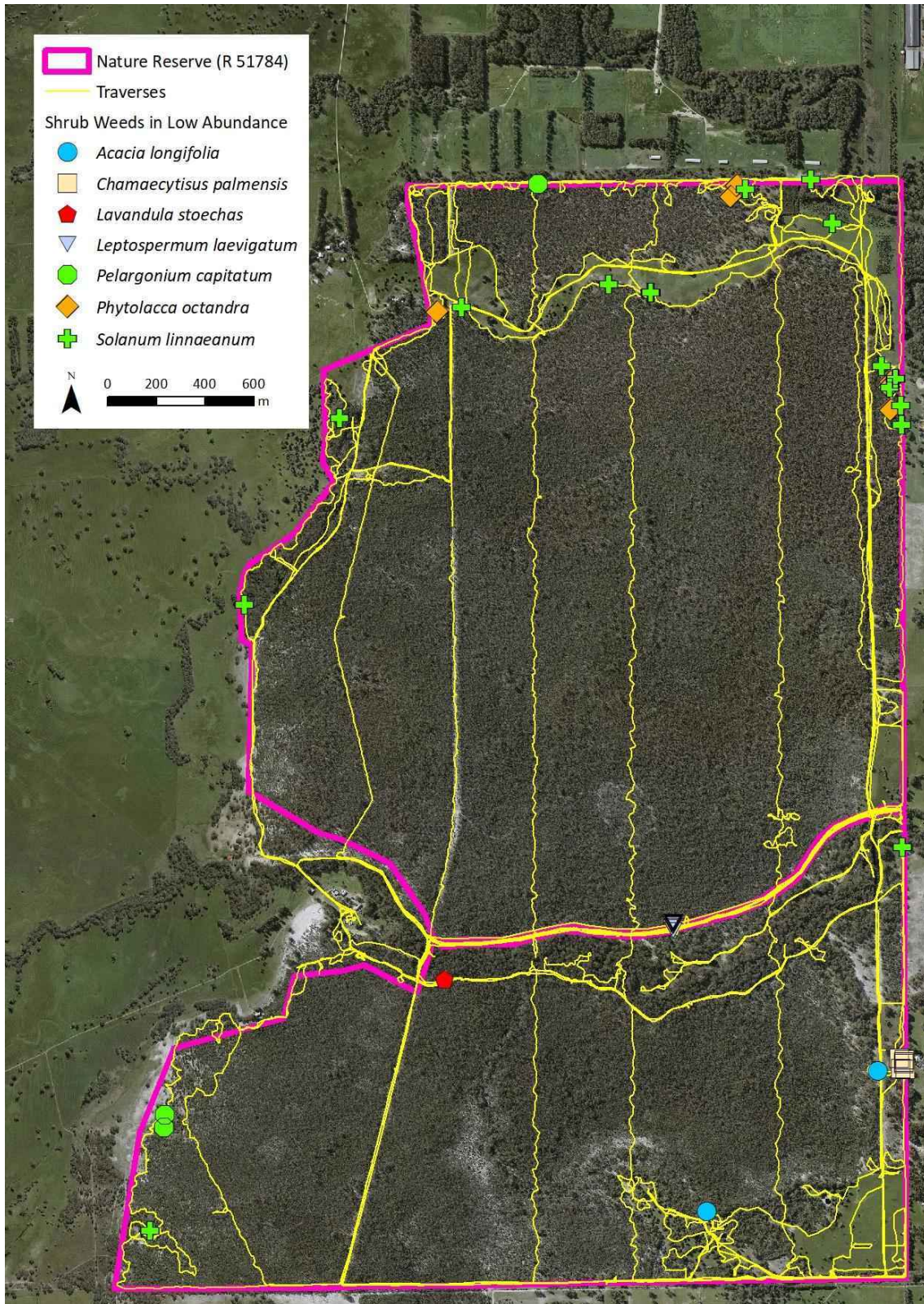


Figure 8: Location of Shrubs in Low Abundance

3.1.2. OTHER WEEDS MAPPED

The 9 herb/climbing weed species mapped are listed in Table 4 Table 3, with photos included in Appendix 3.

Table 4: Herb/Climber Observations

Abundance / Extent	Weed	Comments (counts and areas* limited to reserve)
Abundant and Widespread Figure 9	<i>Zantedeschia aethiopica</i> (Arum Lily)	47.25 ha based on 703 observations on traverses 135 ha based on traverses and 2012 map
Widespread Figure 10	<i>Echium plantagineum</i> (Paterson's Curse)	1.75 ha based on 9 observations on traverses
	<i>Gladiolus angustus</i> (Long Tubed Painted Lady)	120 plants on traverses
	<i>Moraea flaccida</i> (One-leaf Cape Tulip)	4.5 ha based on 50 observations on traverses
Low Abundance and/or Restricted Extent Figure 11	<i>Asparagus asparagoides</i> (Bridal Creeper)	1 ha based on 6 observations on traverses 1 ha based on traverses and 2015 map 13.75 ha based on traverses and 2007 map
	<i>Euphorbia terracina</i> (Geraldton Carnation Weed)	1 site on pile of limestone next to private road estimated less than 10 plants
	<i>Freesia alba</i> × <i>leichtlinii</i> (Freesia)	0.5 ha based on 6 observations on traverses (all observations on reserve boundary) 2 ha based on traverses and 2015 map 1.25 ha based on traverses and 2012 map
	<i>Rubus</i> species (Blackberry)	0.25 ha based on 2 observations on traverses 1.75 ha based on traverses and 2017 map 0.75 ha based on traverses and 2017 map
	<i>Watsonia meriana</i> var. <i>bulbillifera</i> (Bugle Lily)	0.25 ha based on 6 observations on traverses (most observations just outside reserve)

*Area based on 50 m x 50 m squares in grid intersected by records

The 2 grass weed species mapped are listed in Table 5, with photos included in Appendix 4.

Table 5: Grass Observations

Abundance / Extent	Weed	Comments (counts and areas* limited to reserve)
Widespread Figure 12	<i>Ehrharta calycina</i> (Perennial Veldt Grass) <i>Ehrharta longiflora</i> (Annual Veldt Grass)	Data combined for <i>Ehrharta</i> species (Veldt Grasses) 37.75 ha based on 703 observations on traverses

*Area based on 50 m x 50 m squares in grid intersected by records

DBCA indicated *Ehrharta calycina* (Perennial Veldt Grass) was the only grass to be recorded, but it was not differentiated from the similar *Ehrharta longiflora* (Annual Veldt Grass) due to identification issues arising from weather and low density of plants. At the time of the survey, both *Ehrharta* species' inflorescences had shed seed, and were yellow. Height was not used diagnostically, although many plants appeared less robust than would usually be expected of *Ehrharta calycina* (Perennial Veldt Grass) on the Swan Coastal Plain.

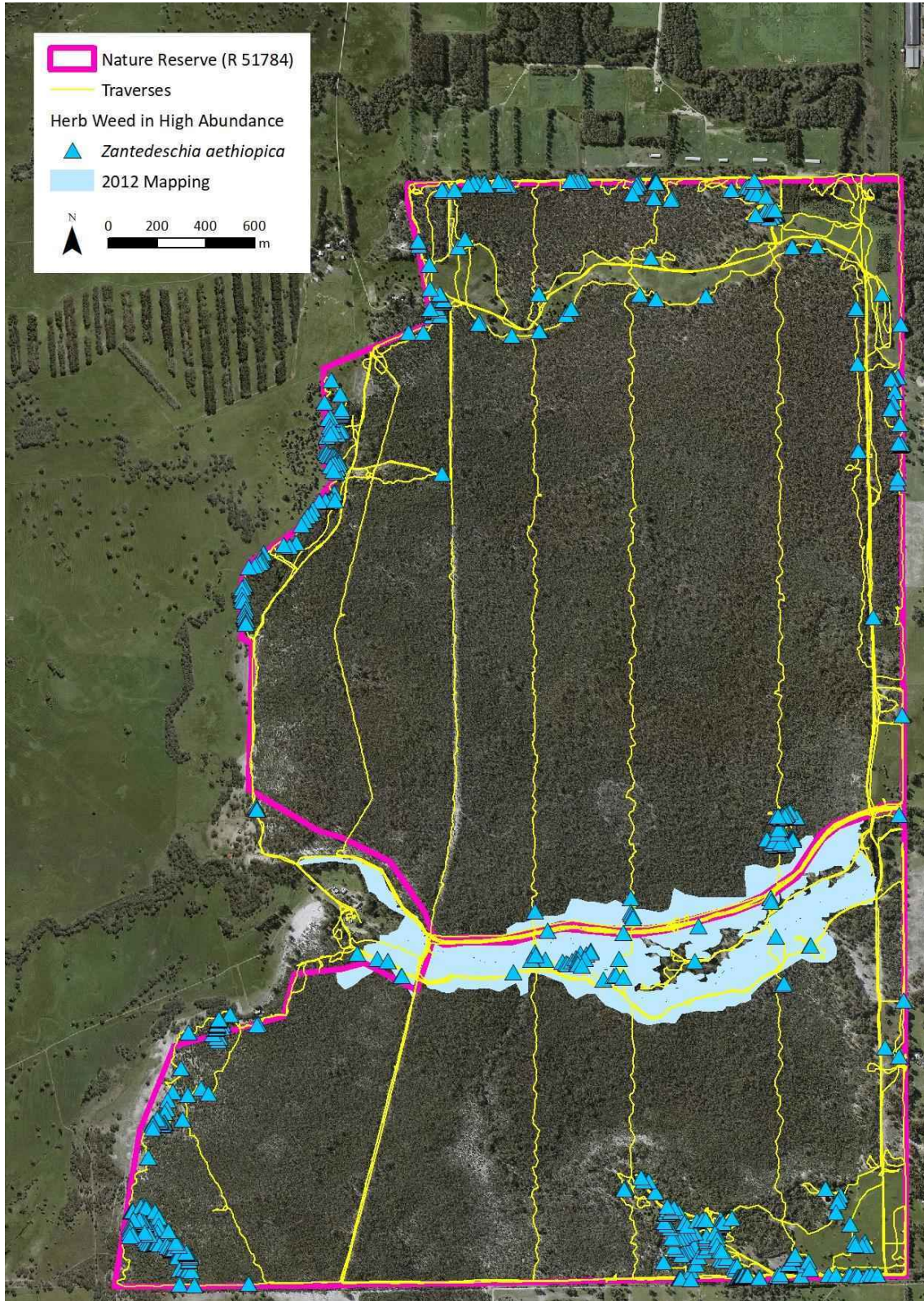


Figure 9: Location of Herb (*Zantedeschia aethiopica*) in High Abundance

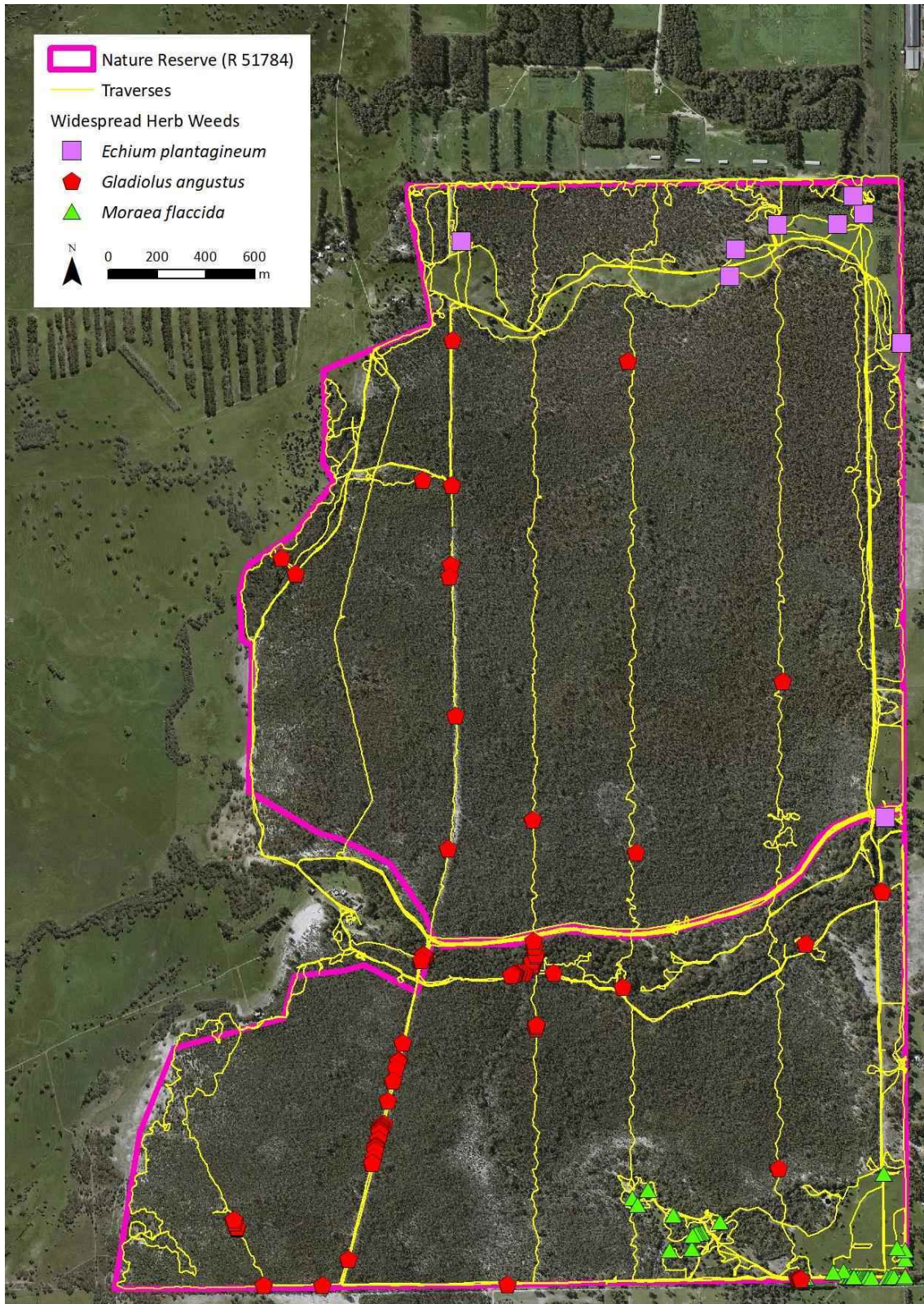


Figure 10: Location of Widespread Herbs

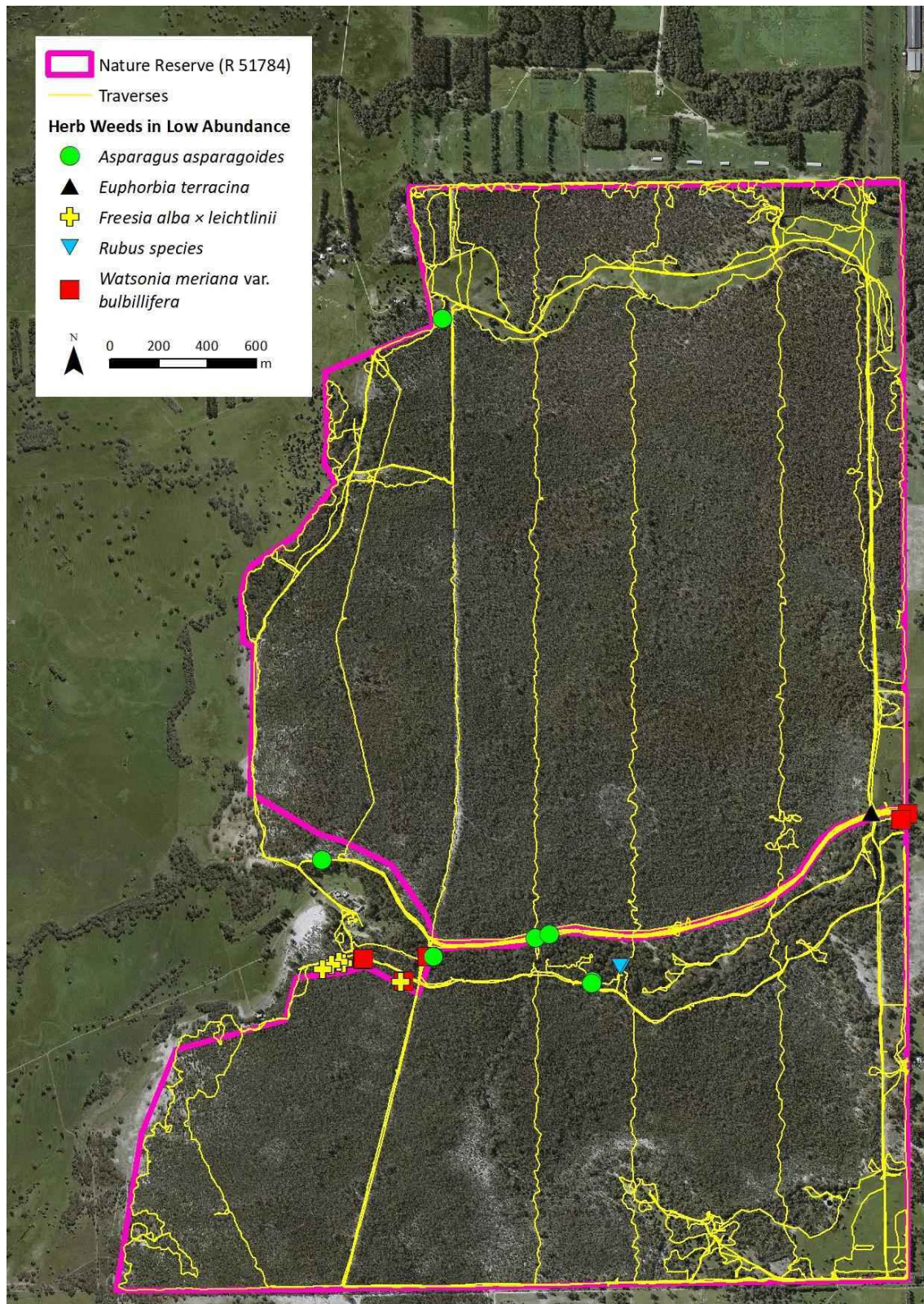


Figure 11: Location of Herbs in Low Abundance

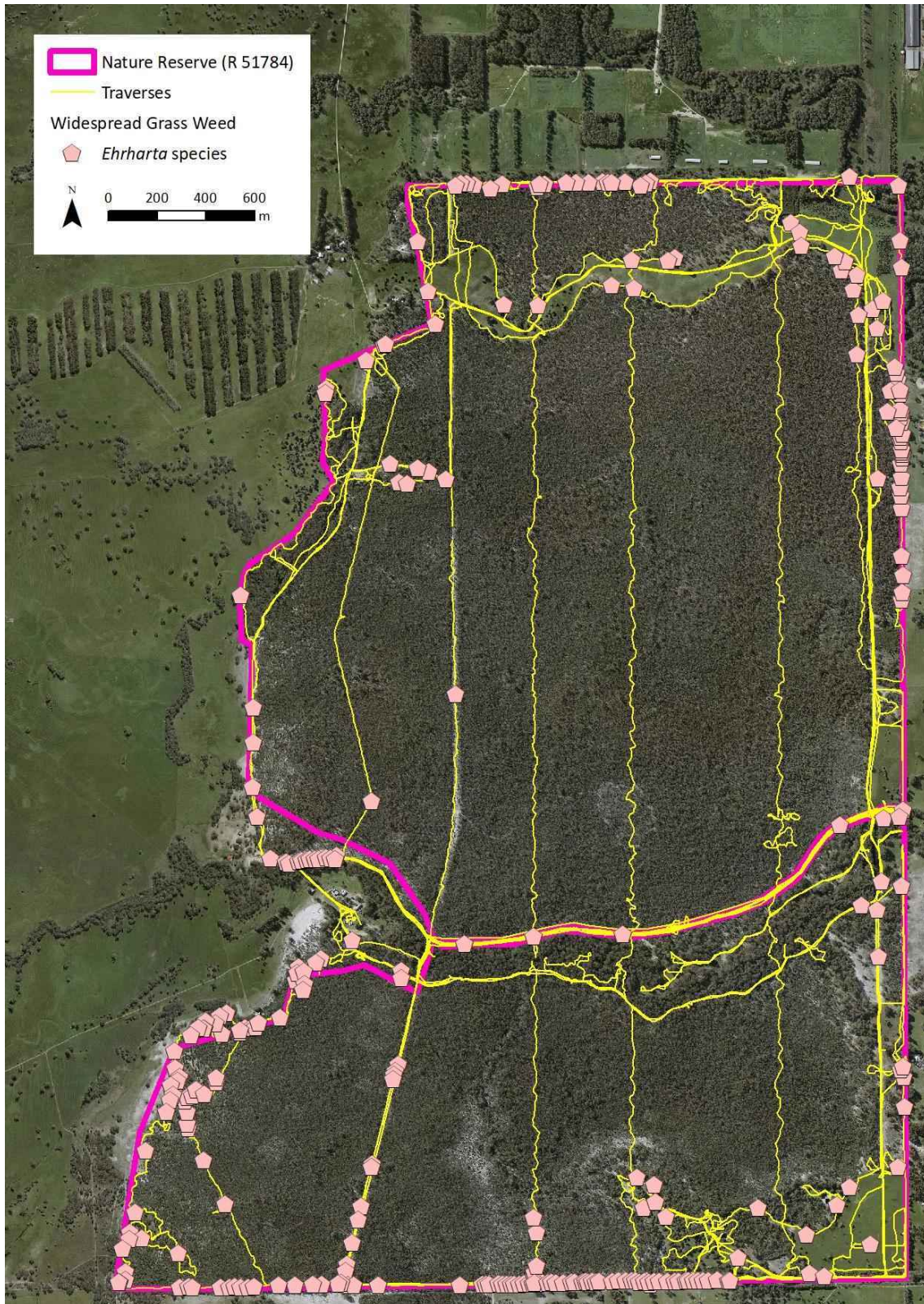


Figure 12: Location of Widespread Grasses (*Ehrharta* species)

3.1.3. WEEDS IN RESERVE NOT MAPPED

The 41 weed species previously recorded in the reserve by Keighery, Keighery, & Gibson (1995) but not mapped were:

- *Aira caryophyllea* (Silvery Hairgrass)
- *Aira cupaniana* (Silvery Hairgrass)
- *Anthoxanthum odoratum* (Sweet Vernal Grass)
- *Briza maxima* (Blowfly Grass)
- *Briza minor* (Shivery Grass)
- *Bromus diandrus* (Great Brome)
- *Cerastium glomeratum* (Mouse Ear Chickweed)
- *Conyza sumatrensis*
- *Cynodon dactylon* (Couch)
- *Disa bracteata*
- *Echinochloa crus-galli* (Barnyard Grass)
- *Hordeum leporinum* (Barley Grass)
- *Hypochaeris glabra* (Smooth Catsear)
- *Isolepis marginata* (Coarse Club-rush)
- *Juncus capitatus* (Capitate Rush)
- *Juncus polyanthemus*
- *Lagurus ovatus* (Hare's Tail Grass)
- *Lolium multiflorum* (Italian Ryegrass)
- *Lotus angustissimus* (Narrowleaf Trefoil)
- *Lotus subbiflorus*
- *Lysimachia arvensis* (Pimpernel)
- *Ornithopus compressus* (Yellow Serradella)
- *Ornithopus pinnatus* (Slender Serradella)
- *Oxalis glabra*
- *Oxalis pes-caprae* (Soursob)
- *Oxalis purpurea* (Largeflower Wood Sorrel)
- *Parentucellia viscosa* (Sticky Bartsia)
- *Petrorhagia dubia*
- *Poa annua* (Winter Grass)
- *Romulea rosea* var. *australis* (Guildford Grass)
- *Rumex acetosella* (Sorrel)
- *Rumex pulcher* (Fiddle Dock)
- *Solanum americanum* (Glossy Nightshade)
- *Sonchus asper* subsp. *asper*
- *Sonchus oleraceus* (Common Sowthistle)
- *Stellaria media* (Chickweed)
- *Trifolium campestre* var. *campestre* (Hop Clover)
- *Ursinia anthemoides* (Ursinia)
- *Vicia sativa* subsp. *sativa*
- *Vulpia bromoides* (Squirrel Tail Fescue)
- *Vulpia myuros* (Rat's Tail Fescue)

It was outside the scope to record additional weeds not likely to be subject to management, but *Lupinus* species (Lupins) and *Cucumis myriocarpus* (Prickly Paddy Melon) were opportunistically observed.

3.1.4. WEEDS ADJACENT RESERVE

Weeds previously mapped by DBCA around the Lowlands Homestead (adjacent to the reserve) but not detected in the reserve in the 2019 reconnaissance survey, included:

- *Agapanthus species* (Agapanthus)
- *Carpobrotus edulis* (Pigface)
- *Ferraria crispa* (Black Flag)

Midge Richardson allowed traverses to extend into her adjacent property in the 2019 reconnaissance survey for logistical reasons, but the gardens of the Lowlands Homestead were not surveyed. *Olea europaea* (Olive) trees were opportunistically observed at the entrance to the private road at the western end of Lowlands Road.

3.1. NON-NATIVE FAUNA

The PTA requested opportunistic observations of non-native animals be recorded.

Evidence of non-native fauna is shown in Figure 13, with photos included in Appendix 5. Rabbit droppings were observed but no active rabbit warrens were observed.

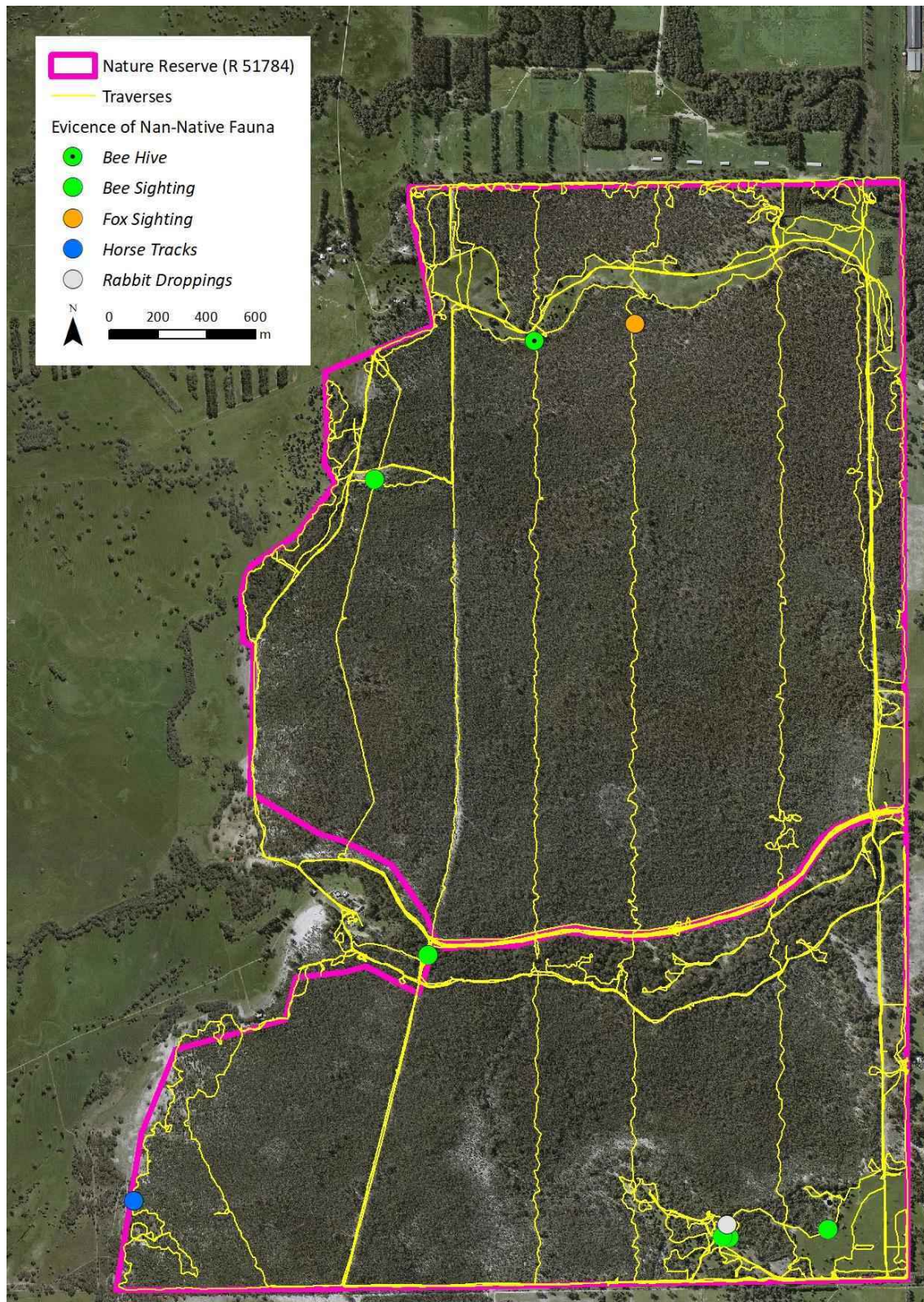


Figure 13: Opportunistic Observations of Non-native Fauna Activity

4. RECOMMENDATIONS

4.1. WEED DATASETS

Weed data collection needs to be fit for purpose, and should take the two discrete but complementary forms of:

- Surveillance to detect new occurrences of weeds in an area; and
- Monitoring to measure changes in abundance and/or extents.

Surveillance is intended to confirm species presence and not to generate quantitative measures for weeds (e.g. extents). Surveillance should be relatively rapid and focused on high-risk areas (such as the reserve's boundaries, tracks, and in proximity of previously recorded weeds outside the reserve (e.g. around the *Olea europaea* (Olive) trees at the western end of Lowlands Road). Surveillance can be passive (conducted whilst undertaking other tasks) or active (undertaken in a more formal targeted manner).

Monitoring is intended to quantitatively measure the effectiveness of management. Given the size of the reserve and issues around access, the most rapid method for measuring changes in extents of weed infestations over time would be to record the number grid squares (e.g. 50 metres x 50 metres) intersected by GPS records of plants (with records being taken at least every 10 metres where infestations are relatively continuous). Reporting can be in this form even if every individual plant (e.g. for shrubs and trees in low abundance, or geophyte herbs in low abundance in proximity to the threatened orchids *Drakaea elastica* and *Caladenia huegelii*) or cover data (e.g. for abundant herbs) was collected to provide more nuanced information for prioritising on-ground management within infestations.

Whilst the 2019 reconnaissance survey has generated minimum counts/extents of weeds it should be considered a surveillance survey as:

- the scope was to conduct a reconnaissance survey to identify key species and their broad distribution onsite;
- the survey was not comprehensive;
- traverses were not all along 'fixed' lines and therefore not intended to be replicable; and
- the detectability of some weeds in some areas was suboptimal as a result of the weather.

Tiered objectives of prevention, elimination, containment and management are summarised in Table 6, adapted from the Model for Management and Monitoring of Invasive Species developed by the Department of Agriculture and Food and shown in Figure 14.

Table 6: Framework for Weed Objectives

Objective	Scenario	Targets
Prevention	<ul style="list-style-type: none"> Weed absent from area 	<ul style="list-style-type: none"> No introductions No germinants reach maturity (set seed)
Eradication	<ul style="list-style-type: none"> Small localised populations Large discrepancy between current and potential impact Elimination feasible and potential high impact 	<ul style="list-style-type: none"> No seed set in reserve Removal of mature plants (timeframe may vary with short to medium term reduction in density/abundance and/or extent)
Containment	<ul style="list-style-type: none"> Rapidly increasing extent and/or density Moderate discrepancy between current and potential impact Elimination not feasible 	<ul style="list-style-type: none"> No increase in extent No increase in density/abundance
Management	<ul style="list-style-type: none"> Low discrepancy between current and potential impact Elimination not feasible and containment irrelevant as threat “naturalised” at or near its potential extent 	<ul style="list-style-type: none"> Minimise negative impacts (e.g. in vicinity of threatened flora) Often considered in terms of total weed cover (e.g. fuel load for fire)

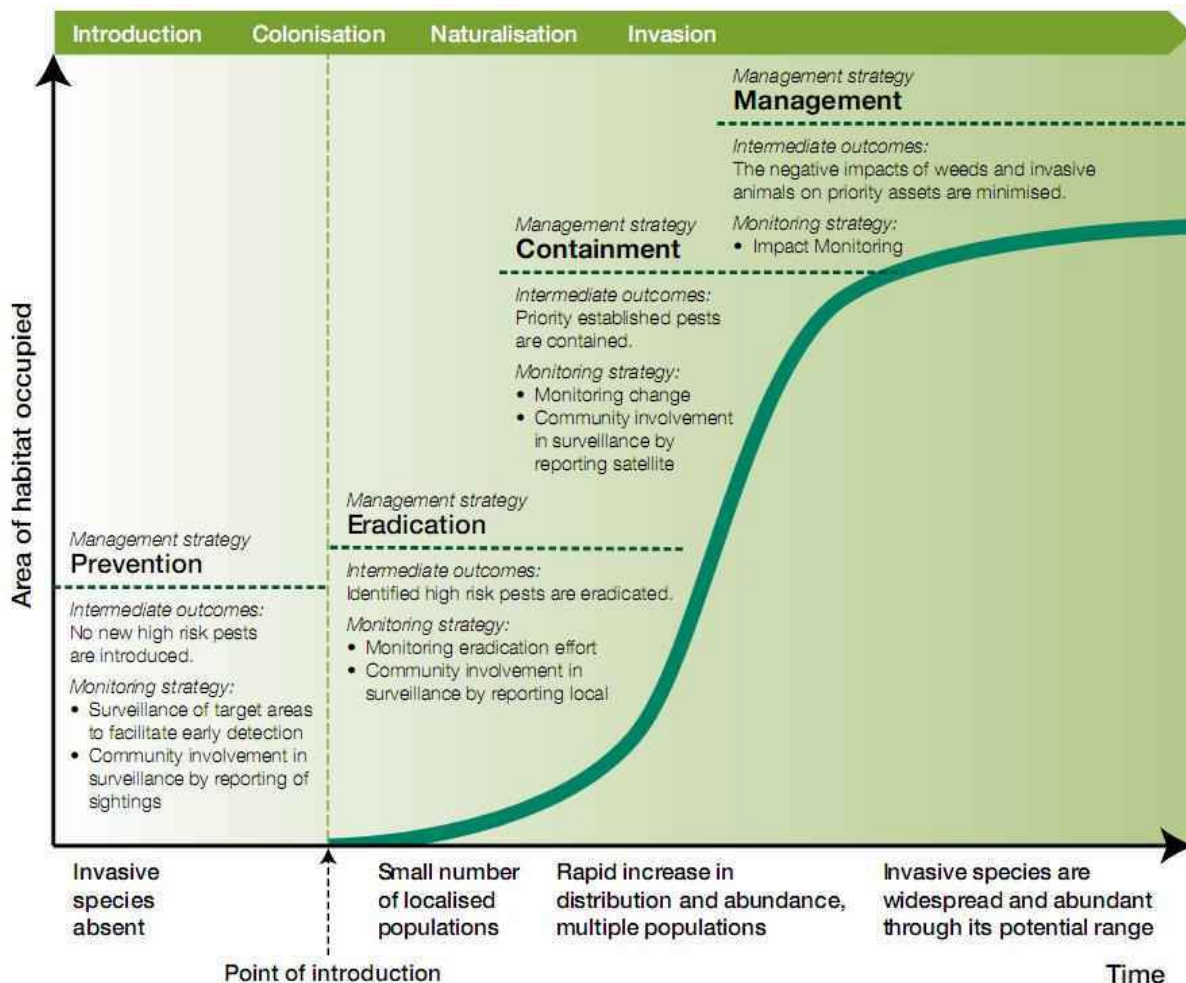


Figure 14 Model for Management and Monitoring of Invasive Species
(De Milliano, Woolnough, Reeves, & Shepherd, 2010)

Weed data collection needs to be fit for purpose as, for example mature and juvenile plants need to be differentiated in records if the objective is to stop seed set within the reserve (i.e. eradicate all mature plants) for a species that could be eradicated for a short period but for which there is a constant seed source for re-invasion (e.g. from gum trees just outside the reserve boundary).

The scope of this report was focused on weed species likely to be subject to management. It is noted that data may need to be collected for some weed species not yet mapped (see Section 3.1.3) in some portions of the reserve where site(asset)-based rather than species(threat)-based priorities are established. For example, the South African weed orchid *Disa bracteata* maybe targeted for control (and therefore monitoring) where it currently appears to occur in low abundance in the vicinity/habitat of the threatened orchids *Drakaea elastica* and *Caladenia huegelii*.

The scope of this report was focused on weed species likely to be subject to management. There are previously cleared areas within the reserve, as shown in Photo 13, in which there are only weeds (even if these are not highly invasive weeds) which could at least in part be displaced by native flora plantings, which could also increase fauna habitat values. Weed objectives and monitoring in these areas could be based on total weed cover or conversely by native plant cover.



Photo 13: Example of Previously Cleared Area

4.1.1. COMPLIMENTARY DATASETS

Other datasets that should be used in conjunction with the weed mapping in developing a weed management program include inputs into a risk assessment that addresses potential incidental damage to fauna habitat and off-target damage to native flora:

- *Phytophthora cinnamomi* (Dieback) is already considered in terms of access in Lowlands Nature Reserve Access Management Information and DBCA has equipment sterilization procedures.
- In addition to the threatened and priority fauna species recorded onsite, it is noted that there appears to be habitat for *Petalura hesperia*, Western Petalura. This is the largest dragonfly in Western Australia, with body length of 10 cm and a wingspan of 13 cm (Barrett, 1998). It is restricted to boggy marshes or seepages beside freshly oxygenated water, and dense vegetation appears to be critical to its habitat requirements of moist soils with roots and vegetation to burrow amongst (Barrett, 1998). This species is known from only 19 locations, with few individuals recorded at each site (Barrett, 1998). The species can be considered threatened and it is believed to be extinct at its only known location on the Swan Coastal Plain, at Bull Creek (Sutcliffe, 2003). Detection is difficult as it is only effectively surveyed when adults are in flight (typically December-January) and it has a 5-6 year larval stage (Barrett, 1998).
- Additional priority and threatened flora surveys may need to be undertaken to create a comprehensive species and location inventory. *Jacksonia gracillima* P3 (Photo 14) was opportunistically observed in the reserve. A specimen was not taken for confirmation as no permission had been sought for taking native flora from the reserve and as it was not targeted its distribution will be more extensive than shown in Figure 15. It is a dense groundcover (Photo 15) that could be planted to capture windblown seed and reduce the establishment of weeds along some sections of fencelines, and increase the viability of the priority flora population, and increase cover for fauna by re-establishing it in previously cleared portions of the reserve.
- More detailed vegetation mapping may need to be undertaken to provide more detailed weed habitat mapping (i.e. areas at risk of invasion by specific weeds), and better delineate values of the reserve. It is noted that several occurrences of vegetation types do not appear to have previously been mapped, including:
 - *Baumea articulata* sumpland shown in Photo 16 on the western boundary in the north of reserve.
 - *Eucalyptus rudis* woodland shown in Photo 17 on the western boundary in the south of reserve.

Objectives need to be prioritised and this can be based on datasets relating to:

- values impacted by weeds (e.g. threatened and priority flora species in competition with weeds, small lizards with burrowing habitat displaced by dense weed root systems etc);
- the difference between current and potential impacts (e.g. the potential to change hydrology, vegetation structure, fire regimes etc); and
- weed status (e.g. Biosecurity and Agriculture Management Act 2007 requirements).



Photo 14: Flower of *Jacksonia gracillima* P3



Photo 15: Habit of *Jacksonia gracillima* P3

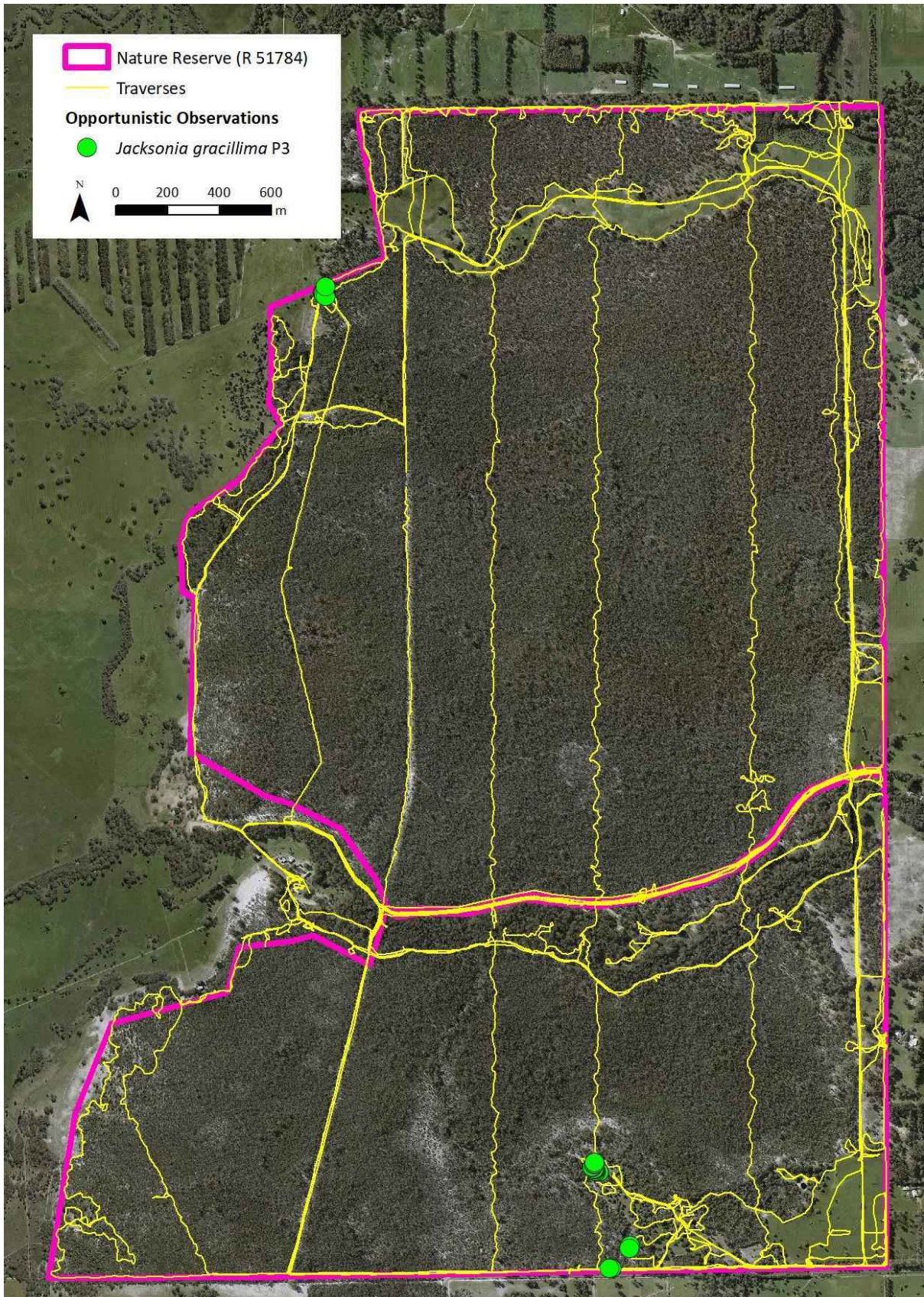


Figure 15: Opportunistic Observations of *Jacksonia gracillima* P3

NB: Not targeted and lack of observations along traverses not indicative of absence



Photo 16: *Baumea articulata* sumpland



Photo 17: *Eucalyptus rudis* woodland

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APPENDIX 1: PHOTOS OF SUSPECTED WEEDS



Photo 18: *Agonis flexuosa* (Peppermint)



Photo 19: *Callistemon phoeniceus* (Lesser Bottlebrush)



Photo 20: *Calothamnus rupestris* (Mouse-Ears)

APPENDIX 2: PHOTOS OF TREE AND SHRUB WEEDS

Photo 21: *Acacia longifolia* (Sydney Golden Wattle)



Photo 22: *Brachychiton populneus* (Kurrajong)



Photo 23: *Casuarina cunninghamiana* (River Sheoak)



Photo 24: *Corymbia citriodora* (Lemon Scented Gum)



Photo 25: *Chamaecytisus palmensis* (Tagasate)



Photo 26: *Eucalyptus saligna* (Sydney Blue Gum)



Photo 27: *Ficus carica* (Edible Fig)



Photo 28: *Gomphocarpus fruticosus* (Narrow-Leaf Cottonbush)



Photo 29: *Leptospermum laevigatum* (Coast Teatree)



Photo 30: *Lavandula stoechas* (Italian Lavender)



Photo 31: *Melaleuca quinquenervia* (Broad-leaved Paperbark)



Photo 32: *Pelargonium capitatum* (Rose Pelargonium)



Photo 33: *Phytolacca octandra* (Red Ink Plant)



Photo 34: *Pinus pinea* (Stone Pine)



Photo 35: *Ricinus communis* (Castor Oil Plant)



Photo 36: *Salix matsunda* (Chinese Willow)



Photo 37: *Schinus terebinthifolia* (Brazilian Pepper)



Photo 38: *Solanum linnaeanum* (Apple of Sodom)

APPENDIX 3: PHOTOS OF HERB AND CLIMBING WEEDS

Photo 39: *Asparagus asparagoides* (Bridal Creeper)



Photo 40: *Echium plantagineum* (Paterson's Curse)



Photo 41: *Euphorbia terracina* (Geraldton Carnation Weed)



Photo 42: *Freesia alba* × *leichtlinii* (Freesia)



Photo 43: *Gladiolus angustus* (Long Tubed Painted Lady)



Photo 44: *Moraea flaccida* (One-Leaf Cape Tulip)



Photo 45: *Rubus* species (Blackberry)



Photo 46: *Watsonia meriana* var. *bulbifera* (Bugle Lily)



Photo 47: *Zantedeschia aethiopica* (Arum Lily)

APPENDIX 4: PHOTOS OF GRASS WEEDS



Photo 48: *Ehrharta species* (Veldt Grass)

APPENDIX 5: PHOTOS OF FERAL/NON-NATIVE FAUNA ACTIVITY



Photo 49: Bee Hive

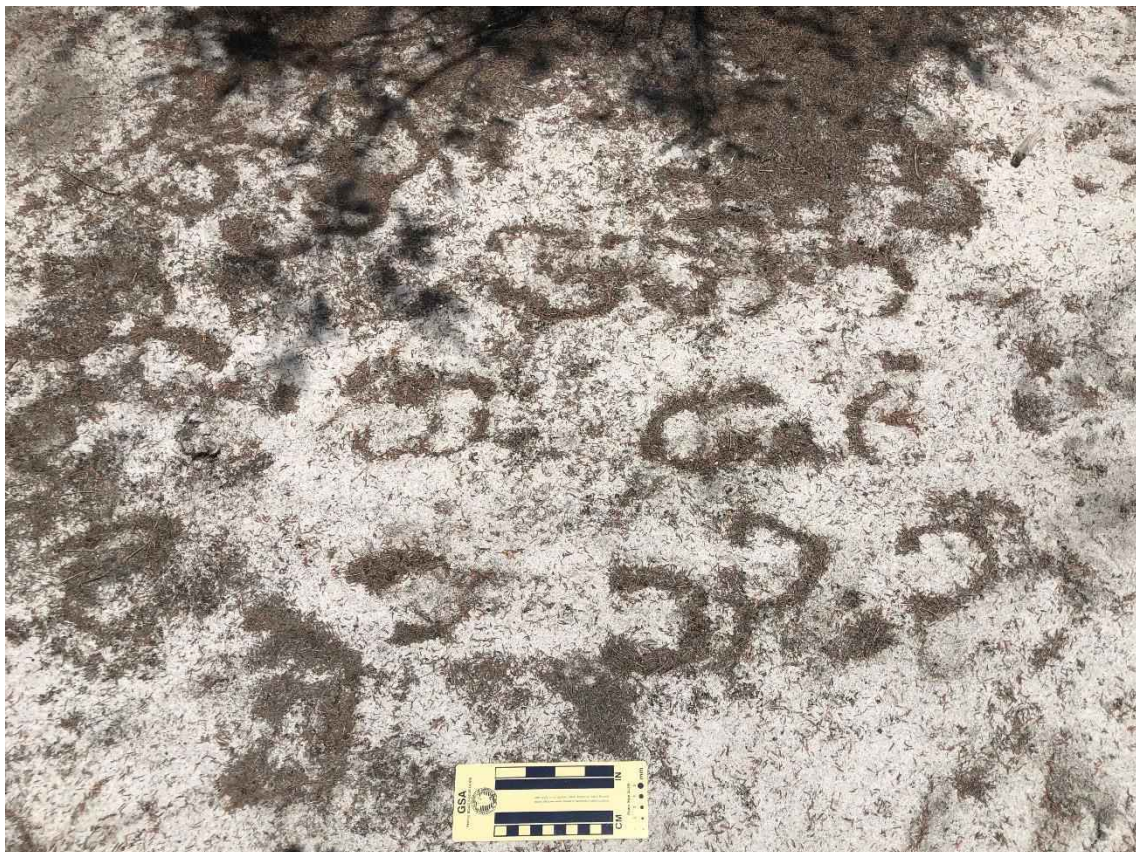


Photo 50: Horse Tracks



Photo 51: Rabbit Droppings

Appendix E - Keysbrook Environmental Values Assessment Report



Public Transport Authority
METRONET Potential Offset Sites
Keysbrook Environmental Values Assessment

January 2020

Executive summary

METRONET is the State government's program of projects to increase the size of Perth's railway network, whilst also supporting the planning of integrated station precincts, to support growth of the Perth metropolitan region.

Where required, METRONET projects will be assessed by the Environmental Protection Authority (EPA) under Section 38 of the *Environmental Protection Act 1986* (EP Act) and/or by the Commonwealth Department of the Environment and Energy (DoEE) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

As part of the State and Federal environmental approvals processes, the Public Transport Authority (PTA) is required to offset significant residual environmental impacts of assessed projects through the implementation of an Offsets Strategy. Through liaison with other State government agencies, a number of potential offset sites have been identified containing suitable environmental values to offset the potential METRONET project impacts. This report presents an Environmental Values Assessments of a potential offset site located in Keysbrook, Western Australia.

GHD Pty Ltd (GHD) was engaged by the PTA to undertake Environmental Values Assessments (EVAs) for six potential offset sites. The purpose of the EVAs is to identify the key environmental values of each site, as well as opportunities for on-ground management works to enable an assessment of their suitability as land acquisition offset sites. This report presents an EVA of a potential offset site located in Keysbrook, Western Australia.

The Keysbrook potential offset site (the survey area) is approximately 257 hectares (ha) and is located on Elliot Road in the suburb of Keysbrook within the Shire of Serpentine Jarrahdale.

Key findings for the vegetation survey

Five broad vegetation types as well as open water and cleared/agricultural land were identified within the survey area. The vegetation types were represented by a *Banksia* low woodland, dryland community, three *Melaleuca* dampland communities and one highly modified community consisting of isolated trees over pasture weeds. The vegetation types are considered to be representative of the Southern River Complex and Bassendean Complex – Central and South. Based on landform and dominant species, the vegetation types identified in the survey area are considered to align with the following Floristic Community Types (FCT) 15, 23a and S01.

The vegetation condition ranged from Good to Completely Degraded. The majority of the survey area comprised Degraded and Completely Degraded areas. Cattle have significantly impacted the vegetation within the survey area through trampling and grazing. Areas in Good condition had dense mid-storey species such as *Astartea scoparia* and /or *Kunzea glabrescens* that inhibited the cattle.

Based on desktop searches, dominant species and field observations, two conservation significant communities were considered likely to occur within the survey area:

- Forests and woodlands of deep seasonal wetlands (SCP15), listed as a Threatened Ecological Community under the *Biodiversity Conservation Act 2016*
- *Banksia* dominated woodlands of the Swan Coastal Plain IBRA region, listed as a Priority 3 Priority Ecological Community by the Department of Biodiversity, Conservation and Attractions (DBCA).

Key findings for fauna and Black Cockatoo survey

Four broad habitat types were identified within the survey area, mixed Banksia woodlands, isolated native and planted trees over weeds, wetlands, and Melaleuca over tall shrubland. All habitat types with the exception of Melaleuca over tall shrubland are degraded with high grazing pressures from cattle that roam freely through the survey area. The highly degraded nature of most habitat types has led to a lack of sufficient understorey and mid-storey suitable to support small ground dwelling mammals and reptiles.

During the survey seven Forest Red-tailed Black Cockatoos perched on a Jarrah stag were observed within the Mixed Banksia Woodland. Old feeding evidence on Marri nuts was also recorded within the isolated native and planted trees over weeds habitat type. The survey area is considered to provide foraging habitat, but limited roosting habitat and very limited (to nil) potential breeding habitat for both Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo.

No evidence of other conservation significant fauna was observed within the survey area during the survey. However, the Southern Brown Bandicoot and South-western Brush-tailed Phascogale are also considered likely to utilise the survey area.

This report is subject to, and must be read in conjunction with, the limitations set out in section 1.5 and the assumptions and qualifications contained throughout the Report.

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Appendices

Appendix A – Figures

Appendix B – Desktop searches

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1. Introduction

1.1 Background

METRONET is the State government's program of projects to increase the size of Perth's railway network, whilst also supporting the planning of integrated station precincts, to support growth of the Perth metropolitan region.

METRONET projects will be assessed by the Environmental Protection Authority (EPA) under Section 38 of the *Environmental Protection Act 1986* (EP Act) and/or by the Commonwealth Department of the Environment and Energy (DoEE) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), where required.

As part of the State and Federal environmental approvals processes, the Public Transport Authority (PTA) is required to offset significant residual environmental impacts of assessed projects through the implementation of an Offsets Strategy. Through liaison with other State government agencies, a number of potential offset sites have been identified containing suitable environmental values to offset the potential METRONET project impacts. This report presents an Environmental Values Assessments of a potential offset site located in Keysbrook, Western Australia.

1.2 Purpose of this report

GHD Pty Ltd (GHD) was engaged by the PTA to undertake Environmental Values Assessments (EVAs) for six potential offset sites. The purpose of the EVAs is to identify the key environmental values of each site, as well as opportunities for on-ground management works to enable an assessment of their suitability as land acquisition offset sites. This report presents an EVA of a potential offset site located in Keysbrook, Western Australia.

1.3 Location

The Keysbrook potential offset site (the survey area) is located on Elliot Road in the suburb of Keysbrook within the Local Government Area (LGA) of the Shire of Serpentine Jarrahdale. The survey area covers 257.41 hectares (ha) and is mapped in Figure 1, Appendix A.

1.4 Scope of works

The scope of works for this EVA includes both desktop and field assessments, including:

- A desktop review of existing information relating to the site
- A reconnaissance level vegetation and fauna survey with targeted assessment of values requiring offset
- The preparation of a short report documenting the findings of the desktop assessment and field survey, and opportunities for on-ground management works
- The provision of all mapping and spatial data.

1.5 Limitations and Assumptions

This report has been prepared by GHD for PTA and may only be used and relied on PTA for the purpose agreed between GHD and the PTA as set out in section 1.4 of this report.

GHD otherwise disclaims responsibility to any person other than PTA arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by PTA and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of access tracks, required hygiene management measures and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

This report has assessed the flora, vegetation and fauna values within the site, as shown in Figure 1, Appendix A. Should the site location change or be refined, further assessment may be required.

2. Methodology

2.1 Desktop assessment

Prior to the field survey, a desktop assessment was undertaken to identify relevant environmental information pertaining to the site. The desktop assessment included a review of:

- Previous flora and fauna assessments of the survey area:
 - # 671 (L77) Yangedi Road, Keysbrook, Environmental Report (Hollick 2014)
- The Department of Biodiversity, Conservation and Attractions (DBCA) Threatened and Priority Ecological Communities (TECs and PECs), Threatened/Priority Flora and Threatened/Priority Fauna Database Searches (5 km buffer of the survey area)
- The DBCA *NatureMap* database for conservation significant flora and fauna species previously recorded within 5 km of the survey area (DBCA 2007–) (Appendix B)
- Regional vegetation complex mapping (e.g. Hedde *et al.* 1980, Webb *et al.* 2016)
- Bush Forever (Government of Western Australia (GoWA) 2000)
- Aerial imagery of the site.

2.2 Field survey

2.2.1 Vegetation

GHD Botanist Angela Benkovic completed a reconnaissance vegetation survey of the survey area on 23 July 2019. The field survey was undertaken to verify the information obtained from the desktop assessment and assess and characterise the broad vegetation types and vegetation condition across throughout the site. Preliminary assessment of occurrence and approximate extent of potential TEC/PECs (including indicative floristic community types (FCTs)) was also completed.

Field survey methods involved a combination of sampling relevés located in identified vegetation units and traversing the site by vehicle and foot. The survey methodology was undertaken with reference to the EPA Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016a).

Broad vegetation types

Broad vegetation types were identified and boundaries delineated using a combination of aerial photography, topographical features and field data/observations. Data recorded at relevé sites included dominant flora taxa from each structural layer (i.e. upper, mid and ground) as well as other observable flora taxa (to assist with FCT identification); full floristics at each relevé site were not recorded. Vegetation data recorded from the survey area is provided in Appendix C.

The vegetation types were described based on structure, dominant taxa and cover characteristics. The broad vegetation type descriptions are consistent with National Vegetation Inventory System (NVIS) Level IV or V, where the dominant species for the three traditional strata (upper, mid and ground) are used to describe the association (NVIS Technical Working Group 2017).

Vegetation condition

The vegetation condition was assessed and mapped in accordance with the vegetation condition rating scale for the South West and Interzone Botanical Provinces of WA (devised by

Keighery (1994) and adapted by EPA (2016a). The scale recognises the intactness of vegetation and consists of six rating levels. The vegetation condition rating scale is outlined in Table 1.

Table 1 Vegetation condition rating scale

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

Preliminary assessment of TECs and PECs

Prior to the field survey, information obtained from the desktop assessments (e.g. DBCA TEC and PEC database) was reviewed to determine conservation significant ecological communities potentially present within the survey area. Additional information was sourced from DBCA (2018, 2019), Gibson *et al.* (1994), GoWA (2000) as well as available recovery plans and conservation advice to assist in the preliminary identification of potential TECs and PECs within the survey area.

During the field survey, DBCA mapped TEC and PEC locations were visited and preliminary identification was based on vegetation structure, typical and common species, and observations on soils, landforms etc. No statistical analyses were completed as part of this scope. Where areas of potential TECs or PECs identified, the occurrence noted and the approximate extent mapped using a GPS enabled handheld tablet.

Flora nomenclature'

Nomenclature used in this report follows that used by the WA Herbarium as reported on *FloraBase* (WA Herbarium 1998–). The conservation status of flora was compared against the current lists available on *FloraBase* and the EPBC Act Threatened species database provided by DEE (2019).

2.2.2 Fauna

GHD Ecologist Madison Roberts completed a Level 1 fauna (reconnaissance) and black cockatoo habitat assessment in conjunction with the vegetation survey on the 23 July 2019. The field survey was undertaken to verify the information obtained from the desktop assessment, describe the key fauna habitat values and identify suitable habitat for conservation significant fauna species.

Field methodology included traversing the site by vehicle and foot. The survey methodology was undertaken with reference to the EPA Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna Surveys (EPA 2016b), EPA Technical Guidance –Terrestrial Fauna Surveys (EPA 2016c).

Habitat assessment

The site was assessed for habitat characteristics based on soil, topography, and vegetation structural complexity, connectivity, disturbance, type and extent of resource availability and value for fauna, particularly black cockatoo and Quenda. Specifically, the assessment included:

- Habitat structure (e.g. vegetation type, presence/absence of over-storey, mid-storey, understorey, and ground cover)
- Presence/absence of refuge including fallen timber (coarse woody debris), hollow-bearing trees and stags and rocks/breakaways
- Location of the habitat within the site in comparison to the habitat within the surrounding landscape
- Habitat connectivity and identification of wildlife corridors within and immediately adjacent to the site
- Identification and evaluation of key habitat features and types identified during the desktop assessment relevant to fauna of conservation significance
- Evaluation of the likelihood of occurrence of conservation significant fauna within the site based on presence of suitable habitat.

Opportunistic fauna observations

Opportunistic fauna searches were conducted throughout the site and focussed on searching the site for tracks, scats, pellets, skeletal remains, diggings, feathers, nests and feeding areas indicating the current or recent presence of fauna with a focus on conservation significant fauna species. Where conservation significant fauna were identified, photographs, GPS points and habitat data were recorded.

Black cockatoo

A black cockatoo habitat assessment was undertaken in conjunction with the broad habitat assessment. The Black Cockatoo habitat assessment included:

- Evaluation of presence and approximate extent of foraging, breeding and roosting habitat (individual mapping of potential breeding tree locations was not undertaken). Foraging, breeding and roosting habitat was defined as per the EPBC Act referral guidelines for three threatened black cockatoo species: Carnaby's Cockatoo (endangered) *Calyptorhynchus latirostris*, Baudin's Cockatoo (vulnerable) *Calyptorhynchus baudinii*, Forest Red-tailed Black Cockatoo (vulnerable) *Calyptorhynchus banksii naso*, (Department of Sustainability, Environment, Water, Populations, and Communities (DSEWPaC) 2012)
- Characterisation of the broadly mapped vegetation types with suitability as black cockatoo foraging, breeding and roosting habitat
- Recording and mapping black cockatoo observations of foraging evidence, breeding and roosting activity.

Fauna nomenclature

Fauna nomenclature used in this report follows that used by the WA Museum and the DBCA *NatureMap* database (DBCA 2007–) with the exception of birds, where by Christidis and Boles (2008) was used.

2.3 Limitations

2.3.1 Desktop limitations

The records from the DBCA searches and *NatureMap* database provide generally accurate information for the general area. However, some records of collections, sightings or trappings cannot be dated or have plain language locality descriptions and may misrepresent the current range of a species (flora and fauna).

2.3.2 Survey limitations

The EPA technical guidance recommend flora and fauna survey reports for environmental impact assessment in WA should contain a section describing the limitations of the survey methods used. The limitations and constraints associated with this field survey are discussed in Table 2. Based on this assessment, the present survey effort has not been subject to any constraints that affect the assessment and the conclusions which have been formed.

Table 2 Field survey limitations

Aspect	Constraint	Comment
Sources of information and availability of contextual information.	Nil	Adequate information is available for the survey area including vegetation complex mapping (Heddle <i>et al.</i> 1980 and Webb <i>et al.</i> 2016) and DBCA Threatened and Priority ecological community, flora and fauna data. A previous survey report by Hollick (2014) was also available.
Scope (what life forms were sampled etc.)	Nil	Vascular flora and terrestrial vertebrate fauna were sampled during the survey. Non-vascular flora, invertebrate and aquatic fauna were not surveyed. This survey focused on dominant flora and conservation significant fauna species.
Proportion of flora collected and identified (based on sampling, timing and intensity) Proportion of fauna identified, recorded and/or collected	Minor	The reconnaissance vegetation survey was undertaken in late June, which is outside of the recommended timing for flora surveys in the South West Botanical Province (EPA (2016a)). The EPA recommends a spring survey (September – November). However, the vegetation survey was focused on describing broad vegetation types and their condition, and did not include a targeted flora assessment. The survey timing was considered appropriate for the purpose of the assessment. The reconnaissance fauna survey was also undertaken in winter 2019. Many cryptic species would not have been identified during a reconnaissance survey and seasonal variation within species often requires targeted surveys at a particular time of the year. The fauna assessment was aimed at identifying broad habitat types and conservation significant terrestrial vertebrate fauna utilising the survey area. The survey timing was considered appropriate for the purpose of the assessment.
Flora determination	Nil	Flora determination was undertaken by the survey botanist in the field. Species that could not be identified in the field were collected and identified at the WA Herbarium.
Completeness and further work which might be needed	Nil	The survey area was easily accessible via vehicle and foot. All areas of the survey area were adequately surveyed for the purpose of the assessment.
Mapping reliability	Minor	The survey was conducted using high-resolution ESRI aerial imagery obtained from Landgate, topographical features, previous vegetation mapping (Heddle <i>et al.</i> 1980 and Webb <i>et al.</i> 2016) and field data. Data was recorded in the field using hand-held GPS tools (e.g. Samsung tablet and Garmin GPS). Certain atmospheric factors and other sources of error can affect the accuracy of GPS receivers. The Garmin GPS units used for this survey are accurate to within ± 5 metres on average. Therefore the data points consisting of coordinates recorded from the GPS may contain minor inaccuracies.
Timing/weather/ season/cycle	Minor	The field surveys were conducted during winter (23rd July 2019). The weather conditions recorded during the survey were generally cool and wet with light winds. The conditions recorded during the survey were considered unlikely to have impacted upon the vegetation survey, however, may have reduced some fauna species activity during the time of the survey. The site appeared to have received moderate rainfall prior to GHD arriving in the morning and the rain had washed away tracks and morphed digging patterns making it difficult to determine species presence.

Aspect	Constraint	Comment
Disturbances (e.g. fire, flood, accidental human intervention)	Minor	Apart from disturbances associated with cattle grazing there were no significant sources of disturbance present during the survey. There was no recent evidence of fire throughout the site which was partly inundated at the time of survey. Recent rainfall and cattle activity had wiped the soil surface clean of recent tracks and diggings making it difficult to determine evidence of fauna activity.
Intensity (in retrospect, was the intensity adequate)	Nil	The survey area was sufficiently covered by the survey team during the survey. The purpose of the survey was a reconnaissance level survey with a focus on conservation significant vegetation and fauna. The survey intensity was sufficient for the survey purpose.
Resources	Nil	Adequate resources were employed during the field survey. One person day was spent undertaking the survey using suitably qualified personnel.
Access restrictions	Nil	No access problems were encountered during the survey.
Experience levels	Nil	The ecologist who executed the survey is suitably qualified and experienced in her respective field. Ecologist Angela Benkovic has over 13 years' experience in undertaking flora and vegetation surveys and assisting with fauna surveys within WA.

3. Desktop assessment

3.1 Literature review

One assessment has been completed within the survey area (supplied by the Shire of Jarrahdale Serpentine), which reported on environmental features, vegetation, flora and fauna. A summary of the results from this assessment is provided below.

Hollick (2014)

The survey area is located within Bush Forever site No. 77 which also extends east and south of the survey area. In addition to its Bush Forever status, the property lies within three Regional Ecological linkages (#83, #86 and #87), connecting the bushland to other areas west, north and east. An Environmentally Sensitive Area covers and extends beyond the property.

Parts of the property are mapped as Conservation Category wetlands, Resource Enhancement wetlands and Multiple Use wetlands. Mapped waterways run through the bushland area.

Five vegetation communities were identified within the property including:

- *Melaleuca preissiana* / *Kunzea glabrescens* low woodland or low open forest, dominated by juvenile and mature *Melaleuca preissiana* and *Kunzea glabrescens*, with sparse natural understorey shrubs (primarily *Astartea scoparia* and *Regelia ciliata*), sedges (including *Baumea vaginalis* and *Juncus kraussii*), and herbs, underlain by dominant pasture grasses and broad leaves
- *Banksia* low open forest, dominated by mature banksias (*Banksia attenuata*, *B. ilicifolia* and *B. menziesii*), with sparse natural understorey (both shrubs and herbs), underlain by dominant pasture grasses and broad leaves
- *Astartea scoparia* / *Regelia ciliata* closed heath, dominated by dense *Astartea scoparia* and *Regelia ciliata*, underlain by pasture grasses and broad leaves
- *Melaleuca* species tall open scrub, dominated by several melaleuca species (*Melaleuca raphiophylla*, *M. uncinata* and *M. viminea*), underlain by pasture grasses and broad leaves
- *Eucalyptus rudis* open forest, dominated by mature *Eucalyptus rudis*, with sparse natural understorey of *Astartea scoparia*, *Pteridium esculentum* and herbs, underlain by dominant pasture grasses and broad leaves.

In general, each community has a natural overstorey with a very sparse (or absent) natural understorey, and is dominated by a ground cover of pasture grasses and broad leaves.

Environmentally significant weeds were rare, with occasional records of *Phytolacca octandra*, *Ehrharta calycina* and *Solanum nigrum*.

The vegetation was classified as Degraded to Good, Degraded and Completely Degraded using the Keighery scale, as almost half of the property is completely cleared for pasture, the bushland is mostly parkland cleared with sparse or absent understorey and only small patches in slightly better condition. The bushland is dominated by pasture grasses and broad leaves, but environmental weeds were rare.

Bird life is abundant in the bushland, particularly water birds, along with frogs and fungi. The area is mapped as a Carnaby's Cockatoo possible breeding area buffer and unconfirmed roosting area buffer. Feral fauna include foxes, rabbits and bees, and cattle are grazed in the area (reportedly since the 1950s).

3.2 Wetlands

There are 11 geomorphic wetlands as described by Hill *et al.* (1996), which occur within or intersect the survey area (Table 3 and Figure 2, Appendix A). Of these, five are Conservation Category wetlands.

Table 3 Geomorphic wetlands within or intersecting the survey area

Name	UFI	Classification	Evaluation
Unknown	7000	Palusplain	Conservation
Unknown	7031	Dampland	Resource Enhancement
Unknown	14712	Dampland	Multiple Use
Unknown	14725	Palusplain	Conservation
Unknown	14726	Sumpland	Multiple Use
Unknown	14727	Sumpland	Conservation
Unknown	14763	Palusplain	Conservation
Unknown	14796	Sumpland	Resource Enhancement
Unknown	14798	Dampland	Conservation
Unknown	15246	Palusplain	Multiple Use
Unknown	16021	Palusplain	Multiple Use

3.3 Land use

3.3.1 DBCA legislated lands

No DBCA-legislated lands intersect the survey area. The closest DBCA managed area is located approximately 5 km north-west from the survey area and is an un-named area for explosives and forestry purposes (Figure 3, Appendix A).

3.3.2 Bush Forever

The entire survey area occurs within Bush Forever Site No. 77, Yangedi Swamp, Keysbrook (Figure 3, Appendix A).

3.3.3 Environmentally Sensitive Areas

The survey area lies within an Environmentally Sensitive Area (ESA). This ESA likely aligns with the presence of Bush Forever sites, TECs and their buffer zones (Figure 3, Appendix A).

3.4 Regional vegetation complexes

Regional vegetation has been mapped by Heddle *et al.* (1980) with updates from Webb *et al.* (2016) based on major geomorphic units on the Swan Coastal Plain (SCP). The mapping indicates that two vegetation complexes are present within the survey area, the Southern River Complex and the Bassendean Complex – Central and South (Figure 4, Appendix A). The Southern River Complex occurs on combinations of the Bassendean Dunes and Pinjarra Plain and the Bassendean Complex – Central and South occurs on the Bassendean Dunes.

- Southern River Complex: Open-woodland of Marri, Jarrah, *Banksia* on the elevated areas and a fringing woodland of *Eucalyptus rudis* (Flooded gum), *Melaleuca raphiophylla* (Swamp paperbark) along the streams. South of the Murray River *Agonis flexuosa* occurs in association with the flooded gum and Swamp Paperbark.
- Bassendean Complex – Central and South: Vegetation ranges from woodland of *Eucalyptus marginata* (Jarrah) - *Allocasuarina fraseriana* (Sheoak) - *Banksia* species to low woodland of *Melaleuca* species, and sedgeland on the moister sites. This area includes

the transition of *Eucalyptus marginata* (Jarrah) to *Eucalyptus tottiana* (Pricklybark) in the vicinity of Perth.

3.5 Conservation significant communities

Desktop searches of the DBCA TEC and PEC database identified one TEC and one PEC potentially occurring within the survey area. One additional TEC was also considered as potentially occurring within the survey area, the Banksia Woodlands of the SCP TEC. Details of these communities, based on a 5 km search buffer are provided in Table 4 and Figure 5, Appendix A.

Table 4 TECs and PECs identified in the DBCA database search that may occur within the survey area

Community	EPBC Act	BC Act/DBCA	Description
<i>Banksia</i> woodlands of the Swan Coastal Plain (TEC)	Endangered	Priority 3	The ecological community is a woodland associated with the Swan Coastal Plain. A key diagnostic feature is a prominent tree layer of <i>Banksia</i> , with scattered eucalypts and other tree species often present among or emerging above the <i>Banksia</i> canopy. The understorey is a species rich mix of sclerophyllous shrubs, graminoids and forbs. The ecological community is characterised by a high endemism and considerable localised variation in species composition across its range (TSSC 2016).
<i>Banksia</i> dominated woodlands of the Swan Coastal Plain IBRA Region (PEC)	As a component of the above TEC	Priority 3	Canopy is most commonly dominated or co-dominated by <i>Banksia attenuata</i> and/or <i>B. menziesii</i> . Other <i>Banksia</i> species that can dominate in the community are <i>B. prionotes</i> or <i>B. ilicifolia</i> . It typically occurs on well drained, low nutrient soils on sandplain landforms, particularly deep Bassendean and Spearwood sands and occasionally on Quindalup sands; it is also common on sandy colluvium and aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau and can occur in other less common scenarios
Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain (SCP15) (TEC)		Vulnerable	<i>Melaleuca raphiophylla</i> or <i>Casuarina obesa</i> dominate this community type. The community occurs on alluvial sediments and is related to the clay pan communities FCT7 and FCT9. It occurs in sites that are inundated for much longer periods and to greater depths than the clay pan communities. Key species included an upper storey of <i>M. raphiophylla</i> , <i>M. teretifolia</i> and <i>M. incana</i> over introduced grass * <i>Cynodon dactylon</i> and introduced/ native aquatic herbs such as * <i>Cotula coronopifolia</i> , * <i>Crassula natans</i> and <i>Lemna disperma</i> .

3.6 Conservation significant flora

The *NatureMap* database search identified the presence/potential presence of five conservation significant flora taxa within 5 km of the survey area. The search recorded:

- One Threatened flora taxon
- One Priority 1 taxon
- One Priority 2 taxon
- One Priority 3 taxon
- One Priority 4 taxon.

The DBCA Threatened and Priority flora searches (TPFL and WAHERB) supplied by the PTA identified eight records of conservation significant flora taxa within a 5 km buffer of the survey area (Figure 5, Appendix A). The DBCA database searches contained no species names or identifiers, therefore no comparisons with the *NatureMap* searches results could be made.

The DBCA database search results indicated one Priority 4 taxon occurs within the survey area. Hollick (2014) noted that *Stylidium longitubum* (Priority 4) had historically been recorded within the survey area.

3.7 Conservation significant fauna

The *NatureMap* database search identified the presence/potential presence of four conservation significant fauna species within 5 km of the site, excluding marine listed species as no marine habitat is present within the site. The search recorded:

- Three species listed under the EPBC Act and/or BC Act as Critically Endangered, Endangered or Vulnerable
- One Priority 4 species.

The DBCA Threatened and Priority fauna search supplied by the PTA identified 24 records of conservation significant fauna within a 5 km buffer of the survey area (Figure 5, Appendix A). The DBCA database searches contained no species names or identifiers, therefore no comparisons with the *NatureMap* searches results could be made.

The DBCA database search results indicate no records of conservation significant fauna occurring within the survey area.

Black cockatoos

Available Carnaby's Cockatoo mapping (GoWA 2019) provides locations of confirmed and possible breeding areas, confirmed, unconfirmed and buffered roosting areas, and feed areas (as outlined by Glossop et al. (2011)). This mapping indicates the survey area lies within a possible Carnaby's Cockatoo breeding area and an unconfirmed roost area. The mapping also indicates the survey area contains plant species which Carnaby's Cockatoos show a preference for when feeding (mapped as feed area requiring investigation). Furthermore, the 2018 Great Cocky Count (Peck et al. 2018) reports that confirmed roosts used by both Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo have been recorded in the Keysbrook area.

4. Field survey

4.1 Broad vegetation type and condition

Five broad vegetation types as well as open water and cleared/agricultural land were identified within the survey area. The vegetation types were represented by a *Banksia* low woodland, dryland community, three *Melaleuca* dampland communities and one highly modified community consisting of isolated trees over pasture weeds (Figure 6, Appendix A).

Banksia low woodland was the dominant vegetation type and was located within the central part of the survey area. *Melaleuca* spp. over a tall shrubland was mapped in the south east, south west and north eastern corners of the survey area. *Melaleuca* spp. low open woodland differed from the previous vegetation type in that it was inundated with water (0.5 m deep) and dominated by aquatic herbs. *Melaleuca preissiana* low woodland, located along the western boundary, was an isolated homogenous stand of *M. preissiana* over open water. The three *Melaleuca* vegetation types corresponded with Conservation and Resource Enhancement Category Wetlands mapped by Hill *et al.* (1996). Isolated natives over weeds was mapped in the north western corner of the survey area. This vegetation type consisted of mature stands of predominately Jarrah (*Eucalyptus marginata*) and Marri (*Corymbia calophylla*) with exotic plantings closer to the homestead. Cleared agricultural land covered approximately 39% (100.67 ha) of the survey area.



The vegetation types are considered to be representative of the Southern River Complex and Bassendean Complex – Central and South. Based on landform and dominant species, the vegetation types identified in the survey area are considered to align with the following FCTs:



- FCT23a – Central *Banksia attenuata* – *B. menziesii* woodlands
- S01 *Astartea* aff. *fascicularis*/ *Melaleuca* species dense shrublands
- FCT15 – Forests and woodlands of deep seasonal wetlands

Table 5 describes the vegetation types mapped within the survey area along with FCT alignment, extent and representative photographs.

The vegetation condition ranged from Good to Completely Degraded. The majority of the survey area comprised Degraded and Completely Degraded areas. Completely Degraded areas were represented by cleared agricultural land that comprised isolated occurrences of native trees over pasture. The *Banksia* low woodland vegetation type was in Degraded condition due to significant impact by cattle grazing and trampling. This vegetation type lacked mid and lower storey structure in most places. Whilst there was moderate species diversity present, most shrubs and herbs had been impacted by grazing (i.e. were chewed to the ground). Similarly with the *Melaleuca* vegetation types, the species diversity was present, but the vegetation was being impacted by grazing. Areas in Good condition had dense mid-storey species such as *Astartea scoparia* and/r *Kunzea glabrescens* that inhibited the cattle grazing/movement. The extents of the vegetation condition ratings within the survey area are presented in Table 6 and mapped in Figure 7, Appendix A.

Table 5 Vegetation types identified within the survey area

Vegetation type and description	Condition and extent (ha)	FCT alignment	Representative photograph
<p>Banksia low woodland <i>Eucalyptus marginata</i> isolated trees over <i>Banksia menziesii</i>, <i>B. attenuata</i> and <i>B. ilicifolia</i> low woodland over <i>Kunzea glabrescens</i> tall sparse shrubland over *<i>Arctotheca calendula</i>, *<i>Ursinia anthemoides</i> and *<i>Poaceae</i> sp. herbland/ grassland</p>	Degraded – 99.94	FCT23a	
<p>Melaleuca spp. over a tall shrubland <i>Eucalyptus rudis</i> isolated trees over <i>Melaleuca preissiana</i> and <i>M. raphiophylla</i> low open forest over <i>Astartea scoparia</i>, <i>M. teretifolia</i> and <i>Kunzea glabrescens</i> tall shrubland over <i>Juncus pallidus</i> and <i>Lepidosperma</i> sp. open sedgeland</p>	Good – 9.28 Degraded – 27.26 Total – 36.54	S01	

Vegetation type and description	Condition and extent (ha)	FCT alignment	Representative photograph
<p>Melaleuca spp low open woodland <i>Melaleuca preissiana</i>, <i>M. teretifolia</i> and <i>M. viminea</i> low open woodland over <i>*Cotula coronopifolia</i>, <i>*Crassula natans</i> and <i>Lemna disperma</i> herbland (inundated)</p>	Degraded – 1.67	FCT15	
<p>Melaleuca preissiana low woodland <i>Melaleuca preissiana</i> low woodland over open water</p>	Good – 4.35	S01	



Vegetation type and description	Condition and extent (ha)	FCT alignment	Representative photograph
<p>Isolated native trees over weeds <i>Eucalyptus marginata</i>, *<i>Eucalyptus</i> spp., <i>Corymbia calophylla</i>, <i>Agonis flexuosus</i> over pasture weeds</p>	Degraded – 9.76	N/A	
<p>Cleared/ agricultural land Predominately agricultural paddocks but also includes firebreaks, tracks and buildings. These areas had occasional, isolated clumps of native trees or shrubs, such as <i>Eucalyptus</i> spp., <i>Corymbia calophylla</i>, <i>Agonis flexuosa</i>, <i>Kingia australis</i> and <i>Melaleuca</i> spp.</p>	Completely Degraded – 100.73	N/A	
Open water	4.43	N/A	

Table 6 Vegetation condition and extent

Vegetation condition	Extent (ha)
Good	13.63
Degraded	138.63
Completely Degraded	100.73
Not rated – Open water	4.43
Total	257.41

4.2 Conservation significant ecological communities

Based on desktop searches, dominant species and field observations, two conservation significant communities were considered likely to occur within the survey area:

- Forests and woodlands of deep seasonal wetlands (SCP15) (TEC)
- *Banksia* dominated woodlands of the SCP IBRA region (PEC).

Conservation significant communities considered likely to occur within the survey area are described in detail below and mapped in Figure 8, Appendix A.

Forests and woodlands of deep seasonal wetlands –SCP15 (TEC)

Melaleuca raphiophylla or *Casuarina obesa* dominate this community type. The community occurs on alluvial sediments and is related to the clay pan communities FCT7 and FCT9. It occurs in sites that are inundated for much longer periods and to greater depths than the clay pan communities. Vegetation type *Melaleuca* spp. low open woodland is considered representative of the Forests and woodlands of deep seasonal wetlands (SCP15) due to its low lying position in the landscape and the presence of typical and common species. Typical and common species included an upper storey of *M. raphiophylla*, *M. teretifolia* and *M. incana* over aquatic herbs such as **Cotula coronopifolia*, **Crassula natans* and *Lemna disperma*. There is 1.67 ha of this community type mapped within the survey area.

Banksia dominated woodlands of the SCP IBRA region (PEC)

Banksia dominated woodlands of the SCP IBRA region is a Priority 3 PEC listed by DBCA. DBCA (2019) describes the *Banksia* PEC as having a canopy that is most commonly dominated or co-dominated by *Banksia attenuata* and/or *B. menziesii*. Other *Banksia* species that can dominate in the community are *B. prionotes* or *B. ilicifolia*. The PEC differs from the EPBC Act listed *Banksia* woodlands of the Swan Coastal Plain TEC in that it has no minimum condition and patch size thresholds.

The Central *Banksia attenuata* – *B. menziesii* woodlands (FCT23a) was identified within the survey area. This FCT is not listed as a TEC under the BC Act or as a PEC by the DBCA. However FCT 23a is considered a component of the *Banksia* dominated woodlands of the SCP IBRA region PEC due to key structural features.

Vegetation type *Banksia* low woodland is considered representative of the *Banksia* dominated woodlands of the SCP IBRA region (PEC). It is not considered representative of the Commonwealth-listed *Banksia* TEC as it does not meet the minimum condition thresholds. There is 99.94 ha of the *Banksia* dominated woodlands of the SCP IBRA region (PEC) within the survey area.

4.3 Broad fauna habitats


Four broad fauna habitats were identified within the survey area based on the predominant landforms, soil and vegetation structure in the area. The habitat types closely align with the


vegetation types outlined in Table 5. The fauna habitats of the survey area are described in Table 7 and mapped in Figure 9, Appendix A.


The native vegetation within the survey area consists predominantly of mixed *Banksia* Woodlands, isolated native and planted trees over weeds, wetlands, and *Melaleuca* over tall shrubland. Most of the habitat within the survey area is degraded with high grazing pressures from cattle that roam freely throughout the survey area.


For the most part, none of the habitat types currently support small ground dwelling mammals and reptiles. The lack of sufficient understorey and mid-storey due to grazing pressures removes shelter and foraging habitat for these small fauna. The habitat appears to be most suited to avian fauna and some areas may provide suitable foraging, potential breeding and roosting habitat for black cockatoos.

Table 7 Broad fauna habitats in the site

Broad Fauna Habitat Types	Extent (ha)	Representative photograph
<p>Mixed Banksia Woodland</p> <p>Corresponding vegetation type: Banksia low woodland</p> <p>Jarrah isolated trees over <i>Banksia menziesii</i>, <i>B. attenuata</i> and <i>B. ilicifolia</i> low woodland over <i>Kunzea glabrescens</i> tall sparse shrubland over weedy grasses and herbs.</p> <p>This habitat type dominates the central survey area and contains poor structural diversity and few microhabitats. Microhabitats include within some fallen tree debris/small-medium banksia logs and small tree hollows. The site is highly disturbed by cattle and lacks sufficient understorey and mid-storey to support most small ground dwelling mammals and reptiles. While isolated Jarrah trees were observed, it is considered limited to no breeding or roosting habitat for black cockatoos is present within this habitat type. Black cockatoo foraging items (e.g. Jarrah, Banksia) are present in this habitat and black cockatoos were observed in this habitat during survey.</p> <p>Conservation Significant Fauna</p> <p>The habitat within the site provides resources for conservation significant fauna including:</p> <ul style="list-style-type: none"> • Forest Red-tailed Black Cockatoo (observed – opportunistic foraging only) • Carnaby’s Cockatoo (foraging only) • South-western Brush-tailed Phascogale (foraging, shelter/refuge) <p>Habitat value – Moderate</p>	99.94	

Broad Fauna Habitat Types	Extent (ha)	Representative photograph
<p>Isolated native and planted trees over weeds</p> <p>Corresponding vegetation types: Isolated native trees over weeds, Cleared/ agricultural land</p> <p>Predominately agricultural paddocks with occasional isolated clumps of native trees or shrubs, such as Jarrah and introduced <i>Eucalyptus</i> spp., Marri, <i>Agonis flexuosa</i>, (Peppermint), <i>Kingia australis</i> and <i>Melaleuca</i> spp over pasture weeds. This habitat type contains poor structural diversity with a scattered overstorey, lack of mid-storey and understorey of pastoral weeds. This area also contains planted trees surrounding the farm house. The lack of vegetation coverage (midstorey and native understorey) makes the habitat type unsuitable for most small mammals and reptiles. While most of the larger trees had been historically felled, about half a dozen live Jarrah remained with the potential to provide black cockatoo breeding and roosting habitat. Various other stags were present in the habitat type which may also provide roosting or breeding habitat (dependant on structural integrity of each tree). Some Jarrah trees were observed to have hollows although most appeared to be occupied by bees. Black cockatoos may opportunistically forage on Marri nuts from the immature trees, and old foraging residue (chewed marri nuts) were observed during the survey.</p> <p>Conservation Significant Fauna</p> <p>The habitat within the site provides resources for conservation significant fauna including:</p> <ul style="list-style-type: none"> • Forest Red-tailed Black Cockatoo (foraging, roosting, breeding) • Carnaby's Cockatoo (foraging, roosting, breeding) • South-western Brush-tailed Phascogale (foraging, shelter/refuge) <p>Habitat value – Moderate</p>	110.48	

Broad Fauna Habitat Types	Extent (ha)	Representative photograph
<p>Wetlands</p> <p>Corresponding vegetation types: <i>Melaleuca</i> spp low open woodland, <i>Melaleuca preissiana</i> low woodland, Open water</p> <p><i>Melaleuca preissiana</i>, <i>M. teretifolia</i> and <i>M. viminea</i> low open woodland over dampland and aquatic herbs (inundated).</p> <p>This habitat type provides poor structural diversity and is seasonally inundated. Grazing pressures are high and the site lacks sufficient understorey to support most small ground dwelling mammals and reptiles. The waterlogged soil prevents soil living fauna from utilizing the area. During wet periods, fauna may use this habitat type as a drinking water supply. Connectivity with apparent woodland/heathland to the adjacent south may allow passage of South-western Brown Bandicoot to access the survey area although they are not considered to be permanent residents.</p> <p>Conservation Significant Fauna</p> <p>The habitat within the site provides resources for conservation significant fauna including:</p> <ul style="list-style-type: none"> • South-western Brown Bandicoot (opportunistic) <p>Habitat value – Moderate</p>	10.46	

Broad Fauna Habitat Types	Extent (ha)	Representative photograph
<p>Melaleuca over tall shrubland</p> <p>Corresponding vegetation type: <i>Melaleuca</i> spp. over a tall shrubland Flooded gum isolated trees over <i>Melaleuca preissiana</i> and <i>M. raphiophylla</i> low open forest over <i>Astartea scoparia</i>, <i>M. teretifolia</i> and <i>Kunzea glabrescens</i> tall shrubland over open sedgeland.</p> <p>This habitat type contains good structural diversity. In general, the midstorey was relatively dense which prevented cattle from accessing parts of the habitat type. The soil is considered too damp to support soil dwelling fauna. There was generally not a lot of leaf litter and woody debris. Small mammals may use this habitat type to forage and shelter. While isolated Flooded gum trees were observed, it is considered limited to no breeding or roosting habitat for black cockatoos is present within this habitat type.</p> <p>Conservation Significant Fauna</p> <p>The habitat within the site provides resources for conservation significant fauna including:</p> <ul style="list-style-type: none"> • South-western Brown Bandicoot (opportunistic foraging) <p>Habitat value – Moderate</p>	36.54	

4.4 Black cockatoo habitat assessment

One species of black cockatoo, Forest Red-tailed Black Cockatoo was recorded during the survey, with the potential for Carnaby's Cockatoo to also occur within the survey area.

The Forest Red-tailed Black Cockatoo is endemic to the south-west humid and sub-humid zones of Western Australia (Mawson and Johnstone 1997). It inhabits the dense Jarrah, Karri and Marri forests receiving more than 600 mm of annual average rainfall. The current distribution is north of Perth and east to Mount Helena, Christmas Tree Well, North Banister, Mt Saddleback, Rocky Gully and the upper King River (Johnstone 1997). More recently the species has been utilising and persisting on the northern portions of the SCP and is now considered a regular sighting (Johnstone et al. 2017). The Forest Red-tailed Black Cockatoo roosts in Jarrah-Marri-Blackbutt habitat on road-sides, paddocks or forest blocks. While the Forest Red-tailed Black Cockatoo feeds on other species (such as *Allocasuarina* cones Snottygobble (*Persoonia longifolia*) fruits), around 90 per cent of its diet is made up of the seeds from Marri and Jarrah fruits. The species has also adapted to feeding on the introduced Cape Lilac tree (*Melia azedarach*) which is common on the Swan Coastal Plain (Johnstone et al. 2017).

Carnaby's Cockatoo is endemic to the south-west of Western Australia with a widespread distribution. Carnaby's Cockatoo nest in hollows of live or dead eucalypts, primarily smooth-barked Salmon Gum and Wandoo (Saunders 1979, 1982) though breeding has been reported in other Wheatbelt tree species and some tree species on the SCP and Jarrah Forest (Saunders 1979, 1982; Storr 1991; Johnstone and Storr 2004). Success in breeding is dependent on the quality and proximity of feeding habitat within 12 km of nesting sites (Saunders and Ingram 1987). Carnaby's forage in native shrubland. Kwongan heathland and woodland dominated by proteaceous plant species such as *Banksia* spp., *Hakea* spp. and *Grevillea* spp. Pine plantations (*Pinus* spp.), eucalypt woodlands and forest that contains foraging species will also be used as well as individual trees or small stands of these species (in paddocks or on road verges).

During the survey seven Forest Red-tailed Black Cockatoos perched on a Jarrah stag were observed within the Mixed *Banksia* Woodland. Old feeding evidence on Marri nuts was also recorded within the isolated native and planted trees over weeds habitat type. Both Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo are known to breed and roost in Marri, Jarrah and introduced eucalypts. The survey area is considered to provide foraging habitat, but limited roosting habitat and very limited (to nil) potential breeding habitat for both species. The extents of black cockatoo habitats within the survey area are detailed in Table 8. The foraging habitat scoring tool available in DEE (2017) was applied to the foraging habitat present within the survey area. Table 9 provides a summary of foraging habitat quality scores.

Table 8 Habitat suitability for black cockatoos

Habitat type	Extent (ha)	Comments
Breeding	110.48	Isolated native and planted trees over weeds (110.48 ha) contains potentially suitable trees for black cockatoo breeding. Mixed <i>Banksia</i> Woodland (99.94 ha) and <i>Melaleuca</i> over tall shrubland (36.54 ha) may contain some potentially suitable trees. Overall the habitats are likely to have very limited to nil breeding habitat present, and where present, the breeding habitat would be considered low quality. No hollows or potential hollow trees were observed during the reconnaissance level survey. There are no confirmed breeding areas in the vicinity of Keysbrook according to the Carnaby's Cockatoo Breeding Areas dataset (GoWA 2019). The closest confirmed breeding area is located 28 km north of the Keysbrook site. It is noted that the Keysbrook site occurs in a floodplain zone, which is

Habitat type	Extent (ha)	Comments
		<p>generally not know to support significant locations of black cockatoo breeding habitat. It is likely there are small, scattered areas of black cockatoo breeding habitat present in the broader area.</p> <p>Known breeding locations in the vicinity of Keysbrook include Mandurah entrance road and forested hills area to the east and further south through Greenlands Road area (for Forest Red-tailed Black Cockatoo). There are also some Carnaby's Cockatoos in nest boxes at Meelup Lake.</p>
Foraging	<p>High quality: 99.94 ha</p> <p>Low quality: 147.02</p>	<p>Mixed <i>Banksia</i> Woodland (99.94 ha), isolated native and planted trees over weeds (110.48 ha) and <i>Melaleuca</i> over tall shrubland (36.54 ha) contain suitable feeding species for black cockatoos. The foraging extent is based on high level vegetation type (and fauna habitat) mapping. A summary of foraging habitat quality is provided in Table 9.</p> <p>Mixed <i>Banksia</i> Woodland (99.94 ha) is considered to provide very high quality foraging for Carnaby's Cockatoo based on the scoring tool. The remaining habitats are considered to provide low quality foraging habitat for both Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo based on the scoring tool. These habitats are likely to have isolated foraging species present.</p> <p>Old foraging evidence recorded during the survey so it is assumed that black cockatoos utilise the survey area for foraging. Black Cockatoos are opportunistic foragers so will utilise suitable areas. The habitat is within 20 km of known breeding so the habitat would be considered supportive foraging habitat.</p>
Roosting	110.48	<p>Isolated native and planted trees over weeds (110.48 ha) contains potentially suitable trees for black cockatoo roosting. Mixed <i>Banksia</i> Woodland (99.94 ha) and <i>Melaleuca</i> over tall shrubland (36.54 ha) may contain some potentially suitable trees. Overall the habitats are likely to have limited (to nil) roosting habitat present, and where present, the roosting habitat would be considered low quality.</p> <p>An unconfirmed roost area (mapped by GoWA 2019) intersects the southern boundary of the survey area.</p>

Table 9 Black Cockatoo foraging habitat quality

	Carnaby's Cockatoo	Forest Red-tailed Black Cockatoo
Starting score	<p>Suitable fauna habitats include:</p> <ul style="list-style-type: none"> Mixed <i>Banksia</i> woodland (99.94 ha) Isolated native and planted trees (110.48 ha) <p>The mixed <i>Banksia</i> woodland habitat comprises isolated Jarrah trees over <i>Banksia menziesii</i>, <i>B. attenuata</i> and <i>B. ilicifolia</i>. This habitat covers 99.94 ha and was given a starting score of 7 (high quality).</p> <p>The isolated native and planted trees habitat comprises occasional isolated clumps of native trees or shrubs, such as Jarrah, introduced <i>Eucalyptus</i> spp. and Marri. This habitat would also provide foraging habitat, but is considered low quality. This habitat covers 110.48 ha.</p>	<p>Suitable fauna habitats include:</p> <ul style="list-style-type: none"> Mixed <i>Banksia</i> woodland (99.94 ha) Isolated native and planted trees (110.48 ha) <i>Melaleuca</i> over tall shrubland (36.54 ha) <p>The mixed <i>Banksia</i> woodland habitat comprises isolated Jarrah trees. Similarly, the isolated native and planted trees habitat comprises occasional isolated clumps of native trees or shrubs, such as Jarrah, introduced <i>Eucalyptus</i> spp. and Marri.</p> <p>The <i>Melaleuca</i> over tall shrubland habitat comprises isolated Flooded gum trees.</p> <p>All of the above habitats are considered low quality and would have a starting score of 1.</p>
Additions	+3 Keysbrook is located on the SCP	No or limited Jarrah and/or Marri showing good recruitment (i.e. evidence of young trees).
	Assumed no suitable breeding habitat (i.e. trees with suitable nest hollows)	Assumed no suitable breeding habitat (i.e. trees with suitable nest hollows)
	The site does not primarily comprise Marri	+2 Primarily contains Marri and/or Jarrah.
	Assumed no trees with potential to be used for breeding (DBH ≥ 500 mm).	Assumed no trees with potential to be used for breeding (DBH ≥ 500 mm).
	Is not a known roosting site, (only unconfirmed)	Is not a known roosting site, (only unconfirmed)
Subtractions	No subtractions	No subtractions
Final score	<p>10</p> <p>The mixed <i>Banksia</i> woodland habitat (covering 99.94 ha) would provide very high quality foraging for Carnaby's Cockatoo based on the scoring tool.</p>	<p>3</p> <p>All of the habitats would provide low quality foraging habitat for Forest Red-tailed Black Cockatoo.</p>

4.5 Conservation significant fauna

No evidence of other conservation significant fauna was observed within the survey area during the survey.

Likelihood of occurrence assessment

An assessment of the likelihood of occurrence for conservation significant fauna in the survey area was conducted (Table 10). This assessment was based on species biology, habitat requirements, the quality and connectivity of available habitat, and local and regional occurrence of species records. The assessment identified one species as recorded present (through evidence) and three species that are considered likely to occur within the site.

Table 10 Summary of conservation significant fauna likelihood of occurrence assessment

Species	Common name	Federal Listing	State Listing	Likelihood of occurrence
Birds				
<i>Calyptorhynchus banksii</i> subsp. <i>naso</i>	Forest Red-tailed Black Cockatoo	VU	VU	Present Forest Red-tailed Black Cockatoos observed within the survey area
<i>Calyptorhynchus latirostris</i>	Carnaby's Cockatoo	EN	EN	Likely The survey area provides suitable foraging, potential roosting and potential breeding habitat. Past surveys have recorded the survey area as Carnaby's Cockatoo feeding habitat (Hollick 2014), Occurs locally.
<i>Isodon fusciventer</i>	South-western Brown Bandicoot	P4		Likely This species may use the survey area opportunistically to forage or as a water source. Known to occur locally.
<i>Phascogale tapoatafa</i> subsp. <i>wambenger</i>	South-western Brush-tailed Phascogale	CD		Likely The survey area has suitable (albeit limited) habitat to support this species including foraging and nesting resources such as tree hollows, rotted stumps and tree cavities. The species has been recorded in the local area.

5. Opportunities for on ground management

The following on ground maintenance will need to be considered:

- Cattle would need to be removed from premises and secure gates put in place to maintain their exclusion. This would promote the regeneration of the mid and lower strata species in all vegetation types.
- Gates will need to be frequently checked to ensure there are no damages as the site is surrounded by agricultural land on three sides.
- To encourage use by bandicoots, the site would need to be rehabilitated, particularly the lower strata vegetation that provides shelter and feral animal control implemented, including rabbit, fox, cat and possibly pigs.
- The *Banksia* low woodland vegetation type should be rehabilitated (planting of additional known food plants) to provide better quality foraging habitat to support black cockatoos.
- Installation of nest tubes (artificial nesting hollows) for black cockatoos
- The condition of the *Banksia* low woodland vegetation type has the potential to improve if suitable recovery and management actions are taken.

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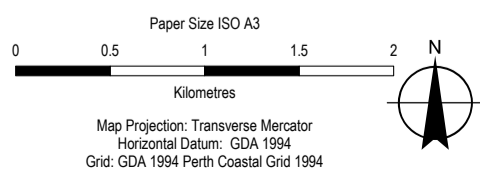
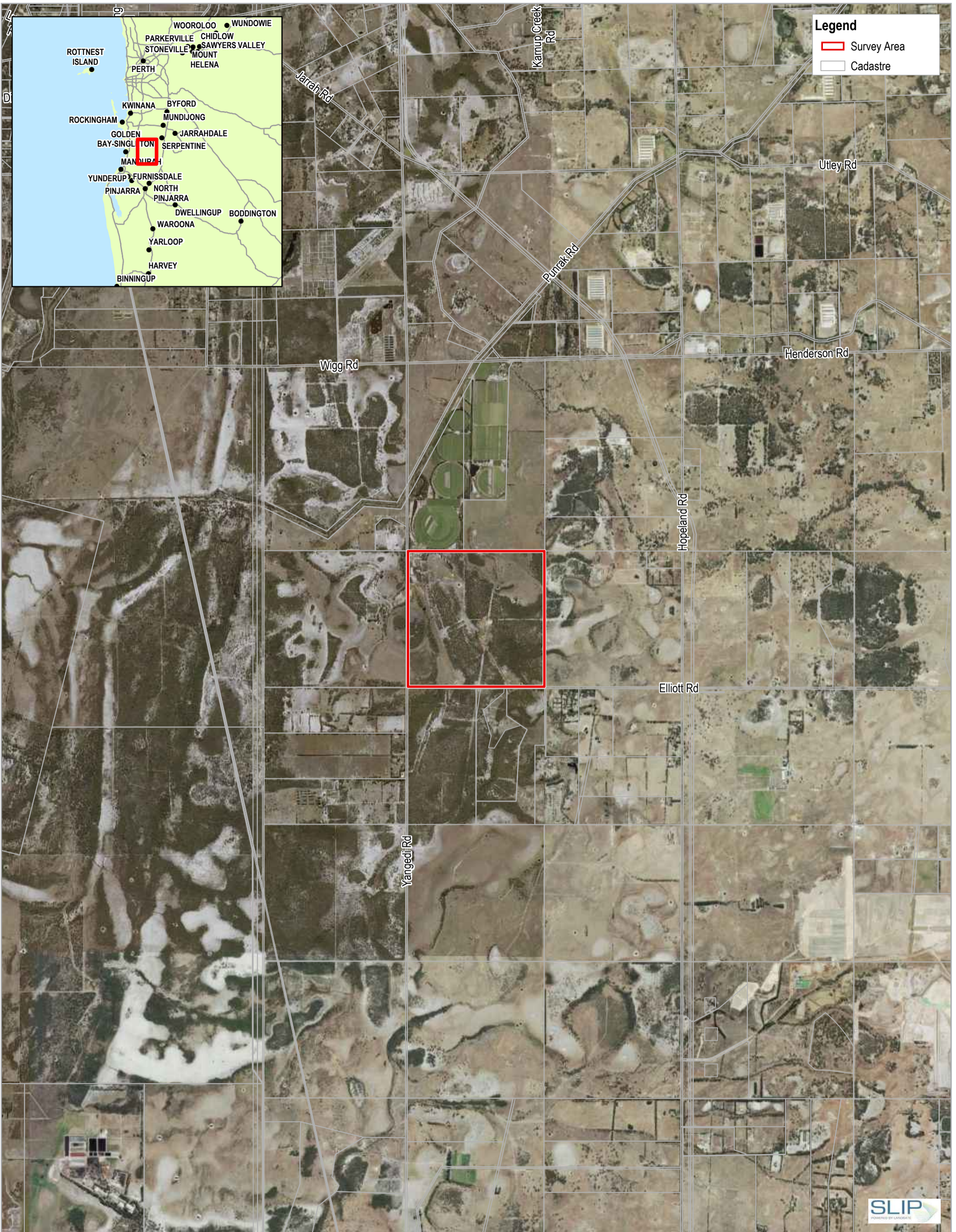
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Appendices

Appendix A – Figures

- Figure 1 Site location**
- Figure 2 Hydrology constraints**
- Figure 3 Land use constraints**
- Figure 4 Vegetation complexes**
- Figure 5 Biological constraints**
- Figure 6 Vegetation types and sample sites**
- Figure 7 Vegetation condition**
- Figure 8 Conservation significant communities**
- Figure 9 Fauna habitat**

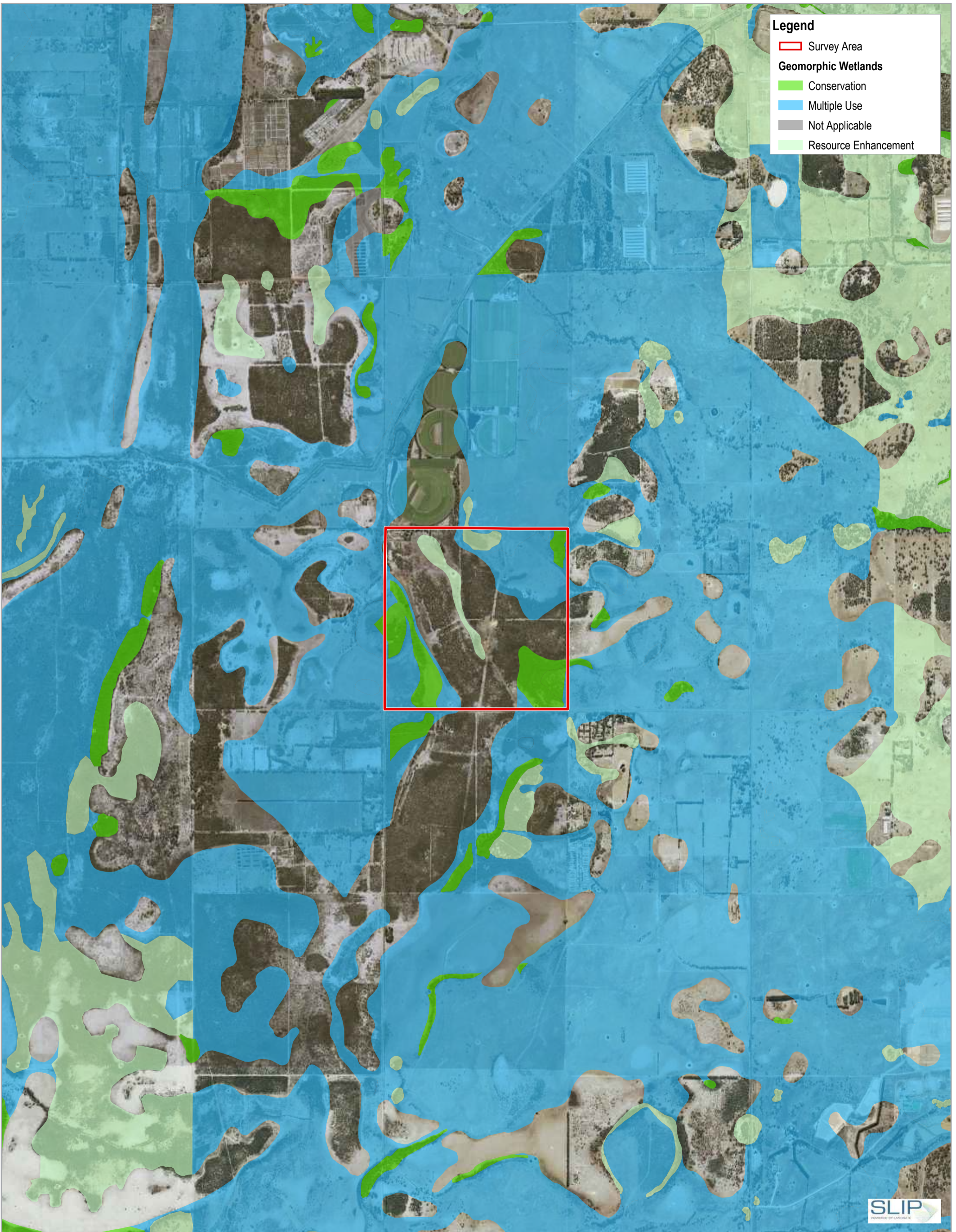


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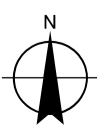
Keysbrook Site Location

Project No. 61-38451-00
Revision No. 0
Date 23/09/2019

FIGURE 1



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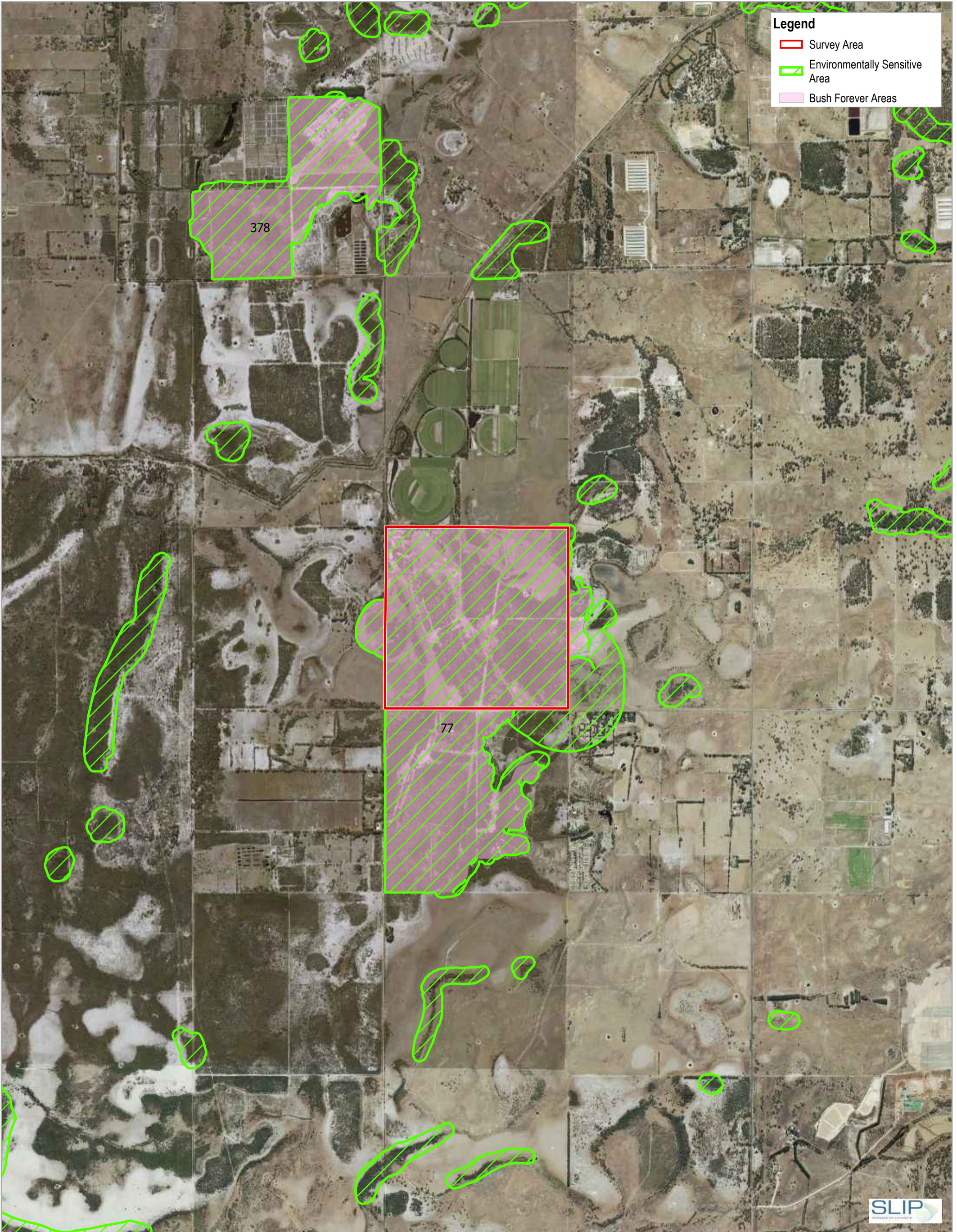


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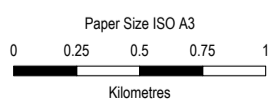
Hydrological constraints

FIGURE 2

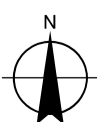


Legend

- Survey Area
- Environmentally Sensitive Area
- Bush Forever Areas



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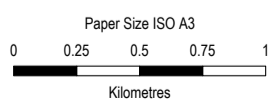
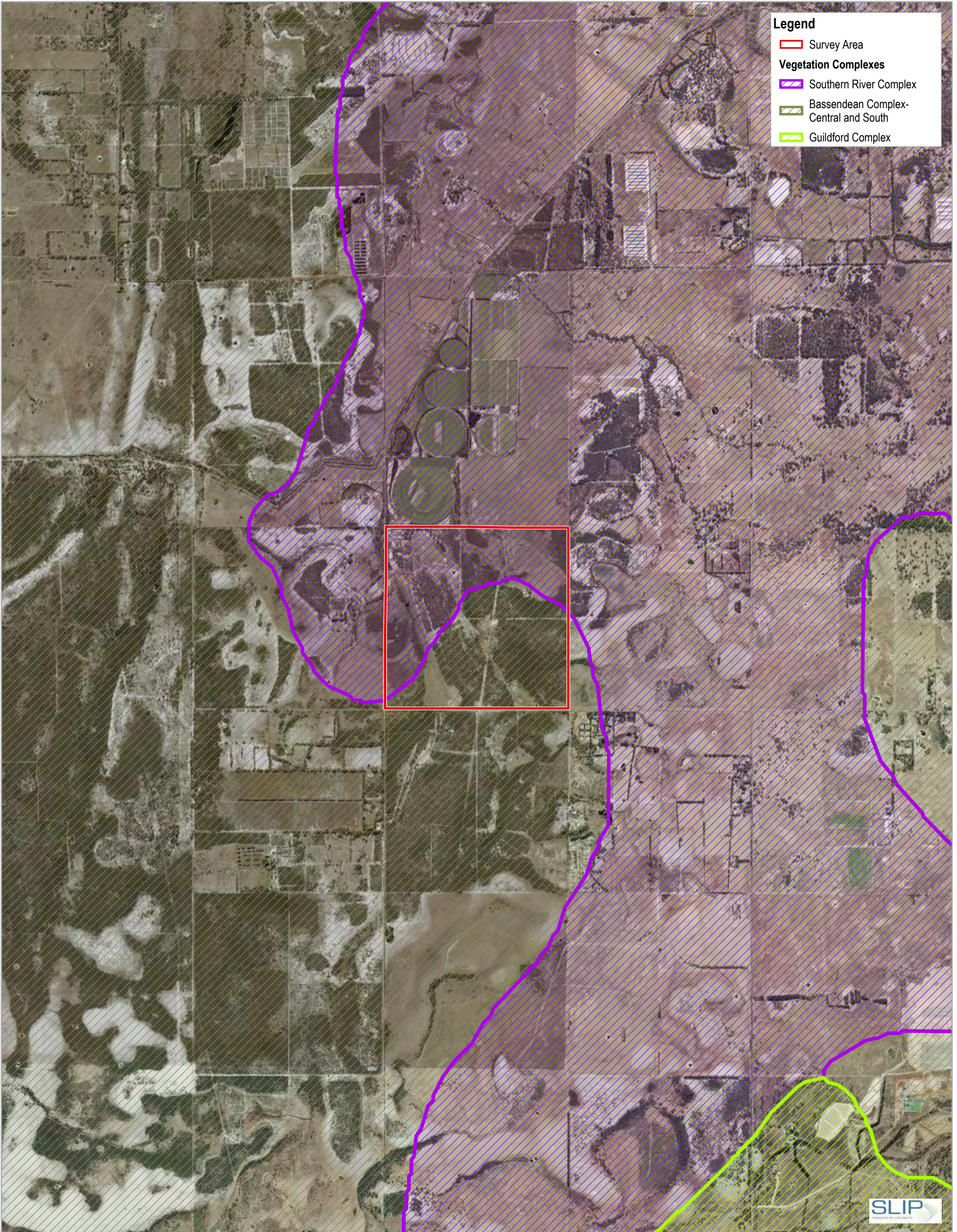


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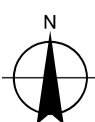
Land use constraints

Project No. 61-38451-00
 Revision No. 0
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FIGURE 3



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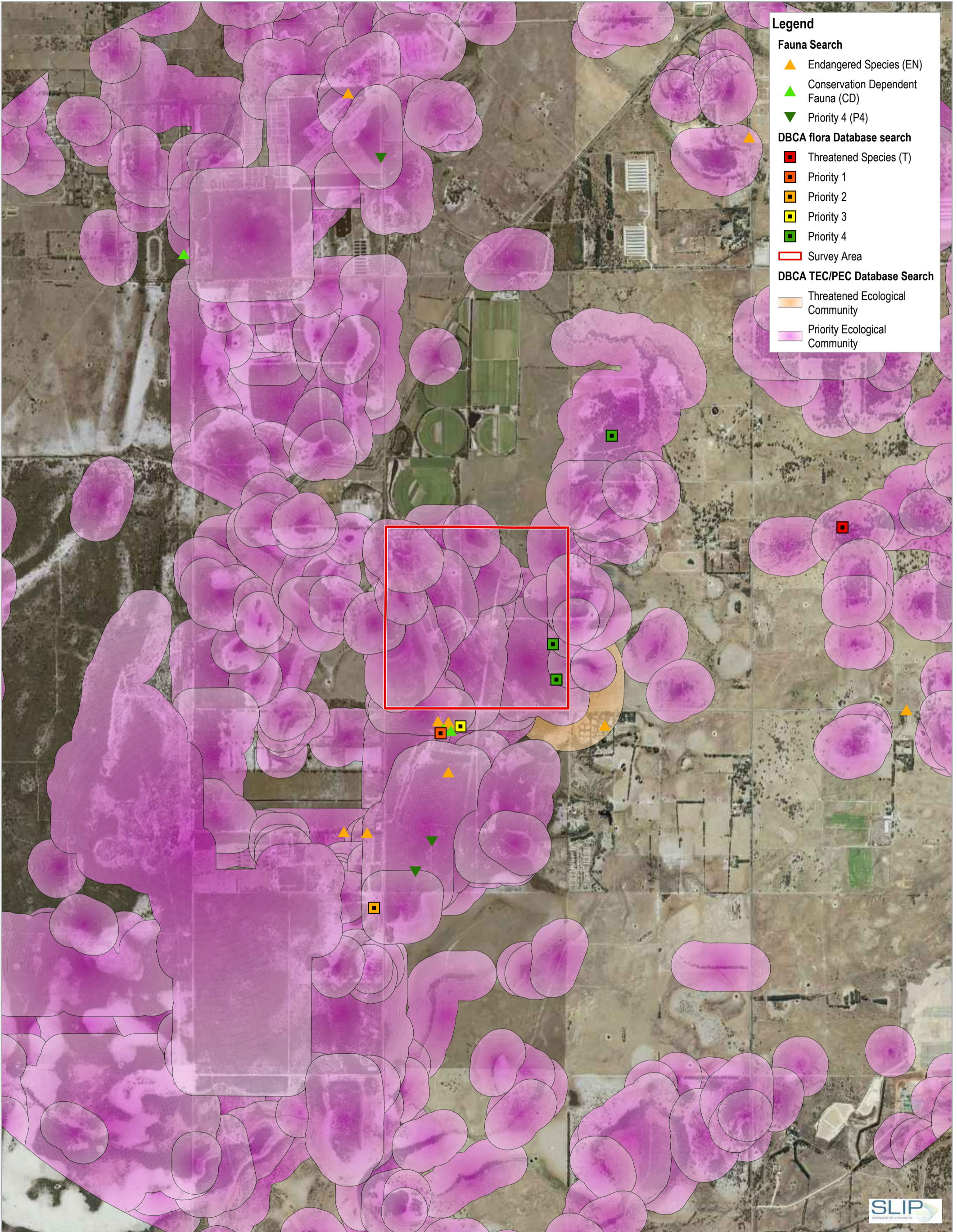


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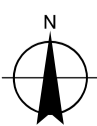
Land use constraints

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FIGURE 4



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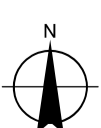
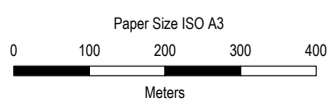
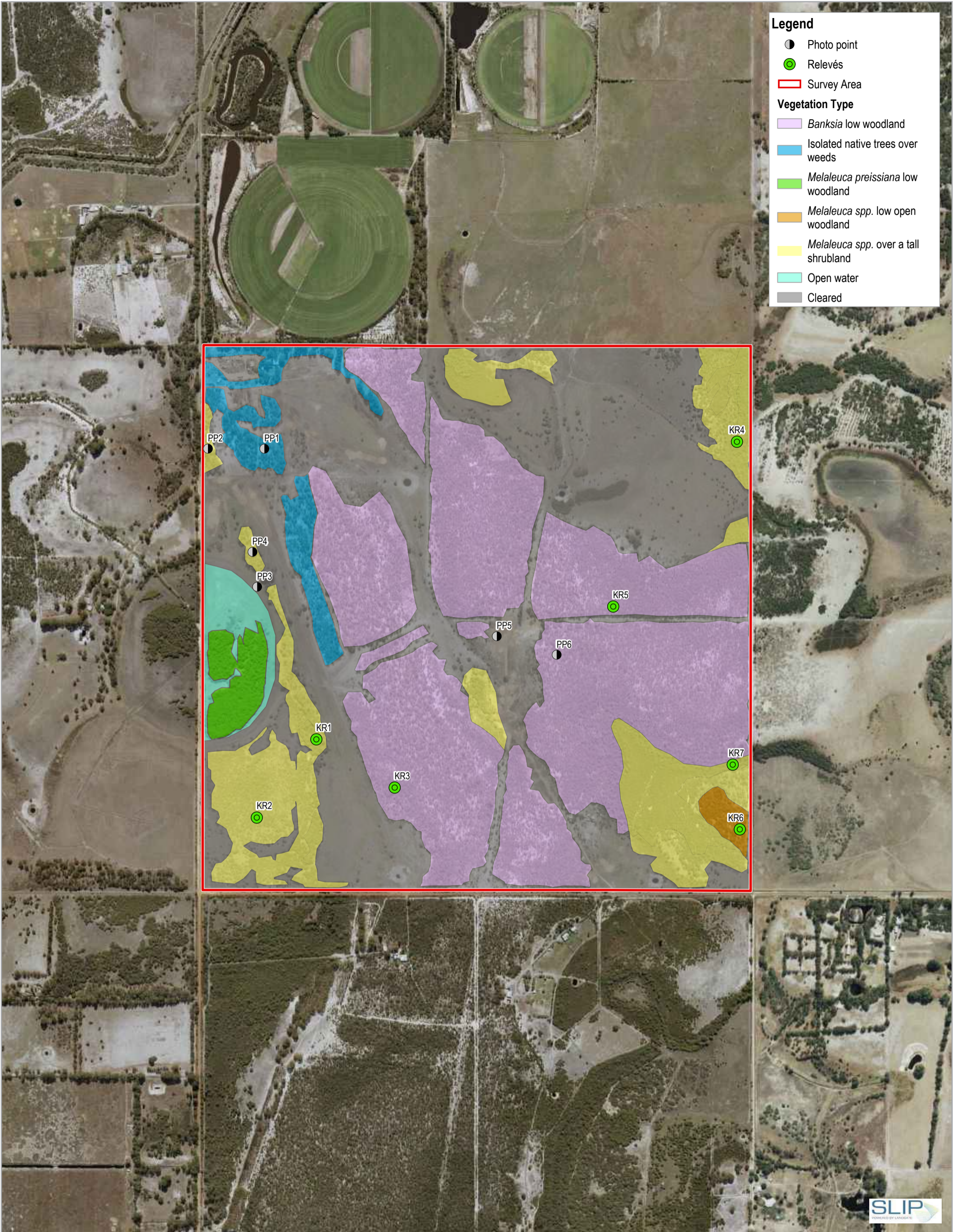


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 Potential Offset Sites Environmental Assessment

Biological constraints

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FIGURE 5



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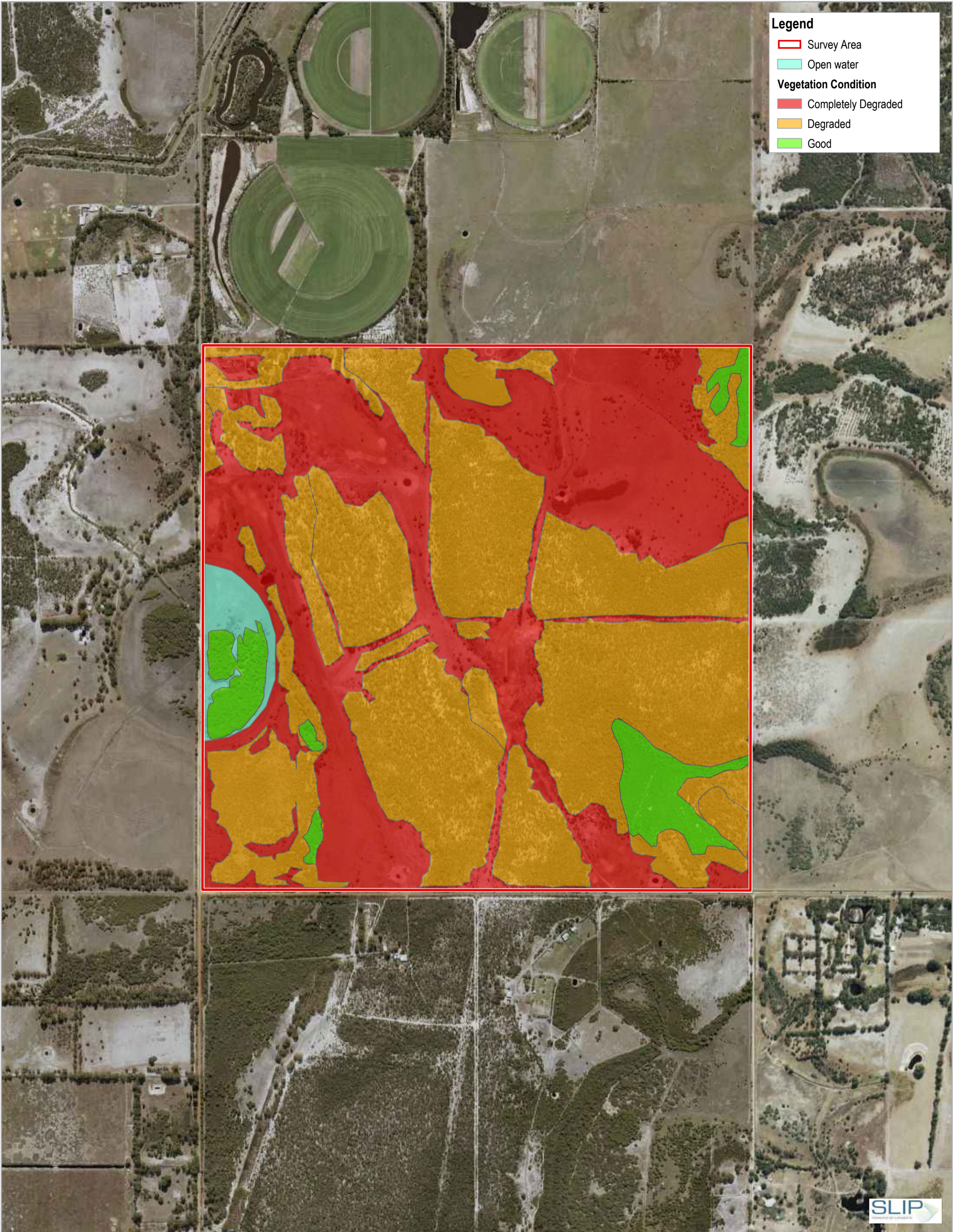


PTA
Potential Offset Sites Environmental Assessment

Vegetation types and relevés

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FIGURE 6

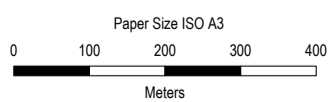


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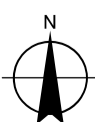
- Survey Area
- Open water

Vegetation Condition

- Completely Degraded
- Degraded
- Good



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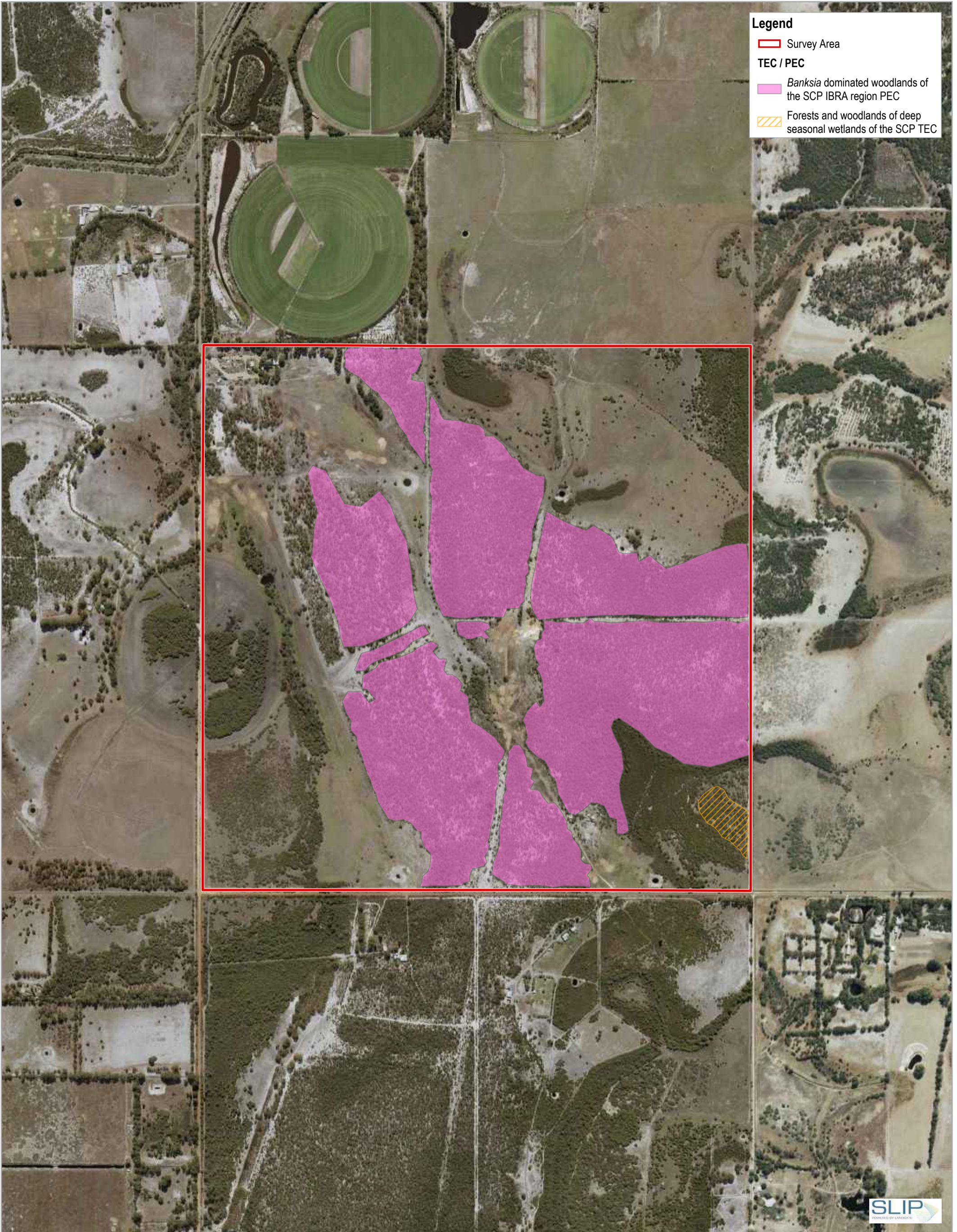


PTA
 Potential Offset Sites Environmental Assessment

Vegetation condition

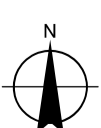
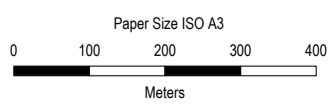
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 Date 23/09/2019

FIGURE 7



Legend

- Survey Area
- TEC / PEC**
- Banksia* dominated woodlands of the SCP IBRA region PEC
- Forests and woodlands of deep seasonal wetlands of the SCP TEC



Map Projection: Transverse Mercator
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 Grid: GDA 1994 Perth Coastal Grid 1994

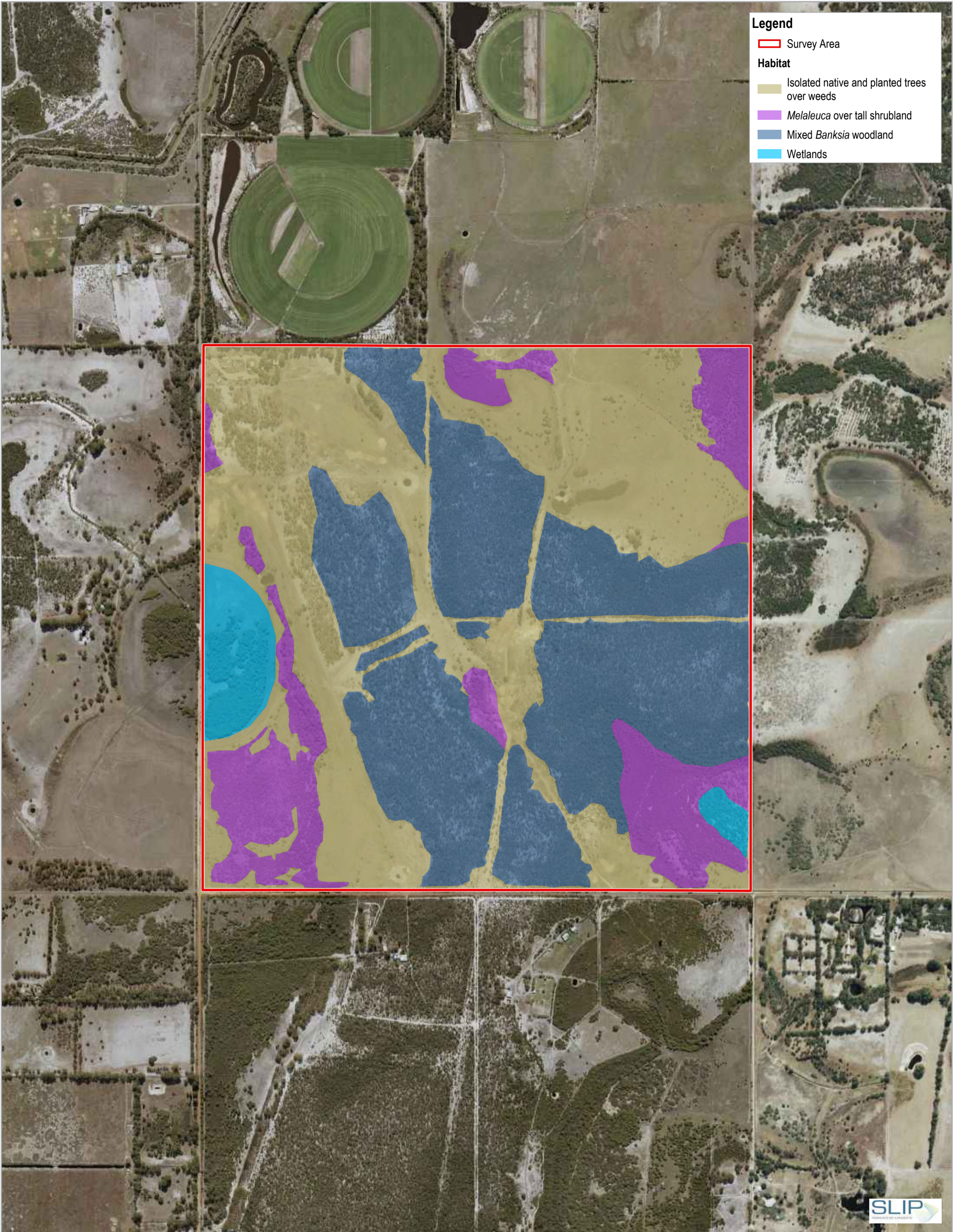


PTA
Potential Offset Sites Environmental Assessment

Conservation significant communities

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FIGURE 8



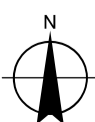
Legend

Survey Area

Habitat

- Isolated native and planted trees over weeds
- Melaleuca* over tall shrubland
- Mixed *Banksia* woodland
- Wetlands

Paper Size ISO A3
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 Meters



Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 Perth Coastal Grid 1994

PTA
 Potential Offset Sites Environmental Assessment

Project No. 61-38451-00
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Fauna habitats

FIGURE 9

Appendix B – Desktop searches

NatureMap Flora (5 km buffer)

NatureMap Fauna (5 km buffer)

Keysbrook CS flora report

Created By Guest user on 17/07/2019

Kingdom Plantae
Conservation Status Conservation Taxon (T, X, IA, S, P1-P5)
Current Names Only Yes
Core Datasets Only Yes
Method 'By Circle'
Centre 115° 53' 06" E, 32° 26' 02" S
Buffer 5km
Group By Family

Family	Species	Records
Ericaceae	1	1
Euphorbiaceae	1	1
Hemerocallidaceae	1	1
Proteaceae	1	2
Stylidiaceae	1	3
TOTAL	5	8

Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
Ericaceae				
1.	48297 <i>Styphelia filifolia</i>		P3	
Euphorbiaceae				
2.	20666 <i>Stachystemon</i> sp. Keysbrook (R. Archer 17/11/99)		P1	
Hemerocallidaceae				
3.	19272 <i>Johnsonia pubescens</i> subsp. <i>cygnorum</i>		P2	
Proteaceae				
4.	18590 <i>Synaphea</i> sp. Fairbridge Farm (D. Papenfus 696)		T	
Stylidiaceae				
5.	7756 <i>Stylidium longitubum</i> (Jumping Jacks)		P4	

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

¹ For NatureMap's purposes, species flagged as endemic are those whose records are wholly contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

Langford CS fauna report

Created By Guest user on 17/07/2019

Kingdom Animalia
Conservation Status Conservation Taxon (T, X, IA, S, P1-P5)
Current Names Only Yes
Core Datasets Only Yes
Method 'By Circle'
Centre 115° 53' 06" E, 32° 26' 02" S
Buffer 5km
Group By Family

Family	Species	Records
Dasyuridae	1	3
Peramelidae	1	4
Psittacidae	2	18
TOTAL	4	25

Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
Dasyuridae				
1.	48070 <i>Phascogale tapoatafa</i> subsp. <i>wambenger</i> (South-western Brush-tailed Phascogale, Wambenger)		S	
Peramelidae				
2.	48588 <i>Isoodon fusciventer</i> (Quenda, southwestern brown bandicoot)		P4	
Psittacidae				
3.	24731 <i>Calyptorhynchus banksii</i> subsp. <i>naso</i> (Forest Red-tailed Black Cockatoo)		T	
4.	24734 <i>Calyptorhynchus latirostris</i> (Carnaby's Cockatoo, White-tailed Short-billed Black Cockatoo)		T	

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

¹ For NatureMap's purposes, species flagged as endemic are those whose records are wholly contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

Appendix C – Vegetation data

Site ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
KEY_1	Myrtaceae	<i>Melaleuca teretifolia</i>		Upper	70-30	4
KEY_1	Asteraceae	<i>Arctotheca calendula</i>		Ground	<2 N	0.1
KEY_1	Poaceae	<i>Poa annua</i>	*	Ground	<2 N	0.1
KEY_1	Poaceae	Poaceae sp.		Ground	<2 N	0.2
KEY_2	Myrtaceae	<i>Melaleuca teretifolia</i>		Mid	70-30	3
KEY_2	Asteraceae	<i>Arctotheca calendula</i>	*	Ground	<2 N	0.1
KEY_2	Poaceae	<i>Poa annua</i>	*	Ground	<2 N	0.1
KEY_2	Poaceae	Poaceae sp.		Ground	<2 N	0.2
KEY_2	Myrtaceae	<i>Melaleuca preissiana</i>		Mid	30-10	4
KEY_2	Myrtaceae	<i>Kunzea glabrescens</i>		Mid	70-30	4
KEY_2	Myrtaceae	<i>Astartea scoparia</i>		Mid	70-30	2
KEY_2	Myrtaceae	<i>Regalia ciliata</i>		Mid	<10	1
KEY_3	Proteaceae	<i>Banksia menziesii</i>		Mid	70-30	5
KEY_3	Proteaceae	<i>Banksia attenuata</i>		Upper	70-30	10
KEY_3	Proteaceae	<i>Banksia ilicifolia</i>		Upper	70-30	10
KEY_3	Myrtaceae	<i>Kunzea glabrescens</i>		Mid	30-10	4
KEY_3	Restionaceae	<i>Desmocladus flexuosus</i>		Ground	<10	0.1
KEY_3	Orchidaceae	Orchidaceae sp.		Ground	<2 N	0.1
KEY_3	Droseraceae	<i>Drosera erythrorhiza</i>		Ground	<2 N	Creeper
KEY_3	Asteraceae	<i>Hypochaeris glabra</i>	*	Ground	<2 N	0.1
KEY_3	Poaceae	Poaceae sp.		Ground	<2 N	0.1
KEY_3	Zamiaceae	<i>Macrozamia riedlei</i>		Ground	<2 T <10	0.3
KEY_3	Casuarinaceae	<i>Allocasuarina fraseriana</i>		Upper	<2 T <10	10
KEY_3	Asteraceae	<i>Ursinia anthemoides</i>	*	Ground	<2 N	0.1
KEY_3	Myrtaceae	<i>Eucalyptus marginata</i>		Mid	<2 T <10	5
KEY_3	Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>		Mid	<2 T <10	1.8
KEY_3	Fabaceae	<i>Jacksonia furcellata</i>		Mid	<2 T <10	1.5

Site ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
KEY_3	Myrtaceae	<i>Melaleuca thymoides</i>		Mid	<2 T <10	1.5
KEY_3	Fabaceae	<i>Acacia pulchella</i>		Mid	<2 T <10	1
KEY_3	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Ground	<2 T <10	0.3
KEY_3	Phytolaccaceae	<i>Phytolacca octandra</i>	*	Ground	<2 T <10	0.5
KEY_3	Dilleniaceae	<i>Hibbertia hypericoides</i>		Ground	<2 T <10	0.5
KEY_3	Lagenophora	<i>Lagenophora huegelii</i>		Ground	<2 T <10	0.1
KEY_3	Proteaceae	<i>Xylomelum occidentale</i>		Mid	<10	4
KEY_3	Lamiaceae	<i>Hemiandra pungens</i>		Ground	<2 T <10	0.2
KEY_4	Myrtaceae	<i>Melaleuca preissiana</i>		Mid	<10	5
KEY_4	Myrtaceae	<i>Kunzea glabrescens</i>		Mid	70-30	5
KEY_4	Myrtaceae	<i>Regelia ciliata</i>		Mid	<10	1
KEY_4	Proteaceae	<i>Banksia ilicifolia</i>		Upper	<2 T <10	8
KEY_5	Proteaceae	<i>Banksia menziesii</i>		Upper	70-30	8
KEY_5	Proteaceae	<i>Banksia attenuata</i>		Upper	70-30	8
KEY_5	Proteaceae	<i>Xylomelum occidentale</i>		Upper	30-10	8
KEY_5	Casuarinaceae	<i>Allocasuarina fraseriana</i>		Upper	<10	10
KEY_5	Proteaceae	<i>Banksia ilicifolia</i>		Mid	<10	5
KEY_5	Myrtaceae	<i>Kunzea glabrescens</i>		Mid	<10	2
KEY_5	Restionaceae	<i>Desmocladius flexuosus</i>		Ground	30-10	0.1
KEY_5	Asteraceae	<i>Arctotheca calendula</i>	*	Ground	30-10	0.1
KEY_5	Poaceae	Poaceae sp.	*	Ground	30-10	0.2
KEY_5	Asteraceae	<i>Ursinia anthemoides</i>	*	Ground	30-10	0.1
KEY_5	Dilleniaceae	<i>Hibbertia tetrandra</i>		Ground	<2 T <10	1
KEY_6	Myrtaceae	<i>Melaleuca preissiana</i>		Mid	70-30	4
KEY_6	Myrtaceae	<i>Melaleuca raphiophylla</i>		Mid	70-30	4
KEY_6	Myrtaceae	<i>Melaleuca teretifolia</i>		Mid	30-10	2
KEY_6	Proteaceae	<i>Hakea varia</i>		Mid	<10	2

Site ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
KEY_6	Myrtaceae	<i>Astartea scoparia</i>		Mid	<10	1.8
KEY_6	Myrtaceae	<i>Kunzea glabrescens</i>		Mid	<10	2
KEY_6	Cyperaceae	<i>Lepidosperma</i> sp.		Ground	<10	0.3
KEY_6	Myrtaceae	<i>Eucalyptus rudis</i>		Upper	<10	15
KEY_6	Myrtaceae	<i>Melaleuca incana</i>		Mid	100-70	3
KEY_6	Cyperaceae	<i>Juncus pallidus</i>		Mid	<10	1.5
KEY_6	Myrtaceae	<i>Hypocalymma angustifolium</i>		Mid	<10	1
KEY_6	Asteraceae	<i>Cotula coronopifolia</i>	*	Ground	<10	0.1

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92633/[https://projects.ghd.com/oc/WesternAustralia2/metronetyanchepraile/Delivery/Documents/6138451-REP-Keysbrook Environmental Values Assessment.docx](https://projects.ghd.com/oc/WesternAustralia2/metronetyanchepraile/Delivery/Documents/6138451-REP-Keysbrook%20Environmental%20Values%20Assessment.docx)

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	A Benkovic M Roberts	J Tindiglia G Gaikhorst		J Tindiglia		24/09/2019
1	J Tindiglia	G Gaikhorst		J Tindiglia		14/01/2020

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Appendix F - TCL and Malaga to Ellenbrook Rail Works Offsets Quantification Table

Table A: TCL Proposal and Malaga to Ellenbrook Rail Works Proposal Offsets Quantification Table

Offset site	Environmental value/MNES	Listing	Proposal	Footprint - estimated impact (ha)	Footprint - estimated required offset (ha)	Total attributed to offset sites (ha)	Total available at offset site (ha)	Quantity remaining at offset site (ha)	See Figure
Lowlands site	Banksia Woodlands of the Swan Coastal Plain (SCP) Threatened Ecological Community (TEC)	MNES	TCL	2.9	13.59	75.93	937.24	861.37	1
			Malaga to Ellenbrook Rail Works (this Proposal)	10.05	62.34				
	Carnaby's Cockatoo foraging habitat (90% offset)	State & Commonwealth MNES	TCL	23	137.1	478	1,063.72	585.72	2
			Malaga to Ellenbrook Rail Works (this Proposal)	81.4	340.9				
	Forest Red-tailed Black Cockatoos foraging habitat (90% offset), including Baudin's for TCL	State & Commonwealth MNES	TCL	16.2	96.7	356.80	1,063.72	585.72	3
			Malaga to Ellenbrook Rail Works (this Proposal)	68.1	260.1				
	Baudin's Black Cockatoos foraging habitat (90% offset)	State & Commonwealth MNES	Malaga to Ellenbrook Rail Works (this Proposal)	81.4	284.1	284.1			3
	Black Cockatoo potential breeding trees	State & Commonwealth MNES	TCL	48 trees	144 trees	1,413 trees	8,096.89 trees	6,683.89 trees	4
			Malaga to Ellenbrook Rail Works (this Proposal)	423 trees	1,269 trees				


Offset site	Environmental value/MNES	Listing	Proposal	Footprint - estimated impact (ha)	Footprint - estimated required offset (ha)	Total attributed to offset sites (ha)	Total available at offset site (ha)	Quantity remaining at offset site (ha)	See Figure
Keysbrook site	Bush Forever site 304 (Whiteman Park)	State	TCL	3	6	40.4	257	216.6	5
			Malaga to Ellenbrook Rail Works (this Proposal)	17.2	34.4				
	Conservation Category Wetlands		TCL	3.2	9.6	15.3	43.15	27.85	
			Malaga to Ellenbrook Rail Works (this Proposal)	1.9	5.7				
			Resource Enhancement Wetlands	0.5	1.5				

Lowlands Offset Site Banksia Woodlands TEC Offset Allocation

Legend

-  Orange outline
-  Black outline
-  Blue hatched area


Vegetation Mapping - Unit (GHD, 2019)

-  Dark blue
-  Light green
-  Red
-  Cyan
-  Purple
-  Brown
-  Dark purple
-  Light blue
-  Pink
-  Cross-hatched

Vegetation Mapping - Condition (GHD, 2019)

-  Dark green
-  Light green
-  Yellow
-  Orange
-  Red

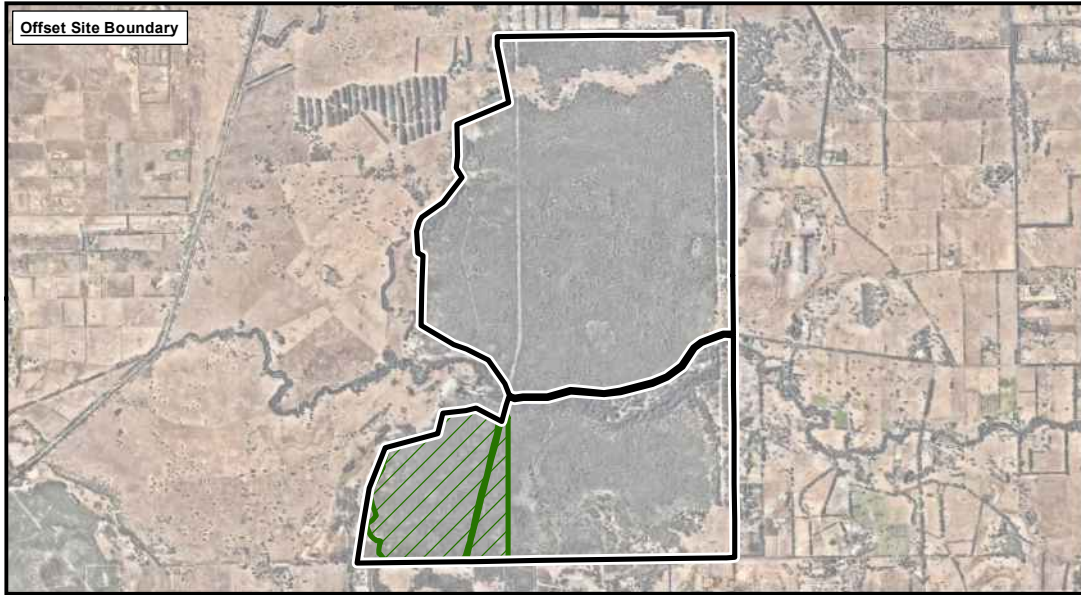
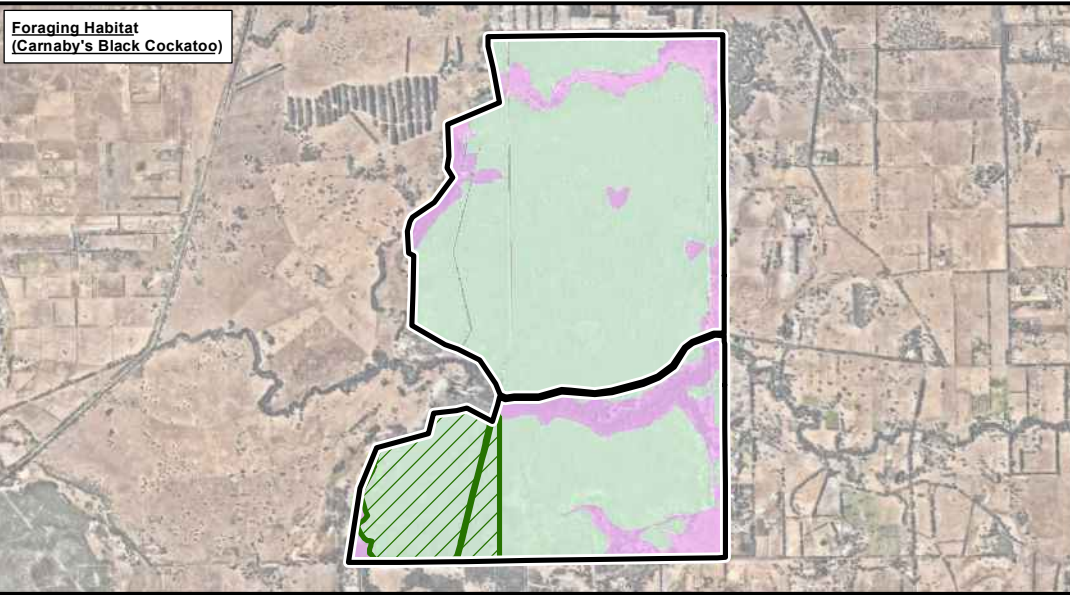
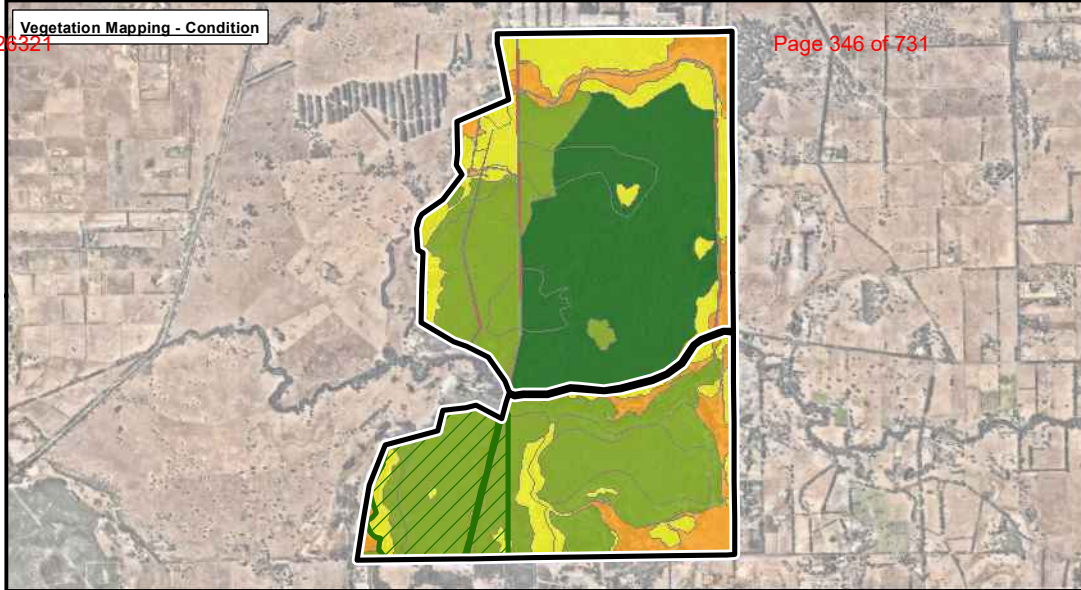
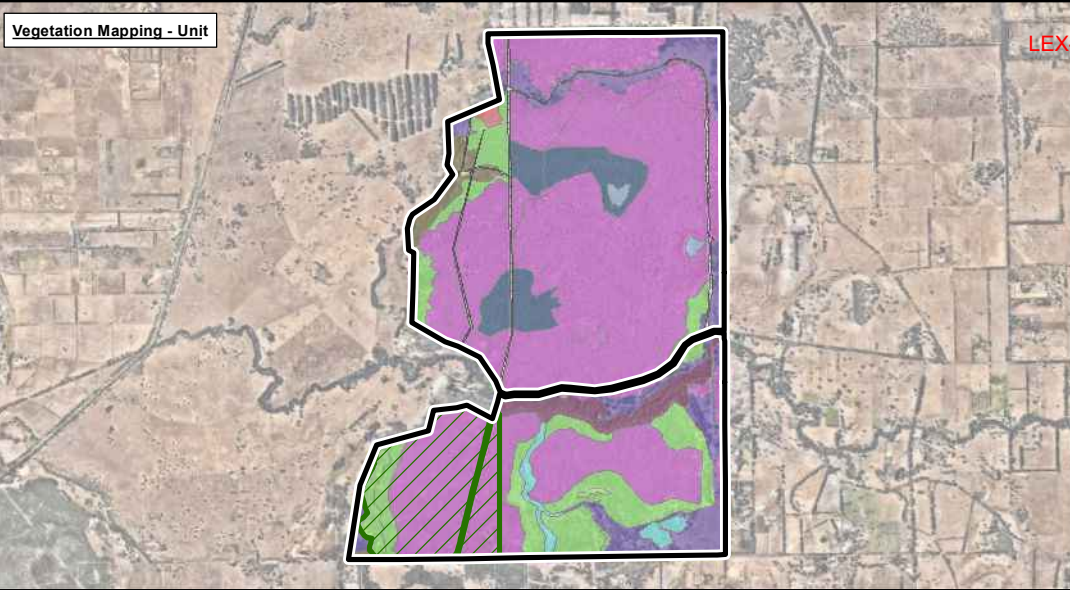
PEC/TEC (GHD Vegetation Mapping, 2019)

-  Brown
-  Green
-  Cyan



Public Transport Authority

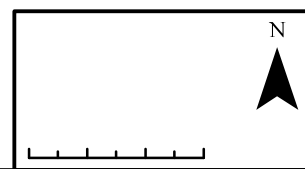
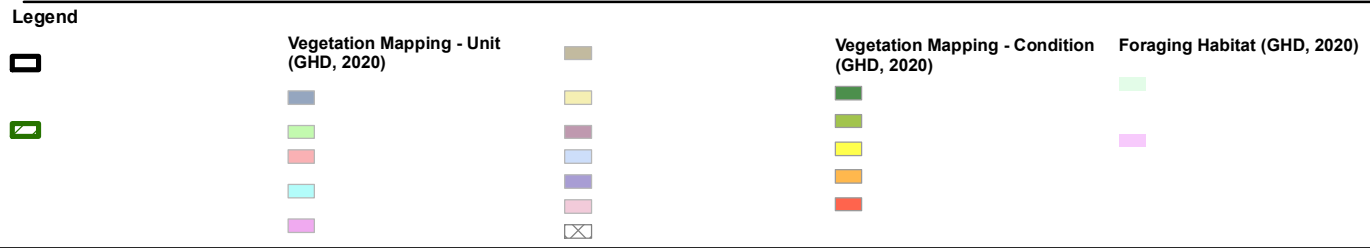


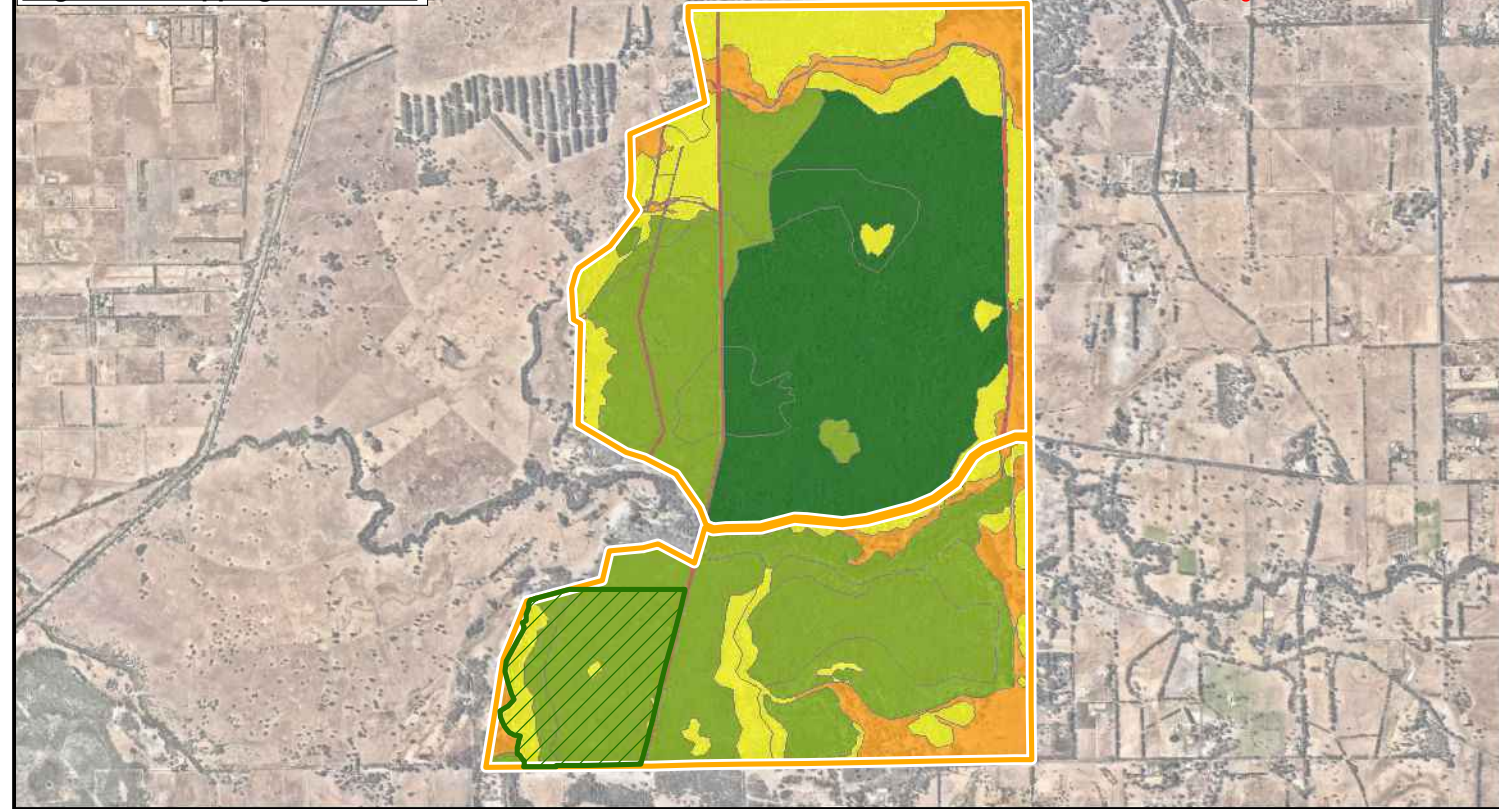
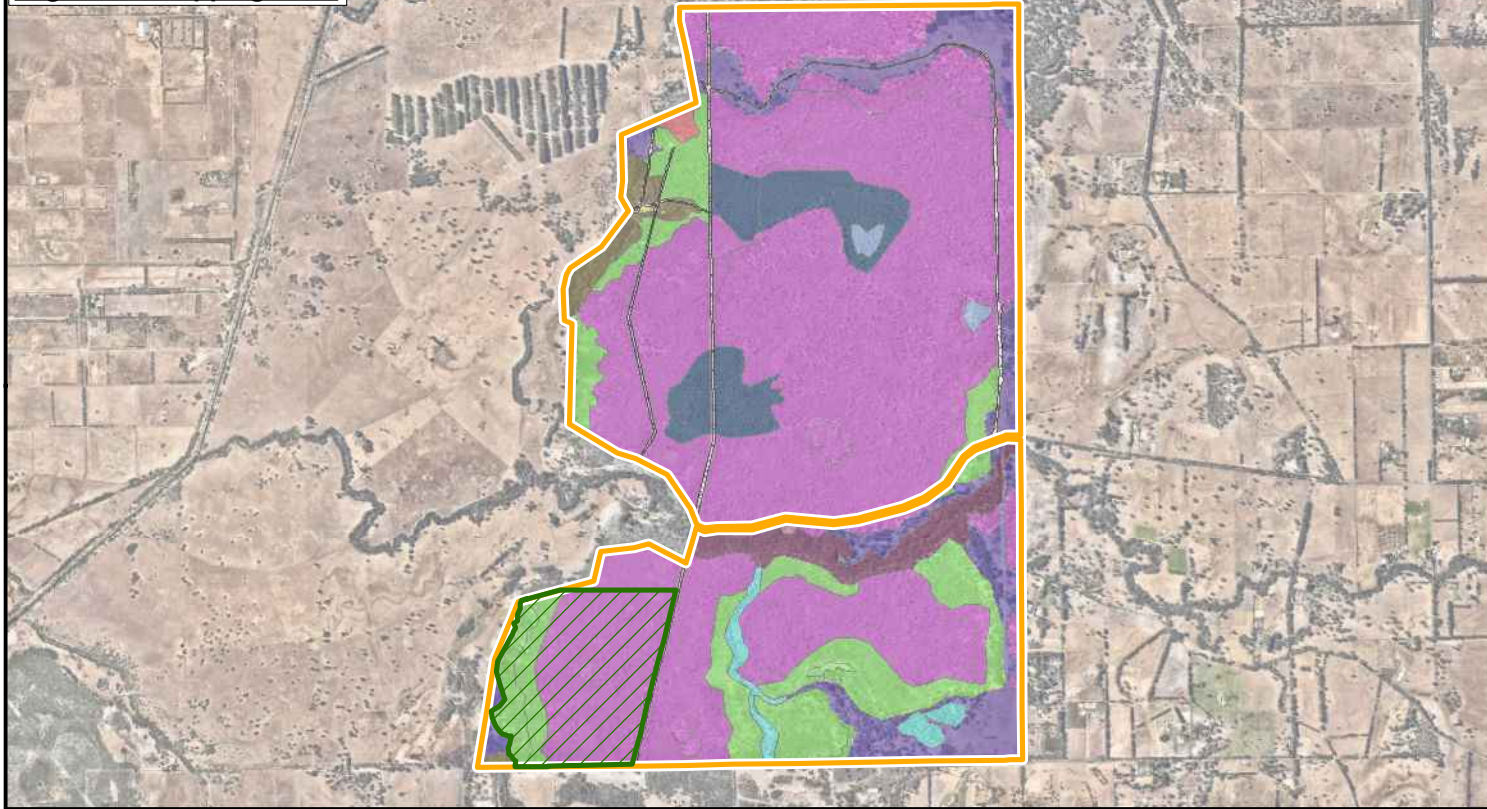


LEX-26321

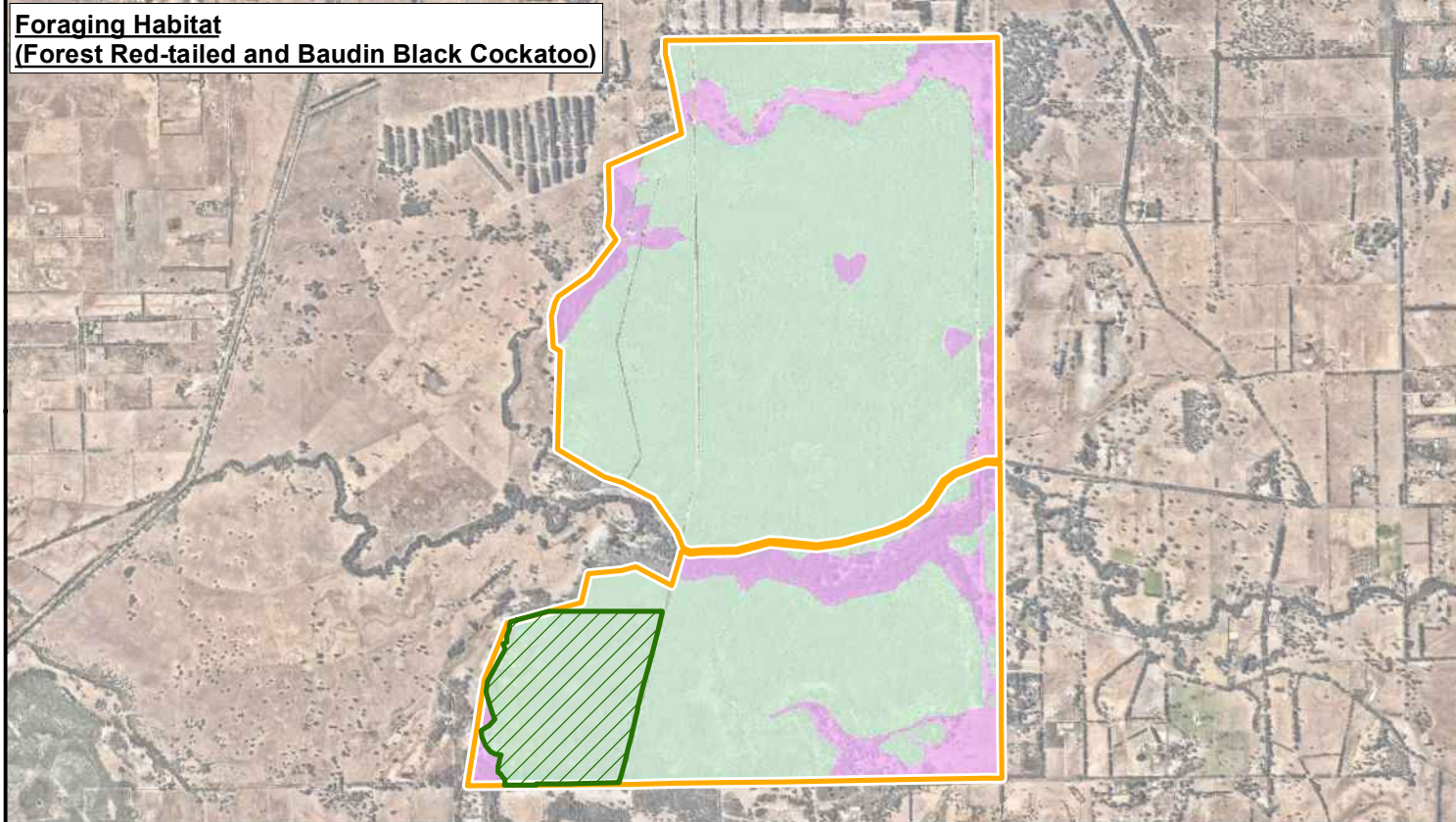
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METRONET | Malaga to Ellenbrook Rail Works Draft Offsets Strategy
 Figure 2 Lowlands Offset Site Carnaby's Black Cockatoo Offset Allocation

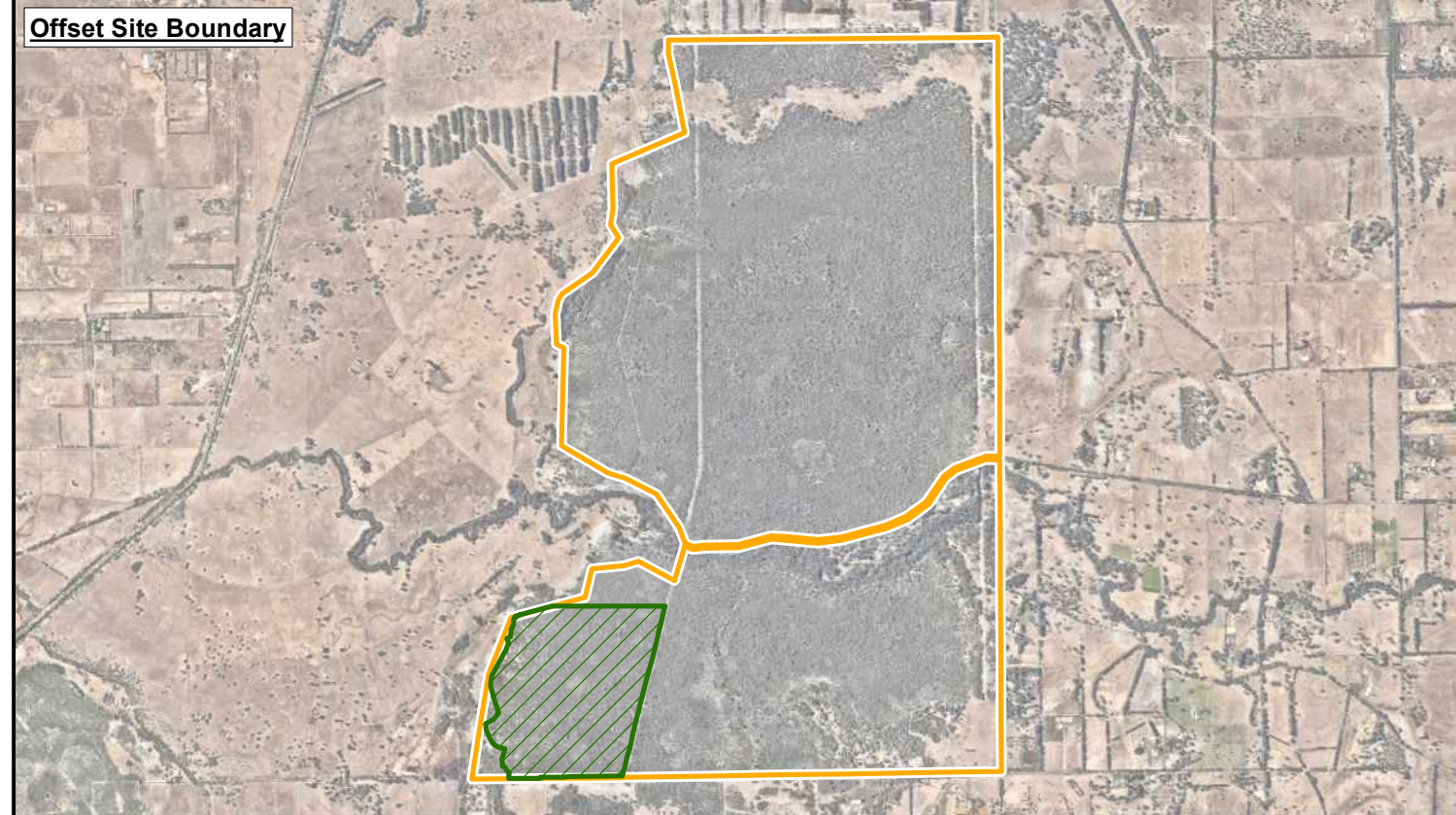




Foraging Habitat
(Forest Red-tailed and Baudin Black Cockatoo)



Offset Site Boundary



Lowlands Offset Site Forest Red-tailed and Baudin's Black Cockatoo Offset Allocation

Legend



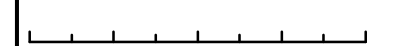
Vegetation Mapping - Unit (GHD, 2019)

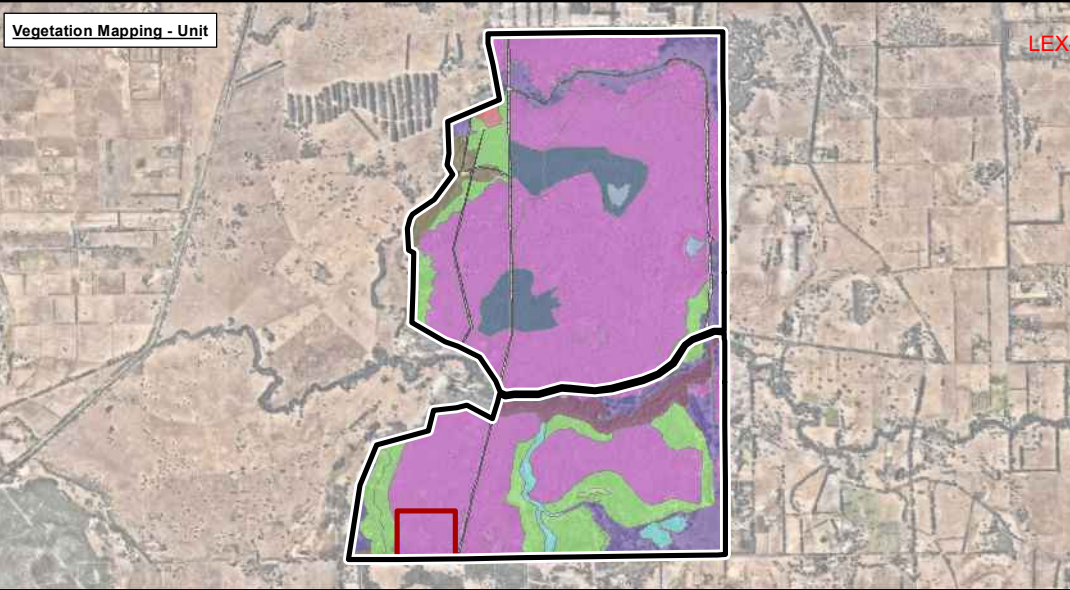


Vegetation Mapping - Condition (GHD, 2019)

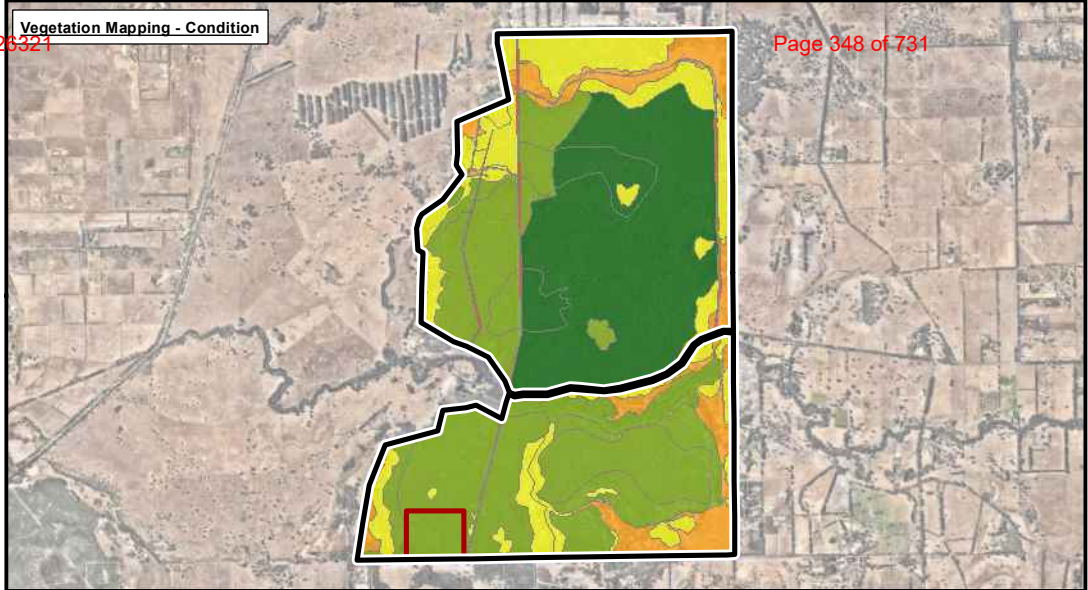


Public Transport Authority

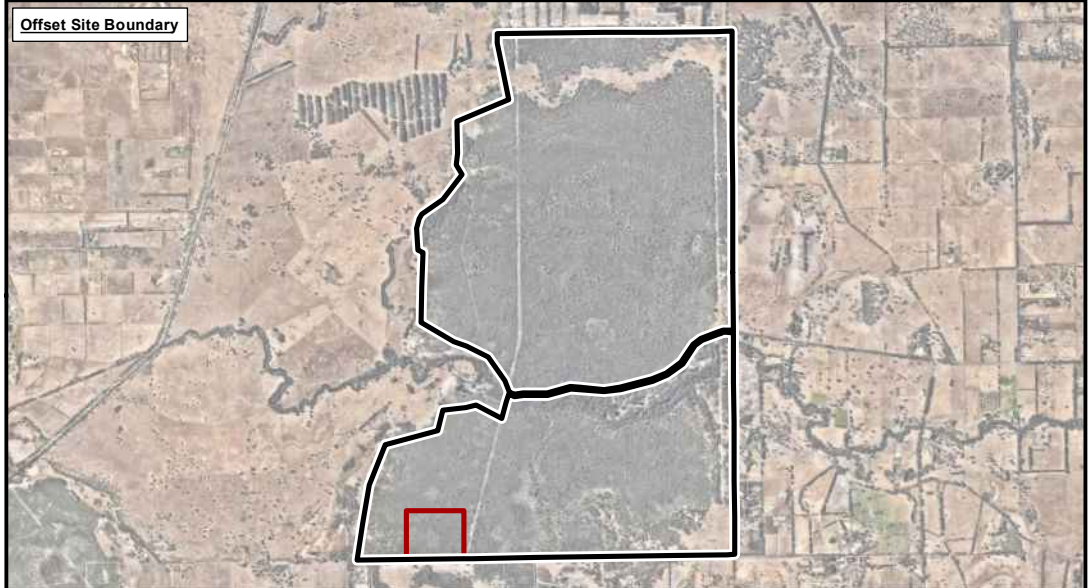
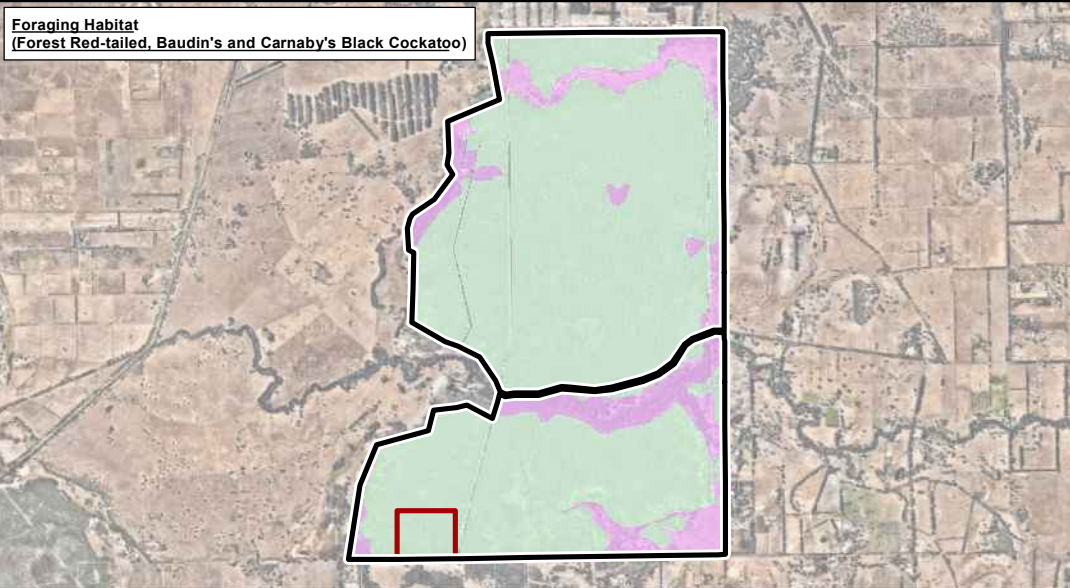




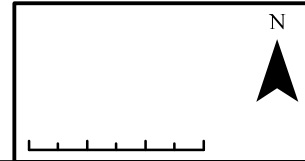
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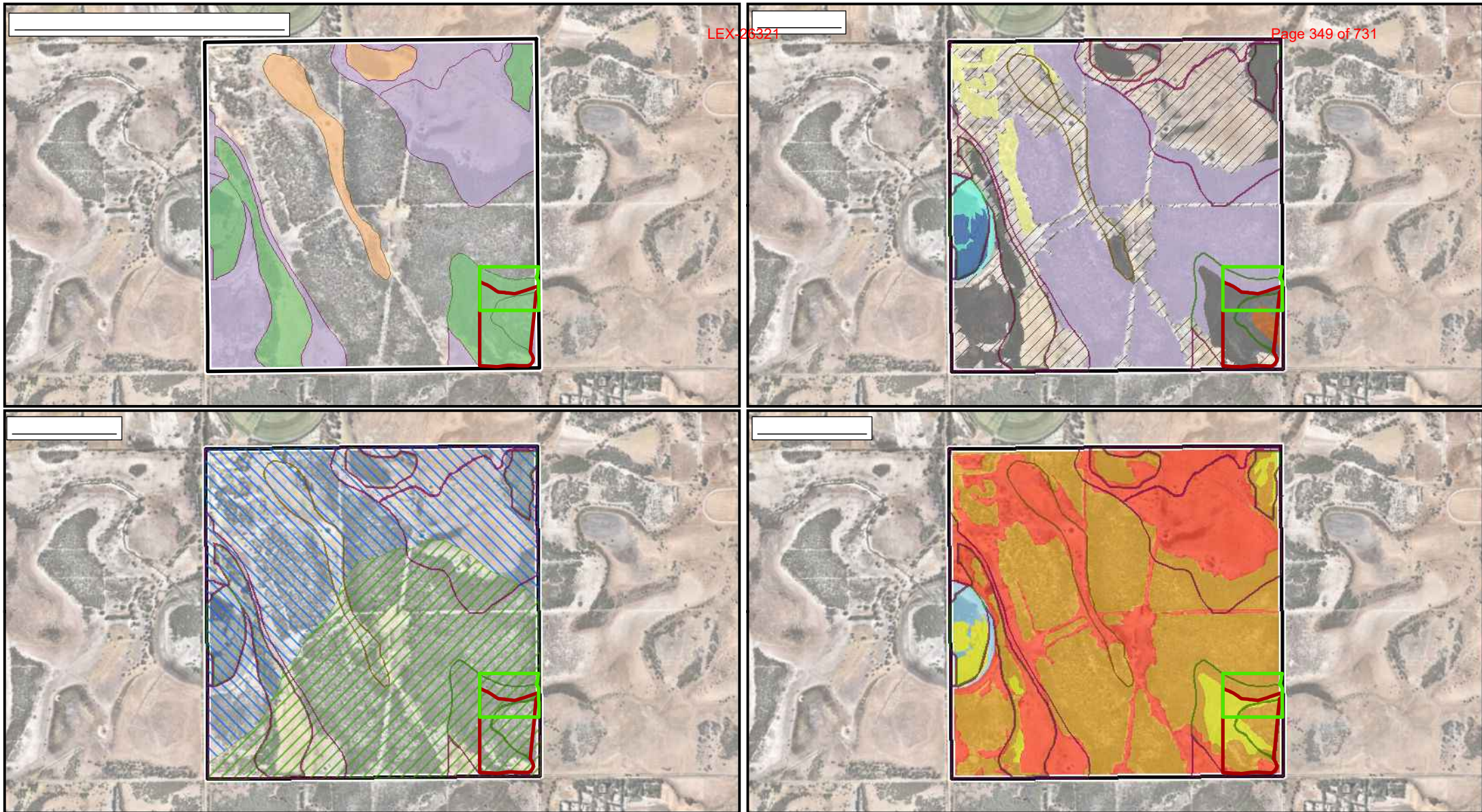


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METRONET | Malaga to Ellenbrook Rail Works Draft Offsets Strategy
 Figure 4 Lowlands Offset Site Black Cockatoo Potential Breeding Trees Offset Allocation





METRONET | Malaga to Ellenbrook Rail Works Draft Offsets Strategy
 Figure 5 **Bush Forever and Conservation Category Wetlands Offset Allocation for the Thornlie-Cockburn Link Proposal**



- [Symbol]
 - [Symbol]
 - [Symbol]
 - [Symbol]
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 - [Symbol]
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 - [Symbol]
 - [Symbol]
 - [Symbol]
 - [Symbol]
 - [Symbol]
 - [Symbol]
- Melaleuca preissiana* riparian wetland
Melaleuca spp. open wetland
Melaleuca spp. terrestrial wetland
 //



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	Banksia Woodlands TEC
EPBC Act status	Endangered
Annual probability of extinction Based on IUCN category definitions	1.2%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator						
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact	Units	Information source	
<i>Ecological communities</i>						
Area of community	Yes	Clearing of 10.05 ha of Banksia Woodland SCP TEC within the Footprint	Area	10.05	Hectares	Surveys (RPS 2020, Woodman 2020) Clearing of 10.05 ha comprised of: 7.01 ha in Very Good condition, 2.31 ha in Good condition, and 0.73 ha in Degraded condition.
			Quality	8	Scale 0-10	
			Total quantum of impact	8.04	Adjusted hectares	
<i>Threatened species habitat</i>						
Area of habitat	No		Area			
			Quality			
			Total quantum of impact	0.00		
<i>Threatened species</i>						
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Birth rate e.g. Change in nest success	No					
Mortality rate e.g. Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator																			
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start area and quality	Future area and quality without offset	Future area and quality with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source			
<i>Ecological Communities</i>																			
Area of community	Yes	8.04	Adjusted hectares	Land acquisition and management of the Lowlands site.	Risk-related time horizon (max. 20 years)	20	Start area (hectares)	62.34	Risk of loss (%) without offset	15%	Risk of loss (%) with offset	5%	6.23	90%	5.61	4.42	8.04	100.00%	Yes
					Future area without offset (adjusted hectares)	53.0	Future area with offset (adjusted hectares)	59.2	1.00	85%	0.85	0.85							
					Time until ecological benefit	0	Start quality (scale of 0-10)	8	Future quality without offset (scale of 0-10)	7	Future quality with offset (scale of 0-10)	8							
<i>Threatened species habitat</i>																			
Area of habitat	No				Time over which loss is averted (max. 20 years)		Start area (hectares)		Risk of loss (%) without offset		Risk of loss (%) with offset								
					Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0											
					Time until ecological benefit		Start quality (scale of 0-10)		Future quality without offset (scale of 0-10)		Future quality with offset (scale of 0-10)								
<i>Threatened species</i>																			
Number of features e.g. Nest hollows, habitat trees	No																		
Condition of habitat Change in habitat condition, but no change in extent	No																		
Birth rate e.g. Change in nest success	No																		
Mortality rate e.g. Change in number of road kills per year	No																		
Number of individuals e.g. Individual plants/animals	No																		

Summary							
Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost (\$)		
					Direct offset (\$)	Other compensatory measures (\$)	Total (\$)
Birth rate	0				\$0.00		\$0.00
Mortality rate	0				\$0.00		\$0.00
Number of individuals	0				\$0.00		\$0.00
Number of features	0				\$0.00		\$0.00
Condition of habitat	0				\$0.00		\$0.00
Area of habitat	0				\$0.00		\$0.00
Area of community	8.04	8.04	100.00%	Yes	\$0.00	#DIV/0!	#DIV/0!
					\$0.00	#DIV/0!	#DIV/0!

Offsets Assessment Guide

For use in determining offsets under the Environment Protection and Biodiversity Conservation Act 1999
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Carnaby's Cockatoo
EPBC Act status	Endangered
Annual probability of extinction <small>Based on IUCN category definitions</small>	1.2%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator						
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact	Units	Information source	
<i>Ecological communities</i>						
Area of community	No		Area			
			Quality			
			Total quantum of impact	0.00		
<i>Threatened species habitat</i>						
Area of habitat	Yes	Clearing of 81.4 ha of Carnaby's Cockatoo foraging habitat within the Footprint.	Area	81.4	Hectares	Fauna Survey (ELA 2020). 81.4 ha of Carnaby's Cockatoo foraging habitat comprised 42.8 ha of High quality, 11.3 ha of Moderate quality and 27.3 had of Low quality foraging habitat.
			Quality	6	Scale 0-10	
			Total quantum of impact	48.84	Adjusted hectares	
<i>Threatened species</i>						
Threatened species						
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Birth rate e.g. Change in nest success	No					
Mortality rate e.g. Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator																											
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start area and quality	Future area and quality without offset	Future area and quality with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source											
<i>Ecological Communities</i>																											
Area of community	No				Risk-related time horizon (max. 20 years)	Start area (hectares)	Risk of loss (%) without offset	Risk of loss (%) with offset																			
					Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0																			
					Time until ecological benefit	Start quality (scale of 0-10)	Future quality without offset (scale of 0-10)	Future quality with offset (scale of 0-10)																			
<i>Threatened species habitat</i>																											
Area of habitat	Yes	48.84	Adjusted hectares	Land acquisition and management of the Lowlands site.	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	340.9	Risk of loss (%) without offset	15%	Risk of loss (%) with offset	5%	Raw gain	34.09	Confidence in result (%)	90%	Adjusted gain	30.68	Net present value (adjusted hectares)	24.17	% of impact offset	43.97	Minimum (90%) direct offset requirement met?	Yes	Cost (\$ total)		Information source
					Future area without offset (adjusted hectares)	289.8	Future area with offset (adjusted hectares)	323.9																			
					Time until ecological benefit	0	Start quality (scale of 0-10)	8	Future quality without offset (scale of 0-10)	7	Future quality with offset (scale of 0-10)	8	Raw gain	1.00	Confidence in result (%)	85%	Adjusted gain	0.85	Net present value (adjusted hectares)	0.85							
Threatened species																											
Threatened species																											
Number of features e.g. Nest hollows, habitat trees	No																										
Condition of habitat Change in habitat condition, but no change in extent	No																										
Birth rate e.g. Change in nest success	No																										
Mortality rate e.g. Change in number of road kills per year	No																										
Number of individuals e.g. Individual plants/animals	No																										

Summary							
Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost (\$)		
					Direct offset (\$)	Other compensatory measures (\$)	Total (\$)
Birth rate	0				\$0.00		\$0.00
Mortality rate	0				\$0.00		\$0.00
Number of individuals	0				\$0.00		\$0.00
Number of features	0				\$0.00		\$0.00
Condition of habitat	0				\$0.00		\$0.00
Area of habitat	48.84	43.97	90.02%	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	Forest Red-tailed Black Cockatoo
EPBC Act status	Vulnerable
Annual probability of extinction <small>Based on IUCN category definitions</small>	0.2%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator						
Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact	Units	Information source	
<i>Ecological communities</i>						
Area of community	No		Area			
			Quality			
			Total quantum of impact	0.00		
<i>Threatened species habitat</i>						
Area of habitat	Yes	Clearing of 68.1 ha of Forest Red-tailed Black Cockatoo foraging habitat within the Footprint.	Area	68.1	Hectares	Fauna Survey (ELA 2020). 68.1 ha of FRT Black Cockatoo foraging habitat comprised 33.6 ha of High quality, 4.3 ha of Moderate quality and 30.2 had of Low quality foraging habitat.
			Quality	6	Scale 0-10	
			Total quantum of impact	40.86	Adjusted hectares	
<i>Threatened species</i>						
Protected matter attributes						
Number of features e.g. Nest hollows, habitat trees						
Condition of habitat Change in habitat condition, but no change in extent						
Birth rate e.g. Change in nest success						
Mortality rate e.g. Change in number of road kills per year						
Number of individuals e.g. Individual plants/animals						

Offset calculator																											
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start area and quality	Future area and quality without offset	Future area and quality with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source											
<i>Ecological Communities</i>																											
Area of community	No				Risk-related time horizon (max. 20 years)	Start area (hectares)	Risk of loss (%) without offset	Risk of loss (%) with offset																			
					Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0																			
					Time until ecological benefit	Start quality (scale of 0-10)	Future quality without offset (scale of 0-10)	Future quality with offset (scale of 0-10)																			
<i>Threatened species habitat</i>																											
Area of habitat	Yes	40.86	Adjusted hectares	Land acquisition and management of the Lowlands site.	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	260.1	Risk of loss (%) without offset	15%	Risk of loss (%) with offset	5%	Raw gain	26.01	Confidence in result (%)	90%	Adjusted gain	23.41	Net present value (adjusted hectares)	22.49	% of impact offset	36.79	Minimum (90%) direct offset requirement met?	Yes	Cost (\$ total)		Information source
					Future area without offset (adjusted hectares)	221.1	Future area with offset (adjusted hectares)	247.1																			
					Time until ecological benefit	0	Start quality (scale of 0-10)	8	Future quality without offset (scale of 0-10)	7	Future quality with offset (scale of 0-10)	8	Raw gain	1.00	Confidence in result (%)	85%	Adjusted gain	0.85	Net present value (adjusted hectares)	0.85							
<i>Threatened species</i>																											
Protected matter attributes																											
Number of features e.g. Nest hollows, habitat trees																											
Condition of habitat Change in habitat condition, but no change in extent																											
Birth rate e.g. Change in nest success																											
Mortality rate e.g. Change in number of road kills per year																											
Number of individuals e.g. Individual plants/animals																											

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	40.86	36.79	90.03%	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
<i>Ecological communities</i>						
Area of community	No		Area			
			Quality			
			Total quantum of impact	0.00		
<i>Threatened species habitat</i>						
Area of habitat	Yes	Clearing of 81.4 ha of Baudin's Cockatoo foraging habitat within the Footprint.	Area	81.4	Hectares	Fauna Survey (ELA 2020). 81.4 ha of Baudin's Cockatoo foraging habitat comprised 42.8 ha of Moderate quality and 38.6 ha of Low quality foraging habitat.
			Quality	5	Scale 0-10	
			Total quantum of impact	40.70	Adjusted hectares	
<i>Threatened species</i>						
Threatened species						
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Birth rate e.g. Change in nest success	No					
Mortality rate e.g. Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator																												
Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start area and quality	Future area and quality without offset	Future area and quality with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost (\$ total)	Information source												
<i>Ecological Communities</i>																												
Area of community	No				Risk-related time horizon (max. 20 years)	Start area (hectares)	Risk of loss (%) without offset	Risk of loss (%) with offset																				
					Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0																				
					Time until ecological benefit	Start quality (scale of 0-10)	Future quality without offset (scale of 0-10)	Future quality with offset (scale of 0-10)																				
<i>Threatened species habitat</i>																												
Area of habitat	Yes	40.70	Adjusted hectares	Land acquisition and management of the Lowlands site.	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	284.1	Risk of loss (%) without offset	15%	Risk of loss (%) with offset	5%	Raw gain	28.41	Confidence in result (%)	90%	Adjusted gain	25.57	Net present value (adjusted hectares)	20.14	% of impact offset	36.64	Minimum (90%) direct offset requirement met?	Yes	Cost (\$ total)		Information source	
					Future area without offset (adjusted hectares)	241.5	Future area with offset (adjusted hectares)	269.9																				
					Time until ecological benefit	0	Start quality (scale of 0-10)	8	Future quality without offset (scale of 0-10)	7	Future quality with offset (scale of 0-10)	8	Raw gain	1.00	Confidence in result (%)	85%	Adjusted gain	0.85	Net present value (adjusted hectares)	0.85								
<i>Threatened species</i>																												
Threatened species																												
Number of features e.g. Nest hollows, habitat trees	No																											
Condition of habitat Change in habitat condition, but no change in extent	No																											
Birth rate e.g. Change in nest success	No																											
Mortality rate e.g. Change in number of road kills per year	No																											
Number of individuals e.g. Individual plants/animals	No																											

Summary							
Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost (\$)		
					Direct offset (\$)	Other compensatory measures (\$)	Total (\$)
Birth rate	0				\$0.00		\$0.00
Mortality rate	0				\$0.00		\$0.00
Number of individuals	0				\$0.00		\$0.00
Number of features	0				\$0.00		\$0.00
Condition of habitat	0				\$0.00		\$0.00
Area of habitat	40.7	36.64	90.02%	Yes	\$0.00	#DIV/0!	#DIV/0!
Area of community	0				\$0.00		\$0.00
					\$0.00	#DIV/0!	#DIV/0!

Appendix H - Lowlands Site Management Plan

Lowlands Site Management - Objectives and Targets						
Activity	Objective	Recovery/Management Plan alignment	Timing	Target	Completion Criteria	Tangible Improvements
Installation of 16.0km of electrified fencing material (including 4 gates)	Install 16 km of electrified fencing material (including 4 gates) at the Lowlands site to minimise and/or prevent unauthorised site access to: * Reduce litter disposal in the area * Reduce the risk of weed and dieback spread * Reduce the risk of unlawful damage to environmental values through unauthorised activities such as 4WDing, illegal dumping, fires etc. * Reduce the risk of stock entering the site to graze	Carnaby's Black Cockatoo Recovery Plan Section 14 - Recovery Actions Action 1 - Protect and Manage Important Habitat Tasks include: Implement management to protect and improve the condition of breeding habitat and associated feeding habitat, including activities that: • Control grazing (e.g. fencing to exclude stock) • Manage fire regimes • Prevent further degradation of habitat	To be completed by the end of the 2nd year of funding	Install 16km of electrified fencing (including 4 gates) by the completion of the 2nd year of funding.	The DBCA to provide evidence to the PTA within the annual compliance reports of the following: 1. Annual progress of task and funding spent. 2. That 16km of electrified fencing has been installed at the Lowlands site in accordance with the objective by the end of the 2nd year of funding.	The installation of fencing will: 1. Reduce weed incursion 2. unauthorised dumping/littering which will degrade vegetation, contaminate soil and/or harm fauna. 3. Reduce unauthorised access including 4WDing that will degrade flora habitat and condition, cause erosion, harm or kill fauna, cause potential contamination and dust etc. 4. Allow the DBCA to enforce penalties to those accessing the site without proper authority. 5. Reduce spread of dieback. 6. Reduce impacts to flora and fauna caused by stock. 7. Reduce unauthorised clearing. Reducing these impacts and pressures will provide tangible improvement to the site and may allow the site's environment values to regenerate.
Management and maintenance to existing access tracks. Complete upgrade works where required	Manage and maintain all tracks within the Lowlands site to allow site entry and access for authorised vehicles, where required. Tracks within the site to have the following benefits/purpose: * Act as firebreaks - allowing fast access to fire fighting requirements * Minimise damage to surrounding habitat as vehicle movement will be limited to tracks * Allow access to areas to carry out other management actions	EPA Technical Report: Carnaby's Black Cockatoo in Environmental Impact Assessment in the Perth and Peel Region Recovery Management and Protection Table 5, Page 20 Habitat management to include the following actions: • Feral animal and nest competitor control • Disease and pest control (e.g. Phytophthora and Marri Canker) • Fire management • Fencing • Weed control	Years 1, 3, 5 and 7	Manage and maintain tracks to a standard to allow required vehicles to transverse the site	The DBCA to provide evidence to the PTA within the annual compliance reports of the following: 1. Annual progress of task and funding spent. 2. That all Lowlands site tracks allow access to required vehicles and upgrade works have been completed in accordance with the objective during years 1, 3, 5 and 7.	The maintenance of tracks will: 1. Reduce weed incursion 2. Isolate vehicle and pedestrian access to restricted tracks, allowing redundant tracks to revegetate naturally. 3. Reduce spread of dieback. 4. Reduce impacts to flora and fauna caused by vehicles. 5. Reduce unauthorised clearing. Reducing these impacts and pressures will provide tangible improvement to the site and may allow the site's environment values to regenerate.
Reserve Management Officer Salary and associated costs	To engage a Reserve Management Officer to manage the implementation of the Lowlands site management activities administered under the PTA offsets strategy site management funding.	Forest Black Cockatoo (Baudin's Cockatoo <i>Calyptorhynchus baudinii</i> and Forest Red-tailed Black Cockatoo <i>Calyptorhynchus banksia naso</i>) Recovery Plan Action 1 - Protect and Manage Important Habitat Tasks include: Implement management to protect and improve the condition of breeding habitat and associated feeding habitat, including activities that: • Control grazing (e.g. fencing) • Manage fire regimes, weeds and dieback • Prevent further degradation of habitat • Maintain natural and artificial water sources used by cockatoos Grand Spider Orchid (<i>Caladenia huegelii</i>) Recovery Plan Section 3 - Recovery Actions: • A range of operational tasks have been carried out to protect populations of <i>C. huegelii</i> , including weed control, application of phosphate and general management of reserves and bushland • Manage access - There is a need to manage both recreational and managerial access at several populations. This management may take the form of fencing, track closure and rehabilitation, and/or interpretive signage. Fenced areas will ideally include a buffer of surrounding habitat • Undertake Weed Control - Weeds are a threat to several populations of <i>Caladenia huegelii</i> . High levels of weeds impact on <i>C. huegelii</i> by competing for resources, degrading habitat, exacerbating grazing pressure, and increasing the risk and severity of fire • Develop and implement a fire management strategy - <i>Caladenia huegelii</i> plants are killed by fire during the above-ground phase of their lifecycle (late April to early November). Fire should therefore be prevented from occurring in populations during these months. Fire also promotes the introduction and proliferation of weed species, and can affect the health of mycorrhizal fungi by removing necessary leaf litter	Annually over seven years	Engage an appropriately qualified person for the position of a Reserve Management Officer	The DBCA to provide evidence to the PTA within the annual compliance reports of the following: 1. Annual progress of task and funding spent. 2. That a Reserve Management Officer has been hired and occupies the Reserve Management Officer role for the Lowlands Site over the seven years, in accordance with the objective.	A dedicated Lowlands site Reserve Management Officer will provide continual site management and monitoring of the site to: 1. Ensure all activities are being implemented as stated. 2. 100% of their chargeable time is dedicated to the Lowlands site. 3. Identify issues promptly and develop appropriate management actions. 4. Streamline site access. 5. Provide one source of information. 6. Directly undertake site actions. 7. Provided updated information as required. 8. Reduce the risks of environmental impacts/unauthorised access. 9. Assist in the natural regeneration of the site. 10. Be available to respond to site as required. 11. Provide tangible improvement to the site and may allow the site's environment values to regenerate.
Signage - Materials and Installation	To erect suitable signage on the Lowlands site which includes site details (conservation status), access details and restrictions.		The funding will be provided over the first four years to allow signage to be relocated if required due to fencing installation.	Erect suitable signage at access points across the Lowlands site to restrict unauthorised access	The DBCA to provide evidence to the PTA within the annual compliance reports of the following: 1. Annual progress of task and funding spent. 2. That appropriate signage has been erected on the Lowlands site, in accordance with the objective and within the scheduled timeframe.	The installation of signage will minimise or reduce unauthorised site access which will: 1. Reduce weed incursion 2. Minimise unauthorised dumping/littering which will degrade vegetation, contaminate soil and/or harm fauna. 3. Reduce unauthorised access including 4WDing that will degrade flora habitat and condition, cause erosion, harm or kill fauna, cause potential contamination and dust etc. 4. Allow the DBCA to enforce penalties to those accessing the site without proper authority. 5. Reduce spread of dieback. 6. Reduce impacts to flora and fauna caused by stock. 7. Reduce unauthorised clearing. Reducing these impacts and pressures will provide tangible improvement to the site and may allow the site's environment values to regenerate.
<i>Phytophthora cinnamomi</i> (dieback) mapping (years 3 and 7) and management plan	To map, manage and monitor the spread of dieback within the Lowlands site. Mapping is to inform the development of a dieback management plan and assess if management measures are sufficient/require revision, monitor management progress.	Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community Section 5.2 Priority Protection and Restoration Actions RESTORE the ecological community within its original range by active abatement of threats, re-vegetation and other conservation initiatives; • Prevent weed invasion by minimising any soil disturbance • Detect and control weeds early. Small infestations should be a priority for removal • Prevent further introduction of feral animals and contain domestic animals within new residential areas. • Implement appropriate fire management regimes for the ecological community taking into account results from research • Manage populations of feral grazing animals that damage native vegetation	Maintenance of wash-down facilities throughout the seven years. Dieback mapping to be completed in years 3 and 7.	Minimise, track and manage the spread of dieback throughout the site	The DBCA to provide evidence to the PTA within the annual compliance reports of the following: 1. Annual progress of task and funding spent. 2. That Dieback mapping has been conducted at the Lowlands site in years 3 and 7 and results are provided to the PTA. 3. That a Lowlands site specific dieback management plan has been developed and is revised according to the most recent dieback mapping data. 4. That the Lowlands site specific dieback management plan is being implemented at the site.	Mapping, monitoring and managing dieback at the Lowlands site will: 1. Provide better understanding of the current impacts and extent 2. Provide improved site management. 3. Actively reduce the spread of dieback throughout the site. 4. Minimise dieback impacts to vegetation. Understanding and managing these impacts and pressures will provide tangible improvement to the site and may allow the site's environment values to regenerate/prevent further impacts.
Weed mapping	Map weeds within the Lowlands site to identify the distribution of weeds throughout the site and prepare targeted weed management plans. Weed mapping will also monitor management progress.		Weed mapping to be completed in years 3 and 7	Conduct weed mapping to develop and update site specific weed management plans and monitor weed management.	The DBCA to provide evidence to the PTA within the annual compliance reports of the following: 1. Annual progress of task and funding spent. 2. That weed mapping has been completed in years 3 and 7 in accordance with the objective. 3. That a Lowlands site specific weed management plan has been developed and is revised according to the most recent weed mapping data. 4. That the Lowlands site specific weed management plan is being implemented at the site.	Mapping, monitoring and managing dieback at the Lowlands site will: 1. Provide better understanding of the current impacts and extent. 2. Provide improved site management. 3. Actively reduce the spread of weeds throughout the site. 4. Minimise weed impacts to vegetation and fauna. Understanding and managing these impacts and pressures will provide tangible improvement to the site and may allow the site's environment values to regenerate/prevent further impacts.

Weed control- materials and program implementation	Conduct weed control at the Lowlands site to reduce the spread of targeted weeds in targeted locations.	Weed control to be carried out annually over 7 years	Control/reduce the spread of targeted weeds across the site within designated areas.	The DBCA to provide evidence to the PTA within the annual compliance reports of the following: 1. Annual progress of task and funding spent. 2. That appropriate weed control measures have been implemented each year of funding to control Lowlands site targeted weeds and environmental values areas in accordance with the objectives.	Weed control at the Lowlands site will: 1. Provide improved site management. 2. Actively remove and reduce the spread of weeds throughout the site. 3. Minimise weed impacts to vegetation and fauna. Understanding and controlling these impacts and pressures will provide tangible improvement to the site and may allow the site's environment values to regenerate/prevent further impacts.
Flora and vegetation survey	District flora officer staff to undertake Lowlands site specific pre-disturbance flora assessments required as part of the DBCA's internal approvals (via the Disturbance Approval System(DAS)) for activities such as fence line clearing, prescribed burns and other activities which have the potential to disturb vegetation.	Annually over seven years	Identify additional management actions that need to be implemented throughout the seven years of management.	The DBCA to provide evidence to the PTA within the annual compliance reports of the following: 1. Annual progress of task and funding spent. 2. The results of the flora and vegetation surveys conducted at the Lowlands site over the seven years in accordance with the objective to be included within the annual compliance reports.	Site specific pre-disturbance flora assessments required as part of the DBCA's internal approvals provide a baseline to assess future management and impacts.
Rubbish Removal	Remove and dispose rubbish/unauthorised dumping throughout the Lowlands site.	Annually over seven years	Remove and dispose of rubbish/unauthorised dumping from the Lowlands site.	The DBCA to provide evidence to the PTA within the annual compliance reports of the following: 1. Annual progress of task and funding spent. 2. That rubbish located within the Lowlands site has been removed and disposed correctly over the seven years.	Removing rubbish from the site will: 1. Minimise and manage impacts to flora and fauna from rubbish and contamination. 2. Minimise and manage contamination. Reducing and removing these impacts and pressures will provide tangible improvement to the site and may allow the site's environment values to regenerate.
Fire Management - prescribed burn	Conduct a prescribed/hazard reduction burn at the Lowlands site to reduce the risks associated with and/or likelihood of wildfires/arson etc.	To be carried out during years 3, 5 and 7. *Note this may be altered in the event of wildfires or unplanned burns occurring on the site	Conduct prescribed burns to reduce the risk of an wildfire at the Lowlands site	The DBCA to provide evidence to the PTA within the annual compliance reports of the following: 1. Annual progress of task and funding spent. 2. That prescribed burns were conducted at the Lowlands site in accordance with the objectives annually over the seven years.	A hot uncontrolled burn or wildfire can cause: 1. Major safety implications to people, infrastructure, flora and fauna. 2. Destroy fauna food sources and habitat. 3. Require reallocation of site management funding for rehabilitation. 4. Destroy TEC/PEC threatened flora and fauna. Reducing this risk will assist in protecting the site's environmental values and reduce the risks associated with fire.
Feral animal monitoring and control (cat, fox, rabbit, kangaroos and pigs)	Conduct feral animal mapping and control at the Lowlands site to reduce the presence of feral animals on the site and minimise associated impacts.	Annually over seven years	Monitor and reduce the presence of feral animals on the Lowlands site	The DBCA to provide evidence to the PTA within the annual compliance reports of the following: 1. Annual progress of task and funding spent. 2. That feral animal monitoring and control activities have been undertaken at the Lowlands site in accordance with the objectives annually over the seven years.	Controlling feral animals will: 1. Reduce competition for resources with native animals. 2. Reduce pressure on native animals which are feral animal prey. 3. Reduce grazing. Reducing and controlling this impact and pressures will provide tangible improvement to the site and may allow the site's environment values to regenerate.
Carnaby's Cockatoo watering point establishment	Establish a watering point at the Lowlands site to encourage Carnaby's Cockatoo to roost within the Lowlands site.	To be completed within the 3rd year of funding	Enhance the likelihood of Carnaby's Black Cockatoos roosting in the site.	The DBCA to provide evidence to the PTA within the annual compliance reports of the following: 1. Annual progress of task and funding spent. 2. That a Carnaby's Cockatoo watering point has been established at the Lowlands site in accordance with the objectives within the 3rd year of funding.	Providing water will increase the likelihood of Carnaby's Cockatoo roosting within the site and may assist in the recovery of the population of Carnaby's Black Cockatoos.

Recovery Plans

Carnaby's Black Cockatoo Recovery Plan
 EPA Technical Report: Carnaby's Black Cockatoo in Environmental Impact Assessment in the Perth and Peel Region
 Forest Black Cockatoo (Baudin's Cockatoo Calyptrorhynchus baudinii and Forest Red-tailed Black Cockatoo Calyptrorhynchus banksia naso) Recovery Plan
 Grand Spider Orchid (Caladenia huegellii) Recovery Plan
 Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community

Appendix I - WA Offset Template

Project Name: METRONET Malaga to Ellenbrook Rail Works Proposal									
Existing environment/ Impact	Mitigation			Significant Residual Impact	Offset Calculation Methodology				
	Avoid and minimise	Rehabilitation Type	Likely Rehab Success		Type	Risk	Likely offset success	Time Lag	Offset Quantification
Clearing of 10.05 ha of Commonwealth listed Banksia Woodlands of the Swan Coastal Plain (SCP) Threatened Ecological Community (TEC) (Banksia TEC), synonymous with the State listed Priority 3 Banksia Dominated Woodlands of the Swan Coastal Plain Priority Ecological Community (PEC) within the Footprint comprising of two patches, Patch 1 (8.54 ha) and Patch 5 (1.51 ha).	<p>Avoid:</p> <ul style="list-style-type: none"> The Proposal has been designed to avoid three patches (Patch 2, 3 and 4) of Banksia TEC that were mapped within close proximity to, or within, the Development Envelope and Footprint. A significant portion of the highest quality vegetation within Banksia TEC Patch 1 (6.95 ha, approximately 30 % of the total mapped area) has been incorporated into a Native Vegetation Retention Area (NVRA). NVRAs are designated no-clearing zones within the Development Envelope. A significant portion of Banksia TEC Patch 1 (7.74 ha, approximately 33% of the total mapped area) has been excluded from the Development Envelope. A significant portion of Banksia TEC Patch 5 (35.94 ha, approximately 97.8% of the total mapped area) has been excluded from the Development Envelope. <p>Minimise:</p> <ul style="list-style-type: none"> Permanent access paths where the rail alignment crosses the junction between Drumpellier Drive and Gnaragara Road have been relocated to minimise the impact on Banksia TEC Patch 5. Embankment and alignment have been modified to minimise impacts to Banksia TEC Patch 5. The location of the dive structure under the southbound carriageway of Tonkin Highway was modified to allow the rail to cross Banksia TEC Patch 1 through the lowest condition vegetation with the lowest quality, where possible. A CEMP will be developed and implemented during construction and includes mitigation and management measures. A Flora and Vegetation Management Plan - TEC Management Plan will be developed and implemented during construction and includes mitigation and management measures to minimise potential impacts to the Banksia TEC. Construction and operational access tracks have been designed to coincide with existing tracks or aligned along cleared areas where practicable. 	<p>Areas cleared for the Proposal not required for future infrastructure or management access will be rehabilitated with consideration for operational safety requirements. Due to the operational and safety requirements within the railway corridor, rehabilitation cannot be implemented in areas of permanent infrastructure.</p>	<p>Rehabilitation of disturbed areas and landscaping of the Proposal 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 relatively successful.</p>	<p>Extent Clearing of 10.05 ha of the Commonwealth listed Banksia Woodlands of the SCP TEC synonymous with Banksia dominated Woodlands of the SCP PEC.</p> <p>Quality 10.05 ha Banksia Woodlands of the SCP TEC comprised of:</p> <ul style="list-style-type: none"> 7.01 ha of vegetation in Very Good condition; 2.31 ha of vegetation in Good condition; and 0.73 ha of vegetation in Degraded condition. <p>Conservation Significance High conservation significance as Banksia Woodland of the SCP TEC is listed as Endangered under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and Priority 3 under the Biodiversity Conservation Act 2016 (BC Act), WA.</p> <p>Land Tenure State</p> <p>Time Scale Permanent</p> <p>According to the agreed significance framework, loss of up to 10.05 ha of Banksia Woodlands of the SCP TEC is likely a significant impact as the Proposal will impact Patch 5, contributing to a 1.8% reduction of the ecological community in the area and Patch 1, contributing to a 10.1% reduction of the ecological community in the area.</p>	<p>Direct offset - land acquisition of the Lowlands Site, in Mardella. The Lowlands site was acquired by the WAPC as an Advanced Offset and reclassified as an A Class reserve (elevated from its Bush Forever status). Proposal to provide funding to the DBCA for seven years of on-ground management at the Lowlands site.</p>	<p>Land acquisition: No risk. The site has already been acquired by the State as an Advanced offset and allocated to the PTA to offset METRONET projects.</p> <p>Long-term: No risk. The site is State-owned and is classified as a Class A Reserve, Bush Forever Site and is proposed to be a State offset site.</p>	<p>What is the type of vegetation being offset or revegetated? No revegetation is proposed. The offset site is known to contain Black Cockatoo foraging habitat, Black Cockatoo breeding trees and Banksia Woodlands of the SCP TEC, the values being offset.</p> <p>Can the values being offset be defined and measured? Yes. As an A Class Reserve, owned and managed by the DBCA, significant environmental surveys have been conducted onsite to define and assess site environmental values, including the extent of values being offset. These surveys have been provided to the PTA. The PTA has conducted an environmental values assessment and weed assessment at the site. A weed management plan is being currently being developed for the site.</p> <p>Operator experience in undertaking action? The DBCA already manages the site due to its Class A conservation status and the PTA proposes to provide funding to the DBCA to prolong the duration of on-ground management works.</p> <p>Is there evidence the environmental values can be re-created (evidence of demonstrated success)? The PTA does not propose to recreate environmental values but instead maintain and manage the site's existing environmental values. The DBCA is responsible for biodiversity conservation in Western Australia and routinely carries out management and restoration activities within native flora and fauna habitats. The DBCA have been managing the site since 2015.</p>	<p>No time lag - Site acquisition and elevation to a Class A conservation reserve has already occurred. Ecological benefit has already been realised due to Class A classification applied in 2015. Provision of funding to the DBCA to prolong on-ground management works will extend and increase ecological benefit.</p>	<p>To offset impacts to 10.05 ha of Banksia Woodlands of the SCP TEC, acquisition and management of approximately 62.34 ha of Banksia Woodlands TEC is required (based on a start quality of 8 at Lowlands). This has been calculated using the Commonwealth Offsets Calculator. The co-location of the Banksia Woodlands TEC with the Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo foraging habitat and potential breeding tree offset is cost effective. The acquisition and management of land is appropriate and the Commonwealth Offset Calculator has been used to ensure the offset is proportionate to the impact.</p>
Loss of 81.4 ha of Black Cockatoo foraging habitat. This comprises 81.4 ha of Carnaby's, 68.1 ha of Forest Red-tailed and 81.4 ha of Baudin's Black Cockatoo foraging habitat and 423 potential breeding trees.	<p>Avoid:</p> <ul style="list-style-type: none"> The Proposal was designed to prioritise placement within existing linear infrastructure corridors where practicable, avoiding clearing of vegetation and fauna habitat. For the northern portion of the Development Envelope, the PTA has aligned the rail corridor adjacent to Drumpellier Drive, near existing cleared road infrastructure along the eastern boundary of Whiteman park. This alignment will reduce fauna habitat disturbance and avoid fragmenting areas of high value fauna habitat. To the south of the Development Envelope, the PTA has largely avoided high value fauna habitat through aligning the rail corridor design to pass through the largely cleared Marshall Paddocks area. The Development Envelope has been reduced by 9.9 ha within Bush Forever site 304 (Whiteman Park) minimising impacts to Black Cockatoo potential breeding trees and foraging habitat. Impacts on high value habitat has been avoided through the establishment of NVRAs. The NVRAs within the Development Envelope will retain 44.6 ha of fauna habitat, including up to 25.6 ha of Black Cockatoo foraging habitat. The NVRAs will retain 201 (30%) Black Cockatoo potential breeding trees. Temporary construction areas are to be placed within existing cleared or Completely Degraded areas adjacent or near to the rail corridors where practicable, to minimise vegetation clearing. Water sensitive urban design principles will be implemented as part of detailed drainage design. This will include infiltration of stormwater as a preference to reduce incidence of pooling of water on the surface which may act as an attractant for fauna species such as Black Cockatoos and place them at increased risk of being struck by a passenger train. Black cockatoo foraging plants will not be used for revegetation within the rail reserve so that the species are not attracted to forage in areas adjacent to moving trains. <p>Minimise:</p> <ul style="list-style-type: none"> The Proposal was designed to prioritise placement within low value fauna habitat areas where possible to minimise impacts to fauna habitat. More than 75% of the Development Envelope is comprised of cleared land or low value fauna habitat. The Proposal was designed to place the temporary construction areas within existing cleared or Completely Degraded areas adjacent or near to the rail corridors where practicable, to minimise vegetation clearing and impacts to fauna habitat. A CEMP will be developed and implemented during construction and includes mitigation and management measures. Black Cockatoo potential breeding trees will be inspected prior to clearing and any trees with active nests will be temporarily protected, including a 10m buffer. 	<p>Areas cleared for the Proposal not required for future infrastructure or management access will be rehabilitated with consideration for operational safety requirements. Due to the operational and safety requirements within the railway corridor, rehabilitation cannot be implemented in areas of permanent infrastructure.</p>	<p>Rehabilitation of disturbed areas and landscaping of the Proposal 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 relatively successful.</p>	<p>Extent Loss of 81.4 ha of Black Cockatoo foraging habitat comprising 81.4 ha of Carnaby's, 68.1 ha of Forest Red-tailed and 81.4 ha of Baudin's Black Cockatoo foraging habitat and 423 potential breeding trees.</p> <p>Quality Clearing of 81.4 ha of Black Cockatoo foraging habitat, consisting of:</p> <ul style="list-style-type: none"> 42.8 ha of High quality, 11.3 ha of Moderate quality and 27.3 ha of Low quality Carnaby's Cockatoo foraging habitat; 33.7 ha of High quality, 4.3 ha of Moderate quality and 30.2 ha of Low quality Forest Red-tailed Black Cockatoo foraging habitat; and 42.8 ha of Moderate quality and 38.6 ha of Low quality Baudin's Cockatoo foraging habitat. <p>Conservation Significance High conservation significance as 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.</p> <p>Land Tenure State</p> <p>Time Scale Permanent</p> <p>According to the agreed significance framework, the residual impact is considered significant. The impacted habitat is consistent with the definition of habitat for all Black Cockatoo species and therefore, the impact is regarded as a significant residual impact.</p>	<p>Direct offset - land acquisition of the Lowlands Site, in Mardella. Lowlands was acquired by the WAPC as an Advanced Offset and reclassified as an A Class reserve (elevated from its Bush Forever status). Proposal to provide funding to the DBCA for seven years of on-ground management at Lowlands.</p>	<p>Land acquisition: No risk. The site has already been acquired by the State as an Advanced offset and allocated to the PTA to offset METRONET projects.</p> <p>Long-term: No risk. The site is State-owned and is classified as a Class A Reserve, Bush Forever Site and is proposed to be a State offset site.</p>	<p>What is the type of vegetation being offset or revegetated? No revegetation is proposed. The offset site is known to contain Black Cockatoo foraging habitat, Black Cockatoo breeding trees and Banksia Woodlands of the SCP TEC, the values being offset.</p> <p>Can the values being offset be defined and measured? Yes. As an A Class Reserve, owned and managed by the DBCA, significant environmental surveys have been conducted onsite to define and assess site environmental values. These surveys have been provided to the PTA. The PTA has conducted an environmental values assessment and weed assessment at the site. A weed management plan is being currently being developed for the site.</p> <p>Operator experience in undertaking action? The DBCA already manages the site due to its Class A conservation status and the PTA proposes to provide funding to the DBCA to prolong the duration of on-ground management works.</p> <p>Is there evidence the environmental values can be re-created (evidence of demonstrated success)? The PTA does not propose to recreate environmental values but instead maintain and manage the site's existing environmental values. The DBCA is responsible for biodiversity conservation in Western Australia and routinely carries out management and restoration activities within native flora and fauna habitats. The DBCA have been managing the site since 2015.</p>	<p>No time lag - Site acquisition and elevation to a Class A conservation reserve has already occurred. Ecological benefit has already been realised due to Class A classification applied in 2015. Provision of funding to the DBCA to prolong on-ground management works will extend and increase ecological benefit.</p>	<p>To offset 81.4 ha of Black Cockatoo foraging habitat, acquisition and management of approximately 340.9 ha of Black Cockatoo foraging habitat is required (based on a start quality of 8, the range represents 90-100% of the offset requirement). This has been calculated using the Commonwealth Offsets Calculator. A separate offset has been calculated and provided for each species of Black Cockatoo, however, due to potentially overlapping foraging habitats within the Lowlands site, there may be an overlap in offset areas.</p> <p>To offset the clearing of 423 Black Cockatoo potential breeding trees, acquisition and conservation of 1,269 potential breeding trees is required. This has been calculated at a 3:1 ratio.</p> <p>The co-location of the Banksia Woodlands TEC with the Black Cockatoo offset is cost effective. The acquisition and management of land is appropriate and the Commonwealth Offset Calculator used to ensure the offset is proportionate to the impact.</p>
					<p>Provision of partial funding to Murdoch University to implement their Black Cockatoo research proposal.</p>	<p>Research agency is unable to secure enough funding to commence the research proposal (i.e. funding from other parties.) Research results unavailable for use in future METRONET offset strategies due to delay in obtaining the data. Results do not present value for money.</p>	<p>What is the type of vegetation being offset or revegetated? Not applicable.</p> <p>Can the values being offset be defined and measured? Not applicable</p> <p>Operator experience in undertaking actions? Murdoch University has proven Black Cockatoo research experience and results.</p> <p>Is there evidence the environmental values can be re-created (evidence of demonstrated success)? Not applicable.</p>	<p>Research is planned to commence mid-2020 and will continue for 5 years. Some results may be available for use throughout the research period and in future PTA METRONET planning.</p>	<p>Provision of funding to Murdoch University will comprise no greater than 10% of the total Black Cockatoo foraging habitat offset proposal. The total dollar amount will be calculated in accordance with the DAWE calculation method which takes into account offset site evaluations and total management costs.</p>

Project Name: METRONET Malaga to Ellenbrook Rail Works Proposal									
Existing environment/ Impact	Mitigation			Significant Residual Impact	Offset Calculation Methodology				
	Avoid and minimise	Rehabilitation Type	Likely Rehab Success		Type	Risk	Likely offset success	Time Lag	Offset Quantification
<p>Potential impacts to 1.9 ha of Conservation Category Wetlands (CCWs), comprised of 0.5 ha of riparian vegetation in Good condition; 1.1 ha in Degraded condition and 0.3 ha in Completely Degraded condition. The CCWs were assessed to be in predominantly Good condition.</p> <p>Potential significant residual impact to 0.5 ha of one Resource Enhancement Wetland (REW), UFI 8678, comprised of 0.3 ha in Excellent condition, 0.1 ha in Good condition and 0.1 ha in Degraded condition.</p>	<p>Avoid:</p> <ul style="list-style-type: none"> The Proposal design has been developed in order to avoid clearing of CCW in Good – Degraded condition wherever practicable. The Proposal was designed to ensure CCW UFI 8724 (Horse Swamp) was outside the Development Envelope. Adjustments to the Development Envelope have been implemented to avoid impacts to wetland habitats along the Development Envelope, including the inclusion of a NVRA within the Development Envelope to apply a 50 m precautionary buffer from the maximum known extent of Horse Swamp. Establishment of NVRAs within the Development Envelope to reduce the impacts on native vegetation and avoid clearing CCWs, including UFI 8417. The PTA will further investigate avoiding areas of CCWs during the detailed design phase, where practicable. Avoidance of dewatering during construction, where practicable and consistent with construction requirements, will continue to be investigated through design and construction methodology. Impacts will be avoided as much as practicable by placing the bores away from sensitive receptors. Where practicable, the design will remain above the water table. No chemicals and/or fuel will be stored or transferred within DPWSA P1 or wellhead protection zones; the Gngara UWPCA in the northern portion of the Development Envelope; or 50 m of existing waterways or wetlands. Where practicable, construction chemicals that are biodegradable and/or less hazardous will be used. <p>Minimise:</p> <ul style="list-style-type: none"> The Development Envelope and the Footprint have been amended in order to minimise impacts on several CCWs along the alignment. Impacts to Bennett Brook have been minimised by minimising the width at which the Development Envelope intersects Bennett Brook. 	<p>Areas cleared for the Proposal within the riparian zone of Bennett Brook that are not required for permanent infrastructure or ongoing management of the railway will be rehabilitated.</p>	<p>Rehabilitation of disturbed areas and landscaping of the Proposal 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 relatively successful.</p>	<p>Extent The Proposal may result in significant residual impacts to 1.9 ha of CCWs and 0.5 ha to one REW - UFI 8678.</p> <p>Quality 1.9 ha of CCWs comprising: 0.5 ha in Good condition, 1.1 ha in Degraded condition and 0.3 ha in Completely Degraded condition.</p> <p>0.5 ha of UFI 8678, comprised of 0.3 ha in Excellent condition, 0.1 ha in Good condition and 0.1 ha in Degraded condition.</p> <p>Conservation Significance CCWs are wetlands which support a high level of attributes and functions and are considered significant at State level. Due to the Excellent quality vegetation within UFI 8678, previous impacts and Aboriginal heritage listing, this impact is considered significant.</p> <p>Land Tenure State Time Scale Permanent</p> <p>According to the agreed significance framework, residual impact is considered significant due to the general high conservation significance of CCWs and the high conservation significance of REW UFI 8678.</p>	<p>Direct land acquisition of a privately-owned Bush Forever site in Keysbrook. The Keysbrook site will be rezoned to Parks and Recreation. The PTA proposes to provide funding to the Local Government to provide seven years of on-ground management, specific to the environmental values being offset.</p>	<p>Land acquisition: No risk as the site has already been acquired by the State and allocated to the PTA to offset METRONET project impacts.</p> <p>Long-term: No risk due to:</p> <ol style="list-style-type: none"> Changing the zoning to Parks and Recreation. The site's Bush Forever Site status. Proposal to provide funding to the Shire of Serpentine Jarrahdale for on-ground management. The intention to transfer the site to conservation estate. 	<p>What is the type of vegetation being offset or revegetated? No revegetation is proposed. The offset site contains existing CCWs and REWs.</p> <p>Can the values being offset be defined and measured? Yes. The PTA's consultant has conducted a site survey to assess and define the site's environmental values. A weed mapping assessment is scheduled for Spring 2020.</p> <p>Operator experience in undertaking actions? It is proposed that the Shire of Serpentine Jarrahdale manage the land. The Shire of Serpentine Jarrahdale have extensive experience conducting site management and conservation works.</p> <p>Is there evidence the environmental values can be re-created (evidence of demonstrated success)? The PTA does not propose to recreate environmental values but instead maintain and manage the site's existing environmental values. The Shire of Serpentine Jarrahdale routinely carries out management and restoration activities within native flora and fauna habitats across its jurisdiction.</p>	<p>No time lag - Site has already been acquired. Ecological benefit has been realised through State purchase. Rezoning to Parks and Recreation and its Bush Forever status will provide ecological benefit. Proposed funding to the Shire of Serpentine Jarrahdale to provide on-ground management works will begin once the arrangement between agencies has been finalised.</p>	<p>To offset impacts to 1.9 ha to CCWs, acquisition and management of approximately 5.7 ha of existing CCW is required (based on a 3:1 ratio).</p> <p>To offset impacts to 0.5 ha of one REW acquisition and management of approximately 1.5 ha of existing REW is required (based on a 3:1 ratio).</p> <p>The co-location of CCW and REW within the Bush Forever offset is cost effective. The acquisition and management of land is appropriate and the offset is considered proportionate to the impact.</p>
<p>Clearing of 17.2 ha of regionally significant bushland within Bush Forever site 304 (Whiteman Park) within the Proposal Footprint.</p>	<p>Avoid:</p> <ul style="list-style-type: none"> Avoidance of areas of Bush Forever sites 198 Beechboro Road Bushland, Ballajura; 200 Caversham Airbase Bushland, West Swan / Whiteman; and 305 Bennett Brook Reserve. Changes to the Development Envelope and Footprint have reduced impacts to Bush Forever site 304 (Whiteman Park) by 17 ha, from 81.7 ha to 64.7, of which on 17.2 ha is classified as regionally significant bushland. The Proposal was designed to prioritise placement within existing linear infrastructure corridors where practicable, avoiding clearing of native vegetation within the Bush Forever site 304 (Whiteman Park). Where possible, native vegetation within Bush Forever has been included within NVRAs to avoid clearing during construction activities. <p>Minimise:</p> <ul style="list-style-type: none"> The Development Envelope was positioned so as to minimise impacts on Bush Forever site 304 (Whiteman Park) by crossing it at its narrowest practicable point, commensurate with the requirements of rail design geometry. The Footprint has been aligned on the edge of Drumpellier Drive to minimise clearing required along Bush Forever site 304's eastern edge. Temporary clearing of Bush Forever site 304 will be minimised wherever practicable. Construction and operational access tracks have been designed to coincide with existing tracks or aligned along cleared areas where practicable. 	<p>Areas cleared for the Proposal will be revegetated where not required for permanent infrastructure or management access with consideration for operational safety requirements.</p> <p>Areas cleared for the Proposal within the riparian zone of Bennett Brook not required for permanent infrastructure or ongoing management of the railway will be revegetated.</p>	<p>Rehabilitation of disturbed areas and landscaping of the Proposal 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 relatively successful.</p>	<p>Extent Clearing of 17.2 ha of regionally significant bushland in Bush Forever site 304 (Whiteman Park) within the Footprint.</p> <p>Quality The 17.2 ha is comprised:</p> <ul style="list-style-type: none"> 10.6 ha of Degraded vegetation; 2.1 ha of Good to Degraded vegetation; 3.9 ha of Good vegetation; 0.3 ha of Very Good to Good vegetation; and 0.3 ha of Very Good vegetation. <p>(10 ha of vegetation is Cleared and 37.5 ha of vegetation is in a Completely Degraded condition.)</p> <p>Conservation Significance Bush Forever vegetation is considered regionally significant bushland by the State.</p> <p>Land Tenure State/Unallocated Crown Land (UCL) (not currently managed for conservation).</p> <p>Time Scale Permanent</p> <p>According to the agreed significance framework, residual impact is considered significant due to the general high conservation significance of the vegetation in Bush Forever, which supports flora and fauna, TECs/PECs, Black Cockatoos, wetlands and provides ecological links.</p>	<p>Direct offset - land acquisition of a privately-owned Bush Forever site in Keysbrook. The Keysbrook site will be rezoned to Parks and Recreation. The PTA proposes to provide funding to the Shire of Serpentine Jarrahdale to provide seven years of on-ground management to the entire site.</p>	<p>Land acquisition: No risk as the site has already been acquired by the State and allocated to the PTA to offset METRONET project impacts.</p> <p>Long-term: No risk due to:</p> <ol style="list-style-type: none"> Changing the zoning to Parks and Recreation. The site's Bush Forever Site status. Proposal to provide funding to the Shire of Serpentine Jarrahdale for on-ground management. The intention to transfer the site to conservation estate. WAPC's ongoing management thereafter. 	<p>What is the type of vegetation being offset or revegetated? No revegetation is proposed. Vegetation contained within the Bush Forever site will be a component of the offset.</p> <p>Can the values being offset be defined and measured? Yes. The PTA's consultant has conducted a site survey to assess and define the site's environmental values.</p> <p>Operator experience in undertaking actions? It is proposed that the Shire of Serpentine Jarrahdale manage the land. The Shire of Serpentine Jarrahdale have extensive experience conducting and managing site conservation works.</p> <p>Is there evidence the environmental values can be re-created (evidence of demonstrated success)? The PTA does not propose to recreate environmental values but instead maintain and manage the site's existing environmental values. The Shire of Serpentine Jarrahdale routinely carries out management and restoration activities within native flora and fauna habitats across its jurisdiction. The Shire will provide additional management to what is currently being undertaken, which should result in ecological benefit to the site.</p>	<p>No time lag - Site has already been acquired. Ecological benefit has been realised through State purchase. Rezoning to Parks and Recreation and its Bush Forever status will provide ecological benefit. Proposed funding to the Shire of Serpentine Jarrahdale to provide on-ground management works will begin once the arrangement between agencies has been finalised.</p>	<p>To offset the clearing of clearing of 17.2 ha of regionally significant bushland in Bush Forever site 304 (Whiteman Park), the PTA propose to manage 34.4 ha of existing Bush Forever at the Keysbrook Bush Forever Site. The PTA proposes to provide funding to the Shire of Serpentine Jarrahdale to provide seven years of on-ground management at the acquired Keysbrook offset site.</p> <p>The application of management measures to an area of existing Bush Forever site (in particular those that do not have existing active conservation management) is cost effective and is relevant to the impact.</p>



**Public Transport
Authority**



Offset Strategy

Malaga to Ellenbrook Rail Works Proposal

October 2020

Document Information

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Executive Summary

The Public Transport Authority of Western Australia (PTA) is proposing to develop the Malaga to Ellenbrook Rail Works (the Proposal) as part of the Western Australian Government's METRONET vision. The Proposal is located between 12 to 22 kilometres (km) north-east of the Perth Central Business District (CBD), within the City of Swan. The Proposal connects to the proposed Bayswater to Malaga railway line at the eastern edge of the Tonkin Highway road reserve.

The Proposal's 464 ha Development Envelope extends east from the Tonkin Highway, north of Marshall Road to Bennett Springs where the railway alignment turns to the north to run adjacent to Drumpellier Drive (formerly Lord Street), passing under Gnangara Road and turning to the northeast to terminate south of The Parkway in Ellenbrook (see Figure 1). A summary of the Proposal is also provided in Table ES1.

Table ES1 - Summary of the Proposal

Item	Details
Proposal title	Malaga to Ellenbrook Rail Works
Proponent name	Public Transport Authority of Western Australia
Short description	The Proposal is to construct and operate a 13km new dual railway track, which connects to the Bayswater to Malaga Rail Works proposal. The Proposal includes the construction and operation of three new stations at Malaga, Whiteman Park and Ellenbrook, with provision for a future Bennett Springs East Station. Provision will also be made for a potential future Rail Stabling Facility at Henley Brook within Whiteman Park.

The Proposal's significant residual environmental impacts to Matters of National Environmental Significance (MNES) are contained within the Indicative Footprint and will be managed through measures described in this Offset Strategy.

This Offset Strategy proposes a direct (land acquisition) offset to counterbalance significant residual impacts to:

- all (100%) of the Banksia Woodlands Threatened Ecological Community (TEC)
- at least 90% of Black Cockatoo foraging habitat
- and 100% of Black Cockatoo potential breeding trees

An indirect offset to counterbalance no more than 10% of Black Cockatoo foraging habitat will be provided through a Murdoch University Black Cockatoo research proposal.

The Lowlands offset site is within the PTA's METRONET offset site portfolio and has previously been used to offset significant residual environmental impacts from the Thornlie-Cockburn Link (TCL) Proposal. Environmental values quantification indicate there is sufficient quantity of commensurate environmental factors available at the Lowlands offset site for the implementation of this Proposal.

The PTA proposes to contribute funding to Murdoch University to partially finance a Black Cockatoo research project. The research project is anticipated to lead to benefits for Black Cockatoo species in Western Australia as it will provide further data on critical Black Cockatoo habitat and species movement and health. This data will be used to inform future environmental impact assessments and potential offset sites.

The Offset Strategy will be revised if required following comments from regulators and to meet approval conditions imposed by the Department of Agriculture, Water and the Environment (DAWE).

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1. Introduction

1.1. Project overview

The Public Transport Authority of Western Australia (PTA) is proposing to develop the Malaga to Ellenbrook Rail Works (the Proposal) as part of the Western Australian Government's METRONET vision. The Proposal is located between 12 to 22 kilometres (km) north-east of the Perth Central Business District (CBD), within the City of Swan. The Proposal connects to the proposed Bayswater to Malaga railway line at the eastern edge of the Tonkin Highway road reserve.

The Proposal includes the installation of 13 km of new dual railway track which spurs off the proposed Bayswater to Malaga Rail Works line, including the construction and operation of three new stations at Malaga, Whiteman Park and Ellenbrook with intermodal rail, bus, carpark, and active mode (cycling and walking) facilities at each station and a potential rail stabling facility. A potential future station is also proposed at Bennett Springs (Figure 1).

The Proposal's 463.8 ha Development Envelope extends east from the Tonkin Highway, north of Marshall Road to Bennett Springs where the railway alignment turns to the north to run adjacent to Drumpellier Drive (formerly Lord Street), passing under Gnangara Road and turning to the northeast to terminate south of The Parkway in Ellenbrook (Figure 1). Predicted direct impacts will be incurred within the 249 ha Indicative Footprint (hereinafter the Footprint) (Figure 1).

The PTA has considered and applied avoidance, minimisation and mitigation measures within the Proposal's Environmental Review Document (PTA 2020). Significant residual environmental impacts to Matters of National Environmental Significance (MNES) of the Proposal will be managed in accordance with this Offsets Strategy.

1.2. Regulatory context

The significant residual environmental impacts to MNES of the Proposal and appropriate offsets to counterbalance these impacts were identified and assessed in accordance with the following legislation, policy and guidelines:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Australian Government 2019);
- EPBC Act *Environmental Offsets Policy* (Australian Government 2012a); and
- *Commonwealth Offsets Assessment Guide* (Australian Government 2012b).

1.3. Regulator assessment of the Proposal

The Proposal has been submitted to the Department of Environment and Water Regulation (DWER) and the Commonwealth Department of Water, Agriculture and Environment (DAWE) for assessment.

1.3.1. Western Australia

The PTA referred the Proposal to the Environmental Protection Authority (EPA) (Government of Western Australia, 1986) on 24 December 2019 under Section 38 of the *Environmental Protection Act 1986* (EP Act). The EPA determined on 18 February 2020 that the Proposal would be formally assessed under the EP Act, with the level of assessment set as Public Environmental Review (PER) with a two week public review period. The Environmental Review Document (ERD) was released for public comment on 27 July 2020.

1.3.2. Commonwealth

The PTA referred the Proposal to the Commonwealth Department of the Environment and Energy (DEE, now the Department of Agriculture, Water and the Environment (DAWE)) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 23 September 2019 and the delegate for the Minister for the Environment determined on 24 December 2019 that the proposal is a Controlled Action under section 75 of the EPBC Act, requiring further assessment and approval. On 16 March 2020, the Commonwealth published the decision on the assessment approach, that the Proposal will undergo an accredited assessment.

1.4. Objectives

The objective of this Offset Strategy is to provide suitable offsets to counterbalance the Proposal's significant residual environmental impacts to Matters of National Environmental Significance (MNES) being:

- Banksia Woodlands of the Swan Coastal Plain (SCP) Threatened Ecological Community (TEC) - endangered.
- Carnaby's Cockatoo (*Calyptorhynchus latirostris*) - endangered.
- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) - vulnerable.
- Baudin's Cockatoo (*Calyptorhynchus baudinii*) - endangered.

1.5. Scope

The scope of this Offset Strategy is to:

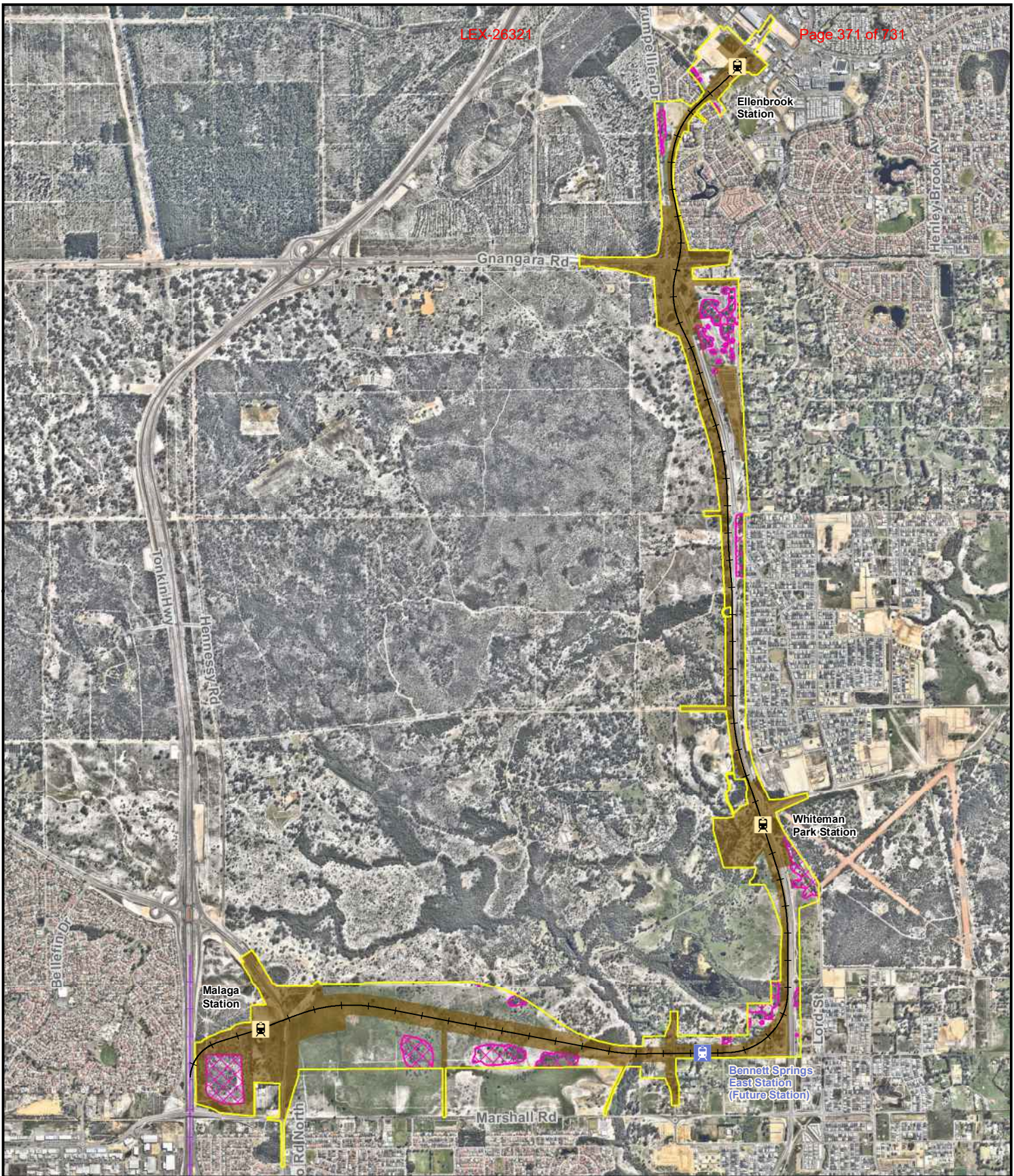
- Summarise the Proposals' significant residual environmental impacts to MNES.
- Apply the Commonwealth *Offsets Assessment Guides* (Australian Government 2012b) (referred to throughout as the 'Commonwealth offset calculator') to the Proposal's significant residual environmental impacts to MNES to determine the extent of offsets that are to be provided to meet regulatory guidelines.
- Provide written evidence that sufficient area of Banksia Woodlands threatened ecological community can be provided at the Lowlands offset site.
- Provide written evidence that a sufficient area of very high quality Carnaby's, high quality Forest Red-tailed and high quality Baudin's Black Cockatoo foraging habitat can be provided at the Lowlands offset site.
- Provide written evidence that a sufficient number of Black Cockatoo potential breeding trees can be provided at the Lowlands offset site.
- Provide map(s) clearly identifying environmental values of the Lowlands Offset Location, and areas within the Lowlands site allocated to other METRONET proposals.
- Provide a summary of the indirect offset, the Black Cockatoo research project.

1.6. Assumptions and limitations

The following assumptions have been made in the preparation of this Offset Strategy:

- The information presented in this version of the Offset Strategy is accurate at the time of writing.
- Information obtained from publically available government databases and/or datasets was considered to be accurate at the time of writing.
- Native Vegetation Retention Areas are designated areas within the Development Envelope that will not be directly impacted by this Proposal, and therefore do not require offsetting.

- Data has been rounded to one decimal place for the purposes of this document, with the exception of TEC data which has been rounded to two decimal places. As a conservative measure, decimal places were rounded up to ensure proposed offsets areas are compliant with guidelines.
- Environmental values assessments (EVAs) inform offsets sites proposed in this Offset Strategy.
- The PTA has sought written in-principle DWER and DAWE endorsement for the purchase of advanced indirect offsets to counterbalance a portion of the Proposal's impact to Black Cockatoos. The indirect offset is to provide funding to Murdoch University to conduct Cockatoo research proposal. At the time of writing, the DWER and DAWE had not provided a response. This Offset Strategy includes the indirect advanced Black Cockatoo research proposal offset to partially counterbalance the Proposal's significant residual impacts to Black Cockatoos.
- Construction and operation of the Proposal will result in direct and indirect impacts associated with the clearing of conservation significant vegetation and fauna habitat. Indirect impacts will be managed in accordance with site-specific management plans and therefore will not be offset (PTA 2020).



METRONET | Malaga to Ellenbrook Rail Works Offset Strategy
Figure 1 The Proposal

- Legend**
- Development Envelope
 - Indicative Footprint
 - Native Vegetation Retention Area
 - Proposed Railway Station
 - Proposed Railway Station (Future)
 - Indicative Railway Alignment



Date Printed: 14/10/2020
 Created By: D.Whiteley
 Approved by: B.Lockley

Scale: 1:40,000 @ A4
 Coordinate System: GDA 1994 MGA Zone 50

2. Significant Residual Environmental Impacts

2.1. Proposal significant residual environmental impacts

Following consideration and application of avoidance, minimisation and mitigation measures the significant residual environmental impacts to MNES are outlined in Table 1.

Table 1: Proposal's Significant Residual Environmental Impacts

Environmental Value (MNES)	Significant residual environmental impact to be offset	Offset Requirement addressed
Banksia Woodlands of the SCP TEC	10.05 ha + 1.81 ha buffer	Refer to Section 4.2
Carnaby's Cockatoo foraging habitat	81.4 ha	Refer to Sections 4.2 and 4.3
Forest Red-tailed Black Cockatoo foraging habitat	68.1 ha	Refer to Sections 4.2 and 4.3
Baudin's Cockatoo foraging habitat	81.4 ha	Refer to Sections 4.2 and 4.3
Black Cockatoo potential breeding trees	423 trees	Refer to Sections 4.2 and 4.4

2.2. Banksia Woodlands

2.2.1. Description

The Commonwealth-listed Banksia Woodlands of the SCP (Banksia Woodlands TEC) is restricted to the SCP Interim Biogeographic Regionalisation for Australia (IBRA) bioregion and immediately adjacent areas, including the Dandaragan Plateau, from Jurien Bay in the north, to Dunsborough in the south, and northwest on the Whicher and Darling escarpments. It typically occurs on well-drained, low nutrient soils on sandplain landforms, particularly deep Bassendean and Spearwood sands and occasionally on Quindalup sands (Commonwealth of Australia 2016).

The Banksia Woodlands TEC is described in the EPBC Act *Approved Conservation Advice* (TSSC 2016) as:

A Woodland associated with the Swan Coastal Plain of southwest Western Australia. A key diagnostic feature is a prominent tree layer of Banksia, with scattered eucalypts and other tree species often present among or emerging above the Banksia canopy. The understorey is a species rich mix of sclerophyllous shrubs, graminoids and forbs. The ecological community is characterised by a high endemism and considerable localised variation in species composition across its range.

The conservation objective under the *Approved Conservation Advice* (TSSC 2016) is to mitigate the risk of extinction of this ecological community, and help recover its biodiversity and function, through protecting it using the EPBC Act and implementing priority conservation actions.

The three key approaches to achieve the conservation objective under the *Approved Conservation Advice* (TSSC 2016) are:

1. Protect the ecological community to prevent further loss of extent and condition;
2. Restore the ecological community within its original range by active abatement of threats, re-vegetation and other conservation initiatives; and

3. Communicate with and support researchers, land use planners, landholders, land managers, community members, including the Indigenous community, and others to increase understanding of the value and function of the ecological community and encourage their efforts in its protection and recovery.

The *Approved Conservation Advice* (TSSC 2016) indicates high conservation value, unmodified and older growth areas are particularly important for retention and management and areas that form important landscape connections, such as wildlife corridors or other patches of particularly high quality or regional importance should be retained.

In addition, the *Approved Conservation Advice* (TSSC 2016) states that buffer zones are ‘contiguous area immediately adjacent to a patch of the ecological community that is important for protecting its integrity’. Areas considered critical to the survival of the Banksia Woodlands TEC include ‘all patches that meet the key diagnostic characteristics and condition thresholds for the ecological community, plus the buffer zones, particularly where this comprises surrounding native vegetation.’

2.2.2. Significant residual impact

The Proposal will result in the clearing of no more than 10.05 ha of Banksia Woodlands TEC in two patches comprising of:

- 7.01 ha of vegetation in Very Good condition;
- 2.31 ha of vegetation in Good condition; and
- 0.73 ha of vegetation in Degraded condition.

Both patches have been assessed as comprising floristic community type (FCT) SCP23a.

As the Proposal will result in the clearing of native vegetation that provides a buffer to the Banksia Woodlands TEC a 25 m buffer around Patch 1 will be included in the offset calculations for Patch 1. The buffer is shown in Figure 2 and results in an additional offset requirement of 1.81 ha of Banksia Woodlands TEC.

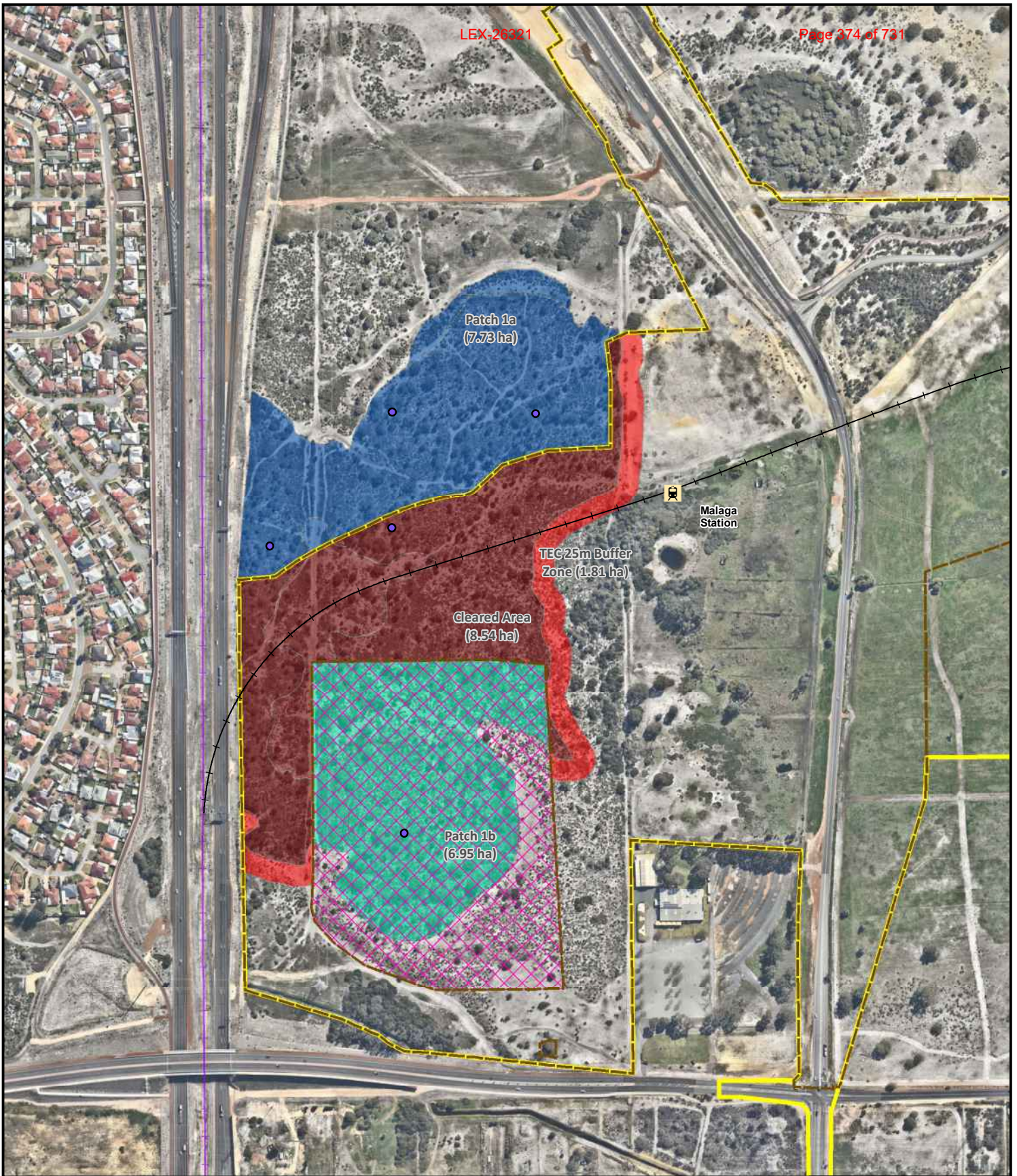
2.2.3. Total quantum of impact

An environmental offset will be provided to counterbalance the clearing of 10.05 ha of Banksia Woodlands of the SCP TEC and 1.81 ha of buffer. Table 2 indicates the quantum of impact calculated from the extent and quality of the Proposal’s impacts.

The proposed direct offset is discussed in Section 4.2.


Table 2: Banksia Woodlands TEC (including Banksia Woodlands PEC) impact calculations in accordance with the Commonwealth Offset Calculator

Criteria	Value	Explanation
Impact area (ha)	11.86	The Proposal will result in the clearing of no more than 10.05 ha of Banksia Woodland TEC within the Footprint and a 1.81 ha buffer as shown in Figure 2.
Quality (scale 0-10)	8	The value of 8 has been applied in the calculator to reflect the majority of the Banksia Woodlands TEC being in Very Good condition.
Total quantum of impact (ha)	9.49	Adjusted based on assessment of quality.



Malaga Patch 1 - Impacts to Banksia Woodland TEC

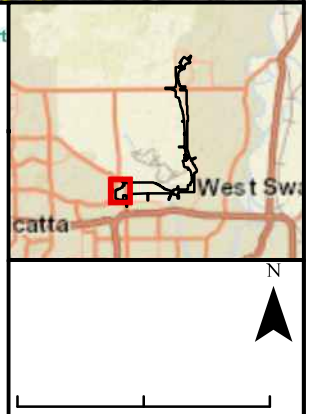
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FCT Quadrat Determination



Public Transport Authority



2.3. Black Cockatoo foraging habitat

2.3.1. Carnaby's Cockatoo habitat

During the breeding season, Carnaby's Cockatoo (*Calyptorhynchus latirostris*) forage in native vegetation that surrounds woodlands used for breeding. During the non-breeding season, Carnaby's Cockatoo forage extensively on:

- Banksia woodlands on the Swan Coastal Plain, including the Perth metropolitan area and Banksia heath on the southern coast;
- Seeding Marri and Jarrah;
- Pine plantations, seasonally, such as that on the Swan Coastal Plain; and
- Native and non-native plants around the Perth metropolitan area, such as liquid amber (Australian Government 2016a).

Breeding habitats (or sites) encompass those areas that contain suitable breeding trees within the range of the species, and associated foraging habitat. Carnaby's Cockatoo's nest in the large hollows of tall living or dead Eucalypts. Formerly breeding activity was typically restricted to Eucalypt woodlands mainly in the Wheatbelt, but recent breeding activity records indicate the species has expanded its breeding range west and southward into the Jarrah-Marri forests of the Darling Scarp and into the Tuart forests of the Swan Coastal Plain, including the Yanchep area, Lake Clifton and near Bunbury (Australian Government 2016a).

2.3.2. Forest Red-tailed Black Cockatoo habitat

Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) are endemic to the humid and sub-humid zones of the south-west of Western Australia, generally inhabiting the Jarrah, Marri and Karri forests within the 600mm average rainfall isohyet. Their current distribution ranges from north of Perth to Augusta and Albany and east to Mount Helena, Christmas Tree Well, North Bannister, Mt Saddleback, Rocky Gully and the upper King River. Family groups and small flocks are now also observed on the Swan Coastal Plain throughout the year. The critical breeding habitat for this species is within remnant patches of old Marri (*Corymbia calophylla*) trees within the Northern and Southern Jarrah Forest IBRA sub-regions (Government of Western Australia 2017).

Roost sites are in Jarrah-Marri-Blackbutt habitat generally situated within 4 km of potential feeding sites. They are most often observed in small flocks at dawn or dusk as they leave or return to a roost site. Approximately 90% of the Forest Red-tailed Black Cockatoo diet is made up of Marri (*Corymbia calophylla*) seeds and Jarrah (*Eucalyptus marginata*) fruit, but they will also feed on the following:

- Blackbutt (*Eucalyptus patens*);
- Karri (*Eucalyptus diversicolor*);
- Sheoak (*Allocasuarina fraseriana*);
- Snottygobble (*Persoonia longifolia*);
- Hakea species;
- The introduced Spotted Gum (*Eucalyptus maculata*); and
- The exotic Cape Lilac (*Melia azedarach*) on the Swan Coastal Plain (Government of Western Australia 2017).

2.3.3. Baudin's Cockatoo habitat

Baudin's Cockatoo (*Calyptorhynchus baudinii*) mainly occurs in Eucalypt forests, especially Jarrah, Marri and Karri forest and is less frequent in partly cleared farmlands and urban areas, including roadside trees and house gardens (Johnstone and Kirkby 2008).

Baudin's Cockatoo breeds in the Jarrah, Marri and Karri forests of the far south-west in areas averaging more than 750 mm of rainfall annually. Breeding generally occurs in woodland or forest, but may also occur in former woodland or forest now present as isolated trees. Areas of breeding are also known from the southern Swan Coastal Plain, the south coast region and the southern Wheatbelt region around Kojonup. Nesting occurs in hollows in live or dead trees of Karri, Marri, Wandoo and Tuart (*Eucalyptus gomphocephala*) (Australian Government 2016b). During the breeding season feeding primarily occurs in native vegetation, particularly Marri (Australian Government 2016b).

Outside the breeding season, the species feeds on Banksia and Hakea species, and *Erodium botrys* (wild geranium), as well as Dryandra species.

Baudin's Cockatoo sometimes associates with Carnaby's Cockatoo and the Forest Red-tailed Black Cockatoo's at sites where food is abundant (Higgins 1999, Saunders 1974), most likely in Jarrah-Marri forest on the Darling Plateau. Breeding, foraging and roosting areas also overlap on the southern Swan Coastal Plain.

2.3.4. Significant residual impact

The Proposal will result in the clearing of no more than 81.4 ha of Carnaby's Cockatoo foraging habitat, including 81.4 ha of Baudin's Cockatoo and 68.1 ha of Forest Red-tailed Black Cockatoo foraging habitat, and 423 potential Black Cockatoo breeding trees.

2.3.5. Total quantum of impact

Carnaby's Cockatoo foraging habitat

An environmental offset will counterbalance the clearing of 81.4 ha of Carnaby's Cockatoo foraging habitat, consisting of 42.8 ha of High quality, 11.3 ha of Moderate quality and 27.3 ha of Low quality habitat.

Table 3 indicates the quantum of impact calculated from the extent the Proposal's impacts to foraging habitat and the quality of habitat impacted.

The proposed direct offset is discussed in Section 4.2.

Table 3: Carnaby's Cockatoo foraging habitat impact calculations in accordance with the Commonwealth Offset Calculator

Criteria	Value	Explanation
Impact area (ha)	81.4	The Proposal will result in the clearing of 81.4 ha of Carnaby's Cockatoo foraging habitat.
Quality (scale 0-10)	6	Clearing of 81.4 ha of Carnaby's Cockatoo foraging habitat comprised of 42.8 ha of High quality habitat, 11.3 ha of Moderate quality and 27.3 of Low quality habitat within the Footprint. A quality rating of 6 has been applied as approximately 48% of the habitat is of Low-Moderate value, there were confirmed sightings of Carnaby's Cockatoo during the field survey (PTA 2020) and the area is mapped by the DBCA as Carnaby's Cockatoo Areas requiring investigation as feeding habitat in the Swan Coastal Plain (SCP) IBRA Region (DBCA-057).

Criteria	Value	Explanation
Total quantum of impact (ha)	48.84	Adjusted based on assessment of quality.

Forest Red-tailed Black Cockatoo foraging habitat

The clearing of Carnaby's Cockatoo foraging habitat includes a subset of 68.1 ha of Forest Red-tailed Black Cockatoo foraging habitat, consisting of 33.65 ha of High quality, 4.3 ha of Moderate quality and 30.2 ha of Low quality habitat. An environmental offset will be provided for this impact.

Table 4 indicates the quantum of impact calculated from the extent the Proposal's impacts to foraging habitat and the quality of habitat impacted.

The proposed direct offset is discussed in Section 4.2.

Table 4: Forest Red-tailed Black Cockatoo foraging habitat impact calculations in accordance with the Commonwealth Offset Calculator

Criteria	Value	Explanation
Impact area (ha)	68.1	The Proposal will result in the clearing of 68.1 ha of Forest Red-tailed Black Cockatoo foraging habitat.
Quality (scale 0-10)	6	Clearing of 68.1 ha of Forest Red-tailed Black Cockatoo foraging habitat comprised of 33.6 ha of High quality habitat, 4.3 ha of Moderate quality and 30.2 ha of Low quality habitat within the Footprint. A quality rating of 6 has been applied as approximately 50% of the habitat is of Low-Moderate value and there were confirmed sightings of Forest Red-tailed Black Cockatoo during the survey (PTA 2020).
Total quantum of impact (ha)	40.86	Adjusted based on assessment of quality.

Baudin's Cockatoo foraging habitat

The clearing of Carnaby's Cockatoo foraging habitat includes 81.4 ha of Baudin's Cockatoo foraging habitat, consisting of 42.8 ha of Moderate quality and 38.6 ha of Low quality habitat. An environmental offset will be provided for this impact.

Table 5 indicates the quantum of impact calculated from the extent the Proposal's impacts to foraging habitat and the quality of habitat impacted.

The proposed direct offset is discussed in Section 4.2.

Table 5: Baudin's Cockatoo foraging habitat impact calculations in accordance with the Commonwealth Offset Calculator

Criteria	Value	Explanation
Impact area (ha)	81.4	The Proposal will result in the clearing of 81.4 ha of Baudin's Cockatoo foraging habitat.
Quality (scale 0-10)	5	Clearing of 81.4 ha of Baudin's Cockatoo foraging habitat comprised of 42.8 ha of Moderate quality and 38.6 ha of Low quality habitat within the Footprint. A quality rating of 5 has been applied as the habitat is of Low-Moderate value. No

Criteria	Value	Explanation
		Baudin's Cockatoo were sighted during the survey (PTA 2020) however it is understood the species may be a vagrant/visitor to the area, and potentially increasing its range due to expanding urban development in its previously mapped range.
Total quantum of impact (ha)	40.7	Adjusted based on assessment of quality.

2.4. Black Cockatoo potential breeding trees

2.4.1. Description

Black Cockatoos are known to breed in large hollow-bearing trees, generally within woodlands or forests. It is generally accepted that the size of the tree (measured as the diameter at breast height (DBH)) can be a useful indication of the hollow-bearing potential of the tree, in which the Black Cockatoo is known to nest (Australian Government 2008). To protect the Black Cockatoo breeding habitat it is vital breeding trees are maintained and protected.

A breeding tree is a tree of species known to support Black Cockatoo breeding within the range of the species which either have a suitable nest hollow OR are of a suitable DBH to develop a nest hollow. For most tree species, suitable DBH is 500 mm. For salmon gum and wandoo, suitable DBH is 300 mm (Australian Government 2008).

2.4.2. Significant residual impact

Black Cockatoo Surveys (PTA 2020) undertaken of the Footprint identified that 423 potential breeding trees will be removed as part of the Proposal, of which 33 contained hollows. A Black Cockatoo hollow assessment survey (PTA 2020) determined that none of the hollows were considered suitable to be used by Black Cockatoos for breeding.

2.4.3. Required offset

An environmental offset will be provided to counterbalance the clearing of 423 Black Cockatoo potential breeding trees. Calculated on a 3:1 ratio, 1,269 existing Black Cockatoo potential breeding trees on a direct land acquisition site will be provided as an offset. The offset proposal is provided in Section 4.2.

3. Land acquisition sites

3.1. Lowlands site

3.1.1. Background

A land parcel on Lowlands Road in Mardella (referred to as the Lowlands site), comprising a total area of approximately 1,138 ha and contained within Bush Forever Site 368 was purchased by the Western Australian Planning Commission (WAPC) in 2014 as an 'Advanced offset'.

In 2012, the Western Australian Government consulted with the Commonwealth Government advising of their intention to purchase the Lowlands site due to its suitability for offsetting environmental impacts associated with the State's Strategic Assessment of the Perth and Peel Region (SAPPR). The State sought formal Commonwealth acknowledgement that the transfer to public ownership for conservation purposes would represent a significant conservation gain as part of a future environmental offsets package for the SAPPR.

The Commonwealth agreed in principle that the Lowlands site could form part of an overall offsets package in the MNES Plan being developed as part of the SAPPR. The Commonwealth also acknowledged that the Commonwealth Offsets Policy (Australian Government, 2012a) allows 'advanced offsets' where the offset is secured before the impact of an action(s) occurs.

Following this advice, the Lowlands Site was purchased by the WAPC in 2014 and a Class 'A' conservation reserve status was applied in 2015. Elevation of conservation status to Class A was conducted in 2015 for urgent management reasons and to honour the agreement made with the former private landowner.

Although the SAPPR is currently on hold, the environmental impacts of the METRONET rail infrastructure proposals were included in the original SAPPR calculations. Therefore in 2019, the Lowlands was allocated by the State to the PTA to offset METRONET Proposals.

Allocation of the Lowlands site to offset significant residual environmental impacts of METRONET rail infrastructure proposals aligns with the:

- Principal State and Commonwealth Lowlands purchase agreement made in 2012.
- The State's original intention to purchase Lowlands as an advanced offset to offset significant residual environmental impacts of proposals included within the SAPPR.
- *WA Environmental Offsets Guidelines* (Government of Western Australia 2014a) "pre-impact" offsets guidelines.
- *Commonwealth Offsets Policy* (Australian Government 2012a) advanced offsets policy.
- Government of Western Australia (2014a) and Australian Government (2012a) guidance to identify and assess the suitability and appropriateness of proposed direct offsets.

A portion of the Lowlands site has been allocated to this Proposal. Another portion has been used to offset the TCL Proposal and the remainder will be allocated to offset other METRONET proposals.

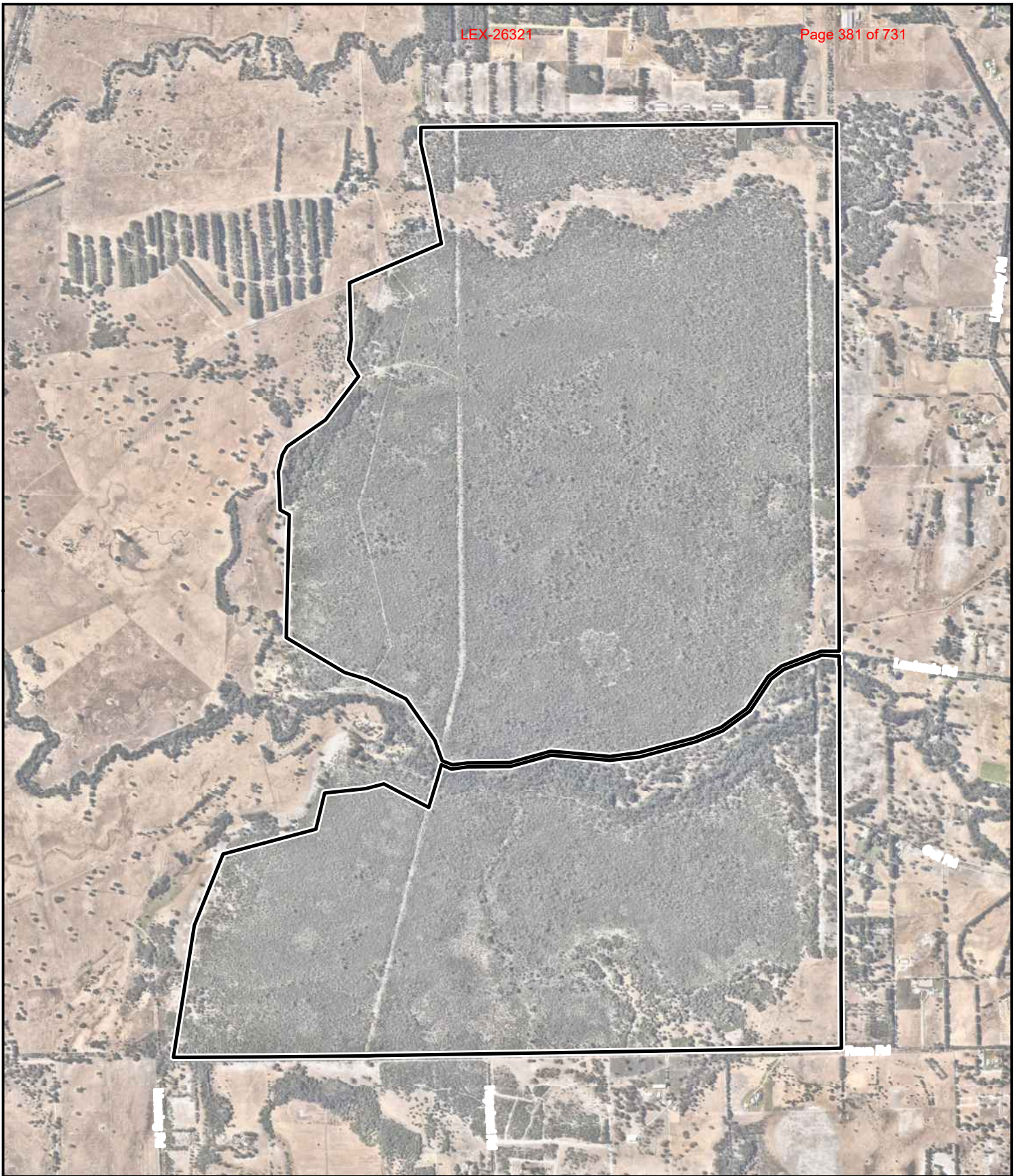
The total area of the Lowlands site is appropriate and proportionate to the quantum of Proposal's impact. The offset should provide a net long-term environmental gain to the values impacted.

3.1.2. Site description

A description of the Lowlands site is presented in Table 6.

Table 6: Lowlands site description

Site aspect	Description
Name of site	Lowlands
Address	Lot 301 Lowlands Road, Mardella
Lot on Plan	Lot 301 on Deposited Plan 77559
Local Government	Shire of Serpentine Jarrahdale
Local Zoning	Environment Conservation Reserve
Size	1,138 ha
Owner	The site is owned by the State of Western Australia, with the DBCA nominated as the responsible entity (a copy Certificate of Title is provided in Appendix A).
Land manager	The DBCA is the responsible management agency (refer to Certificate of Title, provided in Appendix A).
Allocation	The site was purchased as an Advanced offset in 2014 and entirely allocated to the PTA to offset METRONET Proposals in 2019.
Site plan	Figure 3- Site plan for Lowlands site
Layout	<p>The site is irregular in shape with Lowlands Road reserve traversing the site in an east-west direction.</p> <p>The site is void of any structures with the vegetation in Good condition. This site has a waterway that travels adjacent to the Lowlands Road reserve and clearing is generally limited to tracks and fire breaks, with the exception of the south-eastern corner, which has been historically cleared.</p>
Encumbrances	<ul style="list-style-type: none"> • Access easement for the right of carriageway purposes; • Easement in favour of the electricity corporation; • Class A reserve for the purpose of conservation of flora and fauna limited to a depth of 200 m from the natural surface; and • Management Order - M845092.
Summary of relevant site environmental values	<ul style="list-style-type: none"> • Banksia Woodlands; • Carnaby's Cockatoo foraging habitat; • Baudin's Cockatoo foraging habitat; • Forest Red-tailed Black Cockatoo foraging habitat; and • Black Cockatoo Potential breeding trees.



Site Plan for Lowlands Offset Site

Legend



Public Transport Authority



3.1.3. Environmental surveys

The following reports have been prepared based on environmental surveys conducted at the Lowlands site:

- *Floristics of Lowlands* (Keighery et. al 1995). This report was reviewed as part of the GHD (2020a) Lowlands Site desktop assessment scope of work.
- *METRONET Potential Offset Sites - Lowlands Site Environmental Values Assessment* (GHD 2020a). A copy of the report has been provided in Appendix B.
- *Lowlands Reserve Weed Survey - Final* (Woodgis 2020), a copy has been provided in Appendix C.
- Lowlands black cockatoo habitat Assessment against 2017 revised draft guidelines (GHD, 2020b). A copy of the report has been provided in Appendix D.

3.1.4. Environmental values

The Lowlands site is an intact area of native vegetation dominated by mixed Eucalyptus and Banksia woodlands. The site has small areas of partial clearings and lower elevation areas with associated damp land vegetation associations. The site is generally surrounded by cleared land with low-density semi-rural residential properties. The Serpentine River transects the central part of the site and there is some connectivity along this river via riparian woodland, and remnant patches of scattered trees this riparian vegetation provide some canopy connectivity. The environmental values survey identified four declared weeds, with one species listed as a weed of national significance (WONS).

The weed survey (Woodgis 2020) and weed management plan will be used to inform weed control by the DBCA as part of the on-ground management of the Lowlands site.

The Lowlands site's environmental values and condition are summarised in Table 7 and shown in Figure 4 and Figure 5.

Table 7: Lowlands site environmental values

Environmental value	Lowlands site description
Conservation categories	<ul style="list-style-type: none"> • Class 'A' conservation status - 1,122 ha • Bush Forever status - 1,122 ha (An amendment was approved on 28/02/2020 to Bush Forever site 368 to reserve the land to Parks and Recreation and to rationalise the boundary to the cadastre (WAPC 2019, Government of Western Australia 2020))
Native vegetation	The site consists of approximately 1,000 ha of native vegetation, in Excellent to Degraded condition, with the majority of the vegetation in Excellent or Very Good condition. The site is mostly covered by vegetation, with some access tracks and fire breaks.
Regional vegetation complexes	<ul style="list-style-type: none"> • Southern River Complex; • Dardanup Complex; • Guildford Complex; and • Bassendean Complex-Central and South Complexes.
Vegetation types	<ul style="list-style-type: none"> • 712.6 ha - <i>Eucalyptus Banksia</i> woodland (EBw) (FCT21a and 23a); • 63.2 ha - <i>Allocasuarina Banksia</i> woodland (ABw) (FCT21c); • 3.3 ha - <i>Banksia ilicifolia</i> woodland (Biw) (FCT22); • 14.4 ha - <i>Corymbia calophylla</i> open woodland (Cw); • 143.9 ha - <i>Banksia Kunzea</i> woodland (BKw) (FCT21c); • 19.7 ha - <i>Eucalyptus Melaleuca</i> woodland (EMw) (FCT4);

Environmental value	Lowlands site description
	<ul style="list-style-type: none"> • 36 ha - <i>Eucalyptus rudis</i> forest (Ef) (FCT11); • 4.8 ha - <i>Melaleuca</i> woodland (Mw) (FCT5); • 0.6 ha - Tuart woodland (Tw); • 120.6 ha - Scattered natives over weeds (Sn); and • 16.9 ha - Tracks.
Vegetation condition	<ul style="list-style-type: none"> • 712.58 ha - <i>Eucalyptus Banksia</i> woodland (EBw) (FCT21a and 23a) 312.7 ha - Excellent; 300.44 ha Very Good; 99.45 ha - Good. • 63.23 ha - <i>Allocasuarina Banksia</i> woodland (ABw) (FCT21c) 42.18 ha - Excellent; 21.05 ha - Very Good. • 3.27 ha - <i>Banksia ilicifolia</i> woodland (Biw) (FCT22) 3.27 ha - Good. • 14.37 ha - <i>Corymbia calophylla</i> open woodland (Cw) 14.37 ha - Good. • 146.91 ha - <i>Banksia Kunzea</i> woodland (BKw) (FCT21c) 82.5 ha - Very Good; 63.06 ha Good; 1.35 ha - Degraded. • 19.69 ha - <i>Eucalyptus Melaleuca</i> woodland (EMw) (FCT4) 3.4 ha - Very Good; 15.57 ha Good; 0.55 ha Degraded. • 19.69 ha - <i>Eucalyptus rudis</i> forest (Ef) (FCT11) 34.51 ha - Very Good; 1.53 ha - Good. • 4.82 ha - <i>Melaleuca</i> woodland (Mw) (FCT5) 4.66 ha - Good; 0.17 ha Degraded. • 0.57 ha - Tuart woodland (Tw) 0.57 ha - Good. • 120.66 ha - Scattered natives over weeds (Sn) 120.66 ha - Degraded. • 16.69 ha - Tracks 16.69 ha - Completely Degraded.
Conservation significant communities	<ul style="list-style-type: none"> • Banksia woodlands of the SCP TEC; • Low lying <i>Banksia attenuata</i> woodlands or shrublands (SCP21c) PEC; • Banksia dominated woodlands of the SCP IBRA region PEC; and • Tuart (<i>Eucalyptus gomphocephala</i>) woodlands of the SCP PEC.
Priority flora	<p>Four conservation significant flora have historically been recorded within the survey area:</p> <ul style="list-style-type: none"> • <i>Caladenia huegelii</i> (listed as Endangered under the EPBC Act and Critically Endangered under the BC Act); • <i>Drakaea elastica</i> (listed as Endangered under the EPBC Act and Critically Endangered under the BC Act); • <i>Johnsonia pubescens</i> subsp. <i>cygnorum</i> (P2) listed by DBCA; and • <i>Dillwynia dillwynioides</i> (Priority 3) listed by DBCA. <p>During the field survey a new location of <i>Johnsonia pubescens</i> subsp. <i>cygnorum</i> (Priority 2) was recorded.</p>
Fauna habitat types	<p>Four broad fauna habitats were identified within the survey area based on the mapped vegetation types:</p> <ul style="list-style-type: none"> • Mixed Eucalyptus Banksia Woodland; • Flooded Gum Melaleuca woodlands; • Riparian; and • Pasture with scattered trees.
Black Cockatoo habitat	<p>During the one day field visit by GHD (2020a), Carnaby's Cockatoo were seen and heard calling over the survey area. Forest Red-tailed Black Cockatoos were also observed feeding at two locations during the subsequent two day field assessment. Foraging evidence (chewed Marri, Jarrah, Banksia and <i>Allocasuarina</i> nuts) were recorded extensively throughout the Mixed Eucalyptus Banksia Woodlands, and Scattered native tree habitat types with both Carnaby's and Forest Red-tailed Black Cockatoo distinctive mandible marks evident.</p> <p>A summary of the Black Cockatoo habitat (GHD 2020a) is provided below:</p>

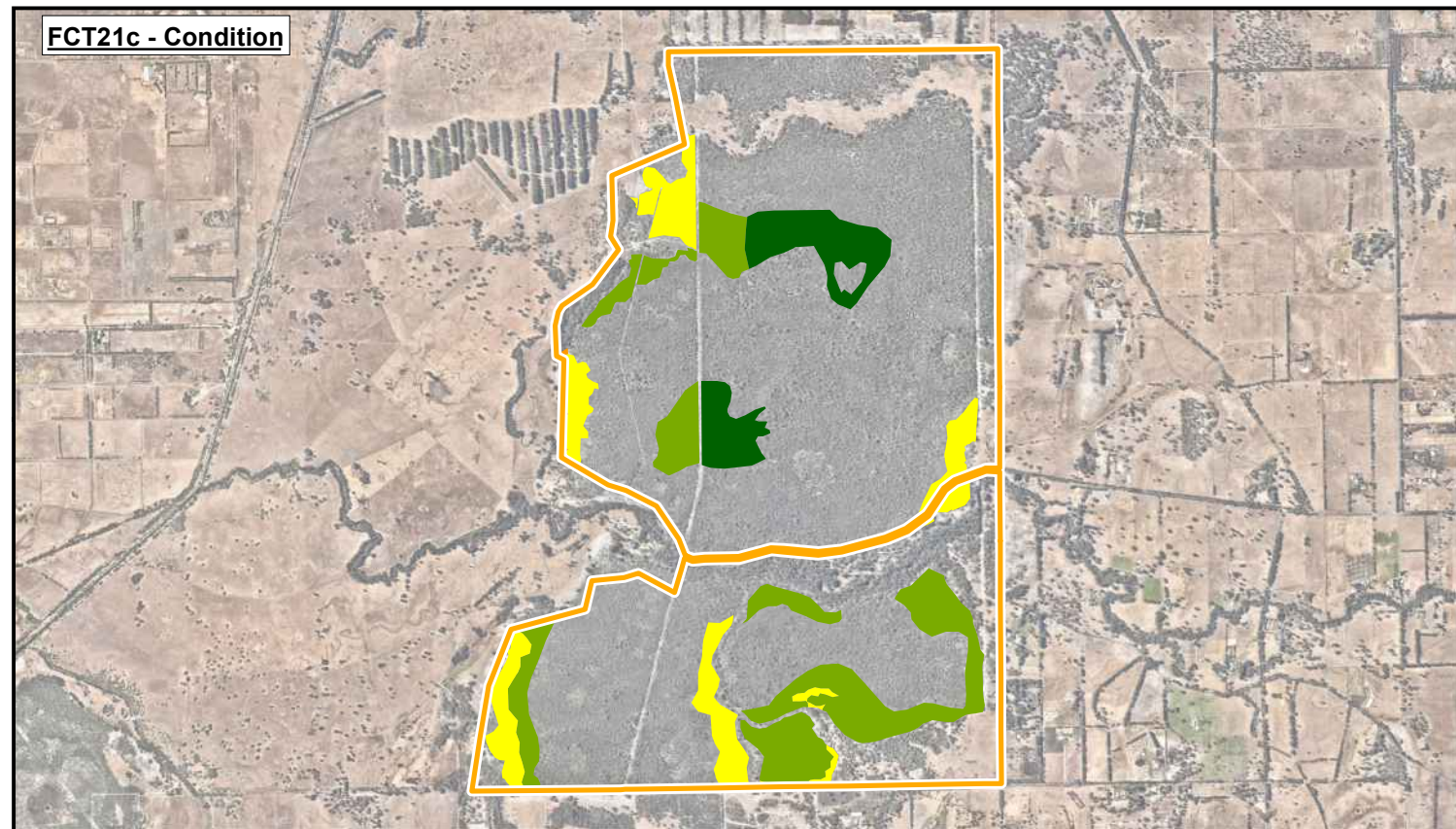
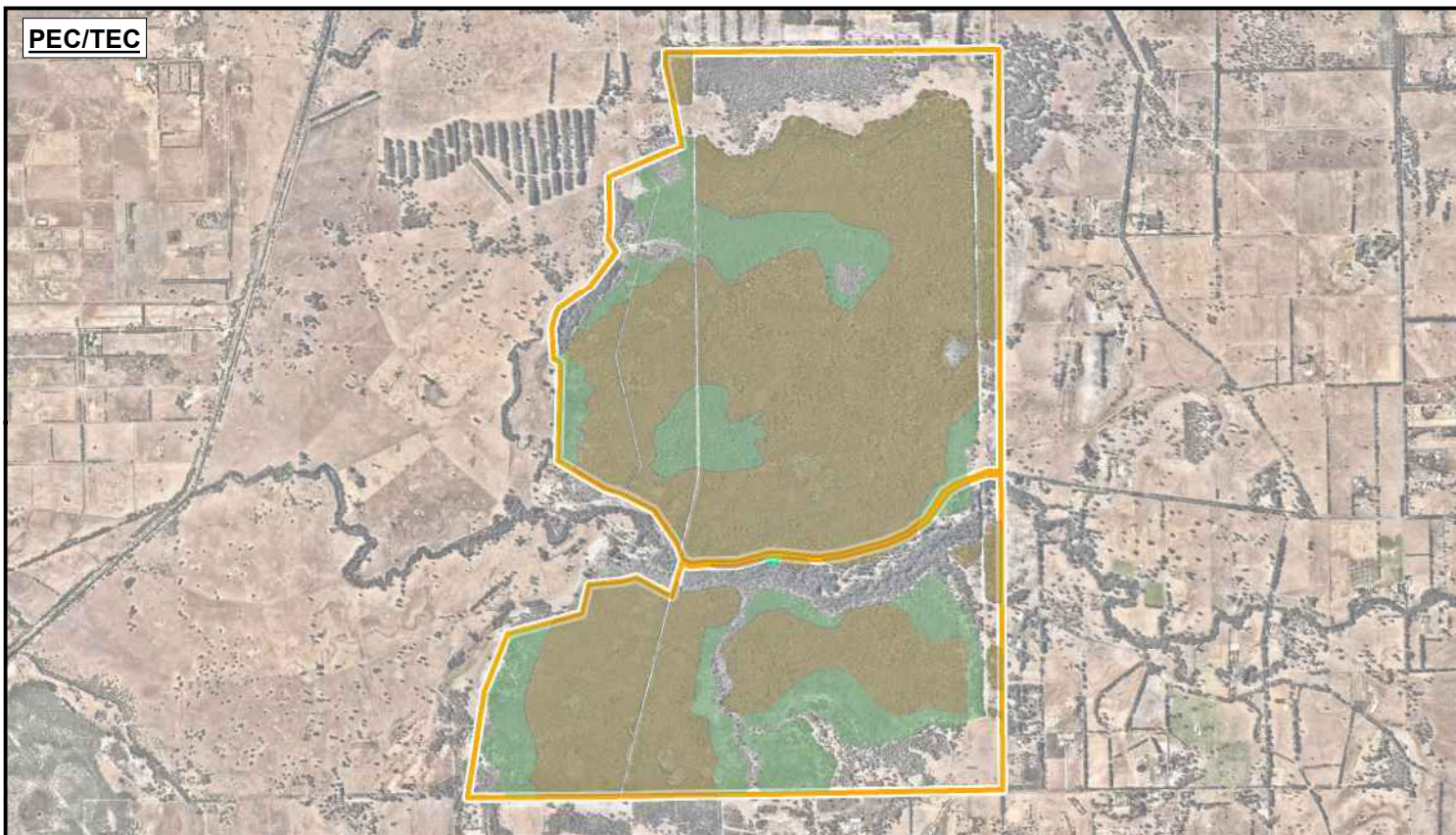
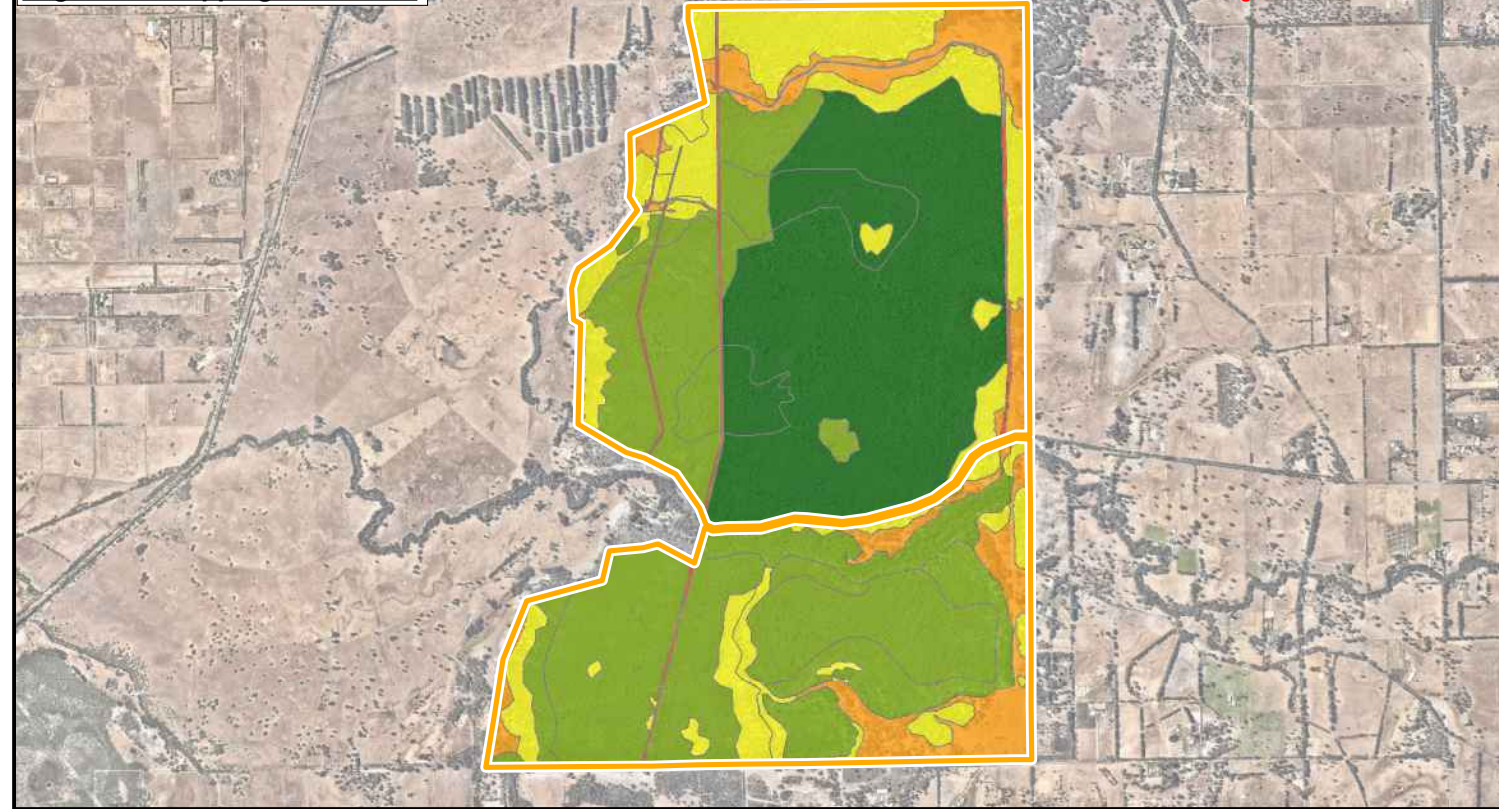
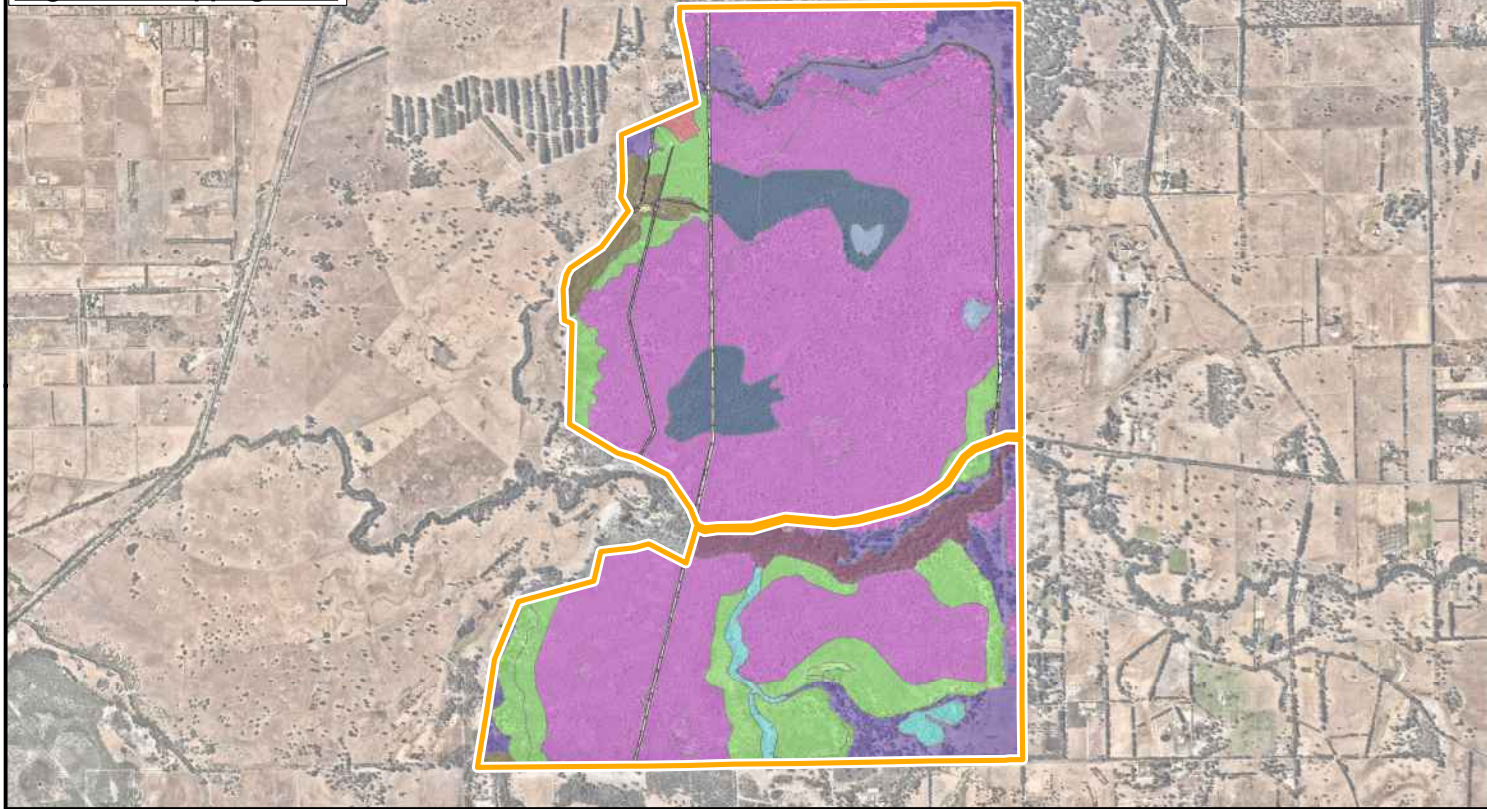
Environmental value	Lowlands site description			
	Habitat Type	Extent (ha)	Comments	
	Breeding	1,122	Each of the habitat types provides for potential breeding habitat.	
	Foraging	1,122	The Mixed Eucalyptus Banksia woodland provide high foraging potential, and the scattered natives, Flooded Gum Melaleuca woodlands and Riparian habitat provide low to moderate potential foraging habitat.	
	Roosting	36.6	Only the Riparian habitat was identified as being suitable for roosting activities.	
	A summary of the quality of black cockatoo foraging habitat (GHD 2020b) is provided below:			
	Habitat type	Carnaby's Cockatoo	Forest Red-tailed Black Cockatoo	Baudin's Cockatoo
	Mixed Eucalyptus Banksia Sheoak woodland (940.3 ha)	Very high quality	High quality	High quality
	Flooded Gum Melaleuca woodland (24.5 ha)	Low quality	Nil	Low quality
	Riparian (36.6 ha)	-	-	-
	Pasture with scattered trees (120.6 ha)	Quality	Nil	Low quality
Black Cockatoo potential breeding trees	GHD (2020a) states that the Lowlands site contains approximately 7.2 Black Cockatoo potential breeding trees per hectare, totalling an estimated 8,096 Black Cockatoo potential breeding trees within the site.			
	Habitat Vegetation Type	Extent (ha)	Potential breeding trees - mean (trees/ha)	Estimated potential breeding trees in habitat type
	Mixed Eucalyptus Banksia Sheoak woodland	940.3	6.3	5,923
	Scattered native trees	120.6	2.4	289
	Flooded Gum Melaleuca woodland	24.5	4	98
	Riparian	36.6	48.8	1,786
	Total	1,122.0	-	8,096
	Total estimated potential breeding trees / ha at the site			7.2

Environmental value	Lowlands site description
<p><i>Caladenia huegelii</i> potential habitat</p>	<p>39.49 ha of vegetation is considered to be known and supporting <i>Caladenia huegelii</i> habitat, based on a 200 m area around known specimens comprised of:</p> <ul style="list-style-type: none"> • 4.85 ha - <i>Banksia Kunzea woodland (BKw)</i> 3.96 ha - Vey Good, 0.89 - Good condition; and • 34.64 ha - <i>Eucalyptus Banksia woodland (EBw)</i> 3.83 - Excellent, 30.54 - Very Good, 0.27 ha - Good condition. <ul style="list-style-type: none"> • 878.57 ha of vegetation is considered to be potentially suitable <i>Caladenia huegelii</i> habitat within <i>Banksia woodlands</i> TEC.
Wetlands	<p>According to GHD (2020a) and based on the DBCA Geomorphic Wetlands SCP database (DBCA – 019), there are eight wetlands that occur within or intersect the Lowlands site:</p> <ul style="list-style-type: none"> • Two CCWs – 4.6 ha <ul style="list-style-type: none"> ○ 3.17 ha - UFI 7296 ○ 1.43 ha - UFI 14848 • Four REWs – 10.64 ha <ul style="list-style-type: none"> ○ 1.77 ha - UFI 7244 ○ 1.6 ha - UFI 14744 ○ 6.42 ha - UFI 14749 ○ 0.85 ha - UFI 14846 • Two MUWs – 104.89 ha <ul style="list-style-type: none"> ○ 31.67 ha - UFI 15250 ○ 73.22 ha - UFI 16021
Wetland condition	<p>Based on the GHD (2020a) survey report:</p> <ul style="list-style-type: none"> • Wetlands are comprised of the following habitat types: <ul style="list-style-type: none"> ○ 24.5 ha of Moderate value Flooded Gum <i>Melaleuca</i> woodlands: <ul style="list-style-type: none"> ▪ Corresponding vegetation associations: Mw, Cw ▪ Comprised an overstorey of Paperbarks with occasional emergent Marri and Flooded gum over sparse to dense shrublands and mixed herbs and sedges, and introduced species such as Arum Lily. ▪ Occurs in lower elevation poor retainage damplands and ephemeral swamp areas. ▪ Moderate structural diversity, likely to be seasonally inundated. ○ 36.6 ha of High value riparian habitat: <ul style="list-style-type: none"> ▪ Corresponding vegetation associations: Ef, Emw, Tw. ▪ Includes banks of the Serpentine River, the waterway and associated tributaries, and sumpland areas. ▪ Comprises dense and very tall stands of Flooded gum forest with occasional Tuart and Paperbarks over Bracken and sedges. • Corresponding vegetation types within the wetlands include: <ul style="list-style-type: none"> ○ 19.7 ha of <i>Eucalyptus Melaleuca</i> woodland (EMw) (FCT4) ○ 30 ha of <i>Eucalyptus rudis</i> forest (Ef) (FCT 11) ○ 0.6 ha of Tuart woodland (Tw). ○ 4.8 ha of <i>Melaleuca</i> woodland (Mw) (FCT5) ○ 14.4 ha of <i>Corymbia calophylla</i> open woodland (Cw). <p>Wetland condition based on GHD (2020a) survey mapping data:</p> <ul style="list-style-type: none"> • 3.17 ha - UFI 7296 CCW – Good 2.67 ha, Degraded 0.50 ha. • 1.43 ha - UFI 14848 CCW – Good 0.85 ha, Degraded 0.58 ha. • 1.77 ha - UFI 7244 REW – Good 1.52 ha, Degraded 0.25 ha. • 1.60 ha - UFI 14744 REW – Very Good 1.15 ha, Good 0.32 ha, Degraded 0.13 ha. • 6.42 ha – UFI 14749 REW – Very Good 1.89 h, Good 4.52 ha, Degraded 0.01 ha. • 0.85 ha – UFI 14846 REW – Degraded 0.85 ha.

Environmental value	Lowlands site description
	<ul style="list-style-type: none"> • 31.67 ha - UFI 15250 MUW – Very Good 0.02 ha, Good 2.73 ha, Degraded 28.80 ha, Completely Degraded 0.12 ha. • 73.22 ha - UFI 16021 MUW – Very Good 4.07 ha, Good 13.24 ha, Degraded 52.64 ha, Completely Degraded 3.27 ha. <p>CCWs are comprised of the following vegetation types and extents:</p> <ul style="list-style-type: none"> • 0.85 ha - <i>Eucalyptus rudis</i> forest 0.85 ha Good • 2.68 ha - <i>Corymbia calophylla</i> open woodland 2.68 ha Good • 1.07 ha - Scattered natives over weeds 1.08 ha Degraded <p>REWs are comprised of the following vegetation types and extents:</p> <ul style="list-style-type: none"> • 0.72 ha - <i>Banksia Kunzea</i> woodland 0.40 ha Very Good, 0.31 ha Good, 0.01 ha Degraded • 1.52 ha - <i>Corymbia calophylla</i> open woodland 1.52 ha Good • 0.09 ha - <i>Eucalyptus Banksia</i> woodland 0.09 ha Very Good • 7.08 ha - <i>Eucalyptus Melaleuca</i> woodland 2.56 ha Very Good, 4.52 ha Good • 1.23 ha - Scattered natives over weeds 1.23 ha Degraded

3.1.5. Overlapping environmental values

Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo foraging habitat and potential breeding trees have all been identified by GHD (2020a) and the DBCA as occurring within the low lying Banksia Woodlands of the SCP TEC mapped within the Lowlands site. Therefore, the proposed physical portions of the Lowlands site applied as the offset for these MNES environmental values overlap.



Extent and Condition of Vegetation

Legend



Vegetation Mapping - Unit (GHD, 2020)



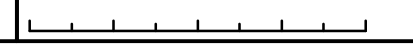
Vegetation Mapping - Condition (GHD, 2020)



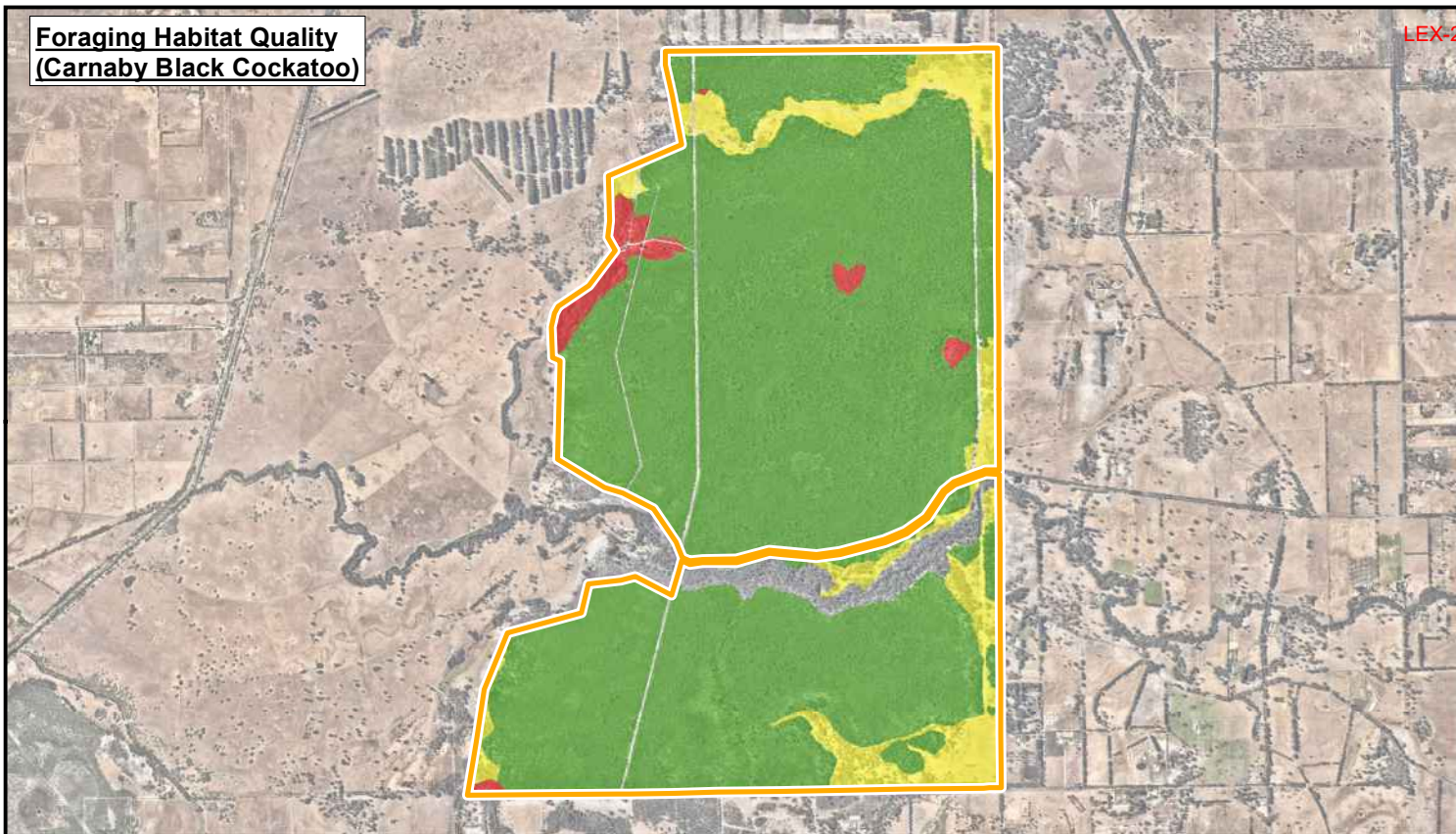
PEC/TEC (GHD Vegetation Mapping, 2020)



Public Transport Authority

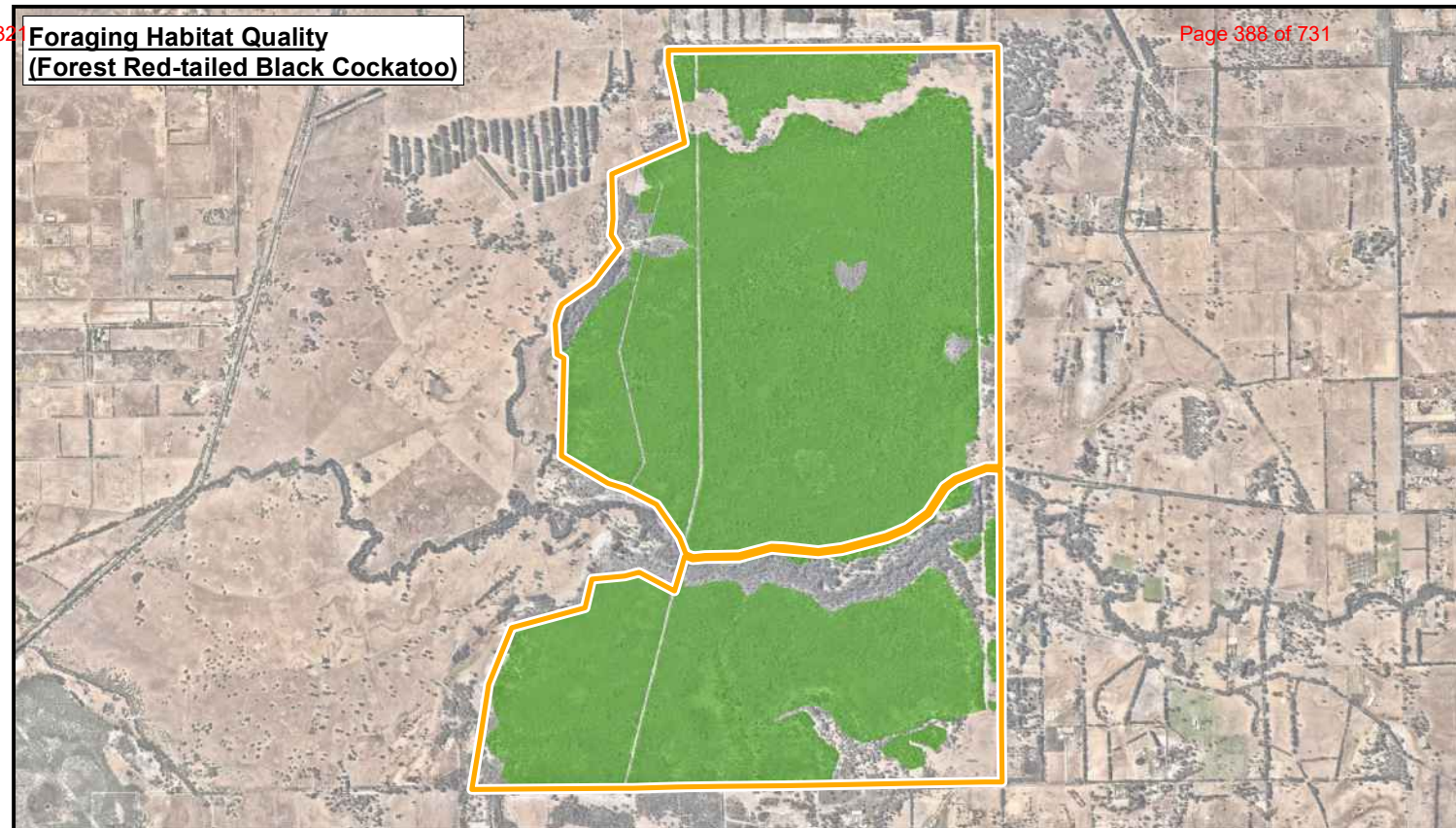


**Foraging Habitat Quality
(Carnaby Black Cockatoo)**



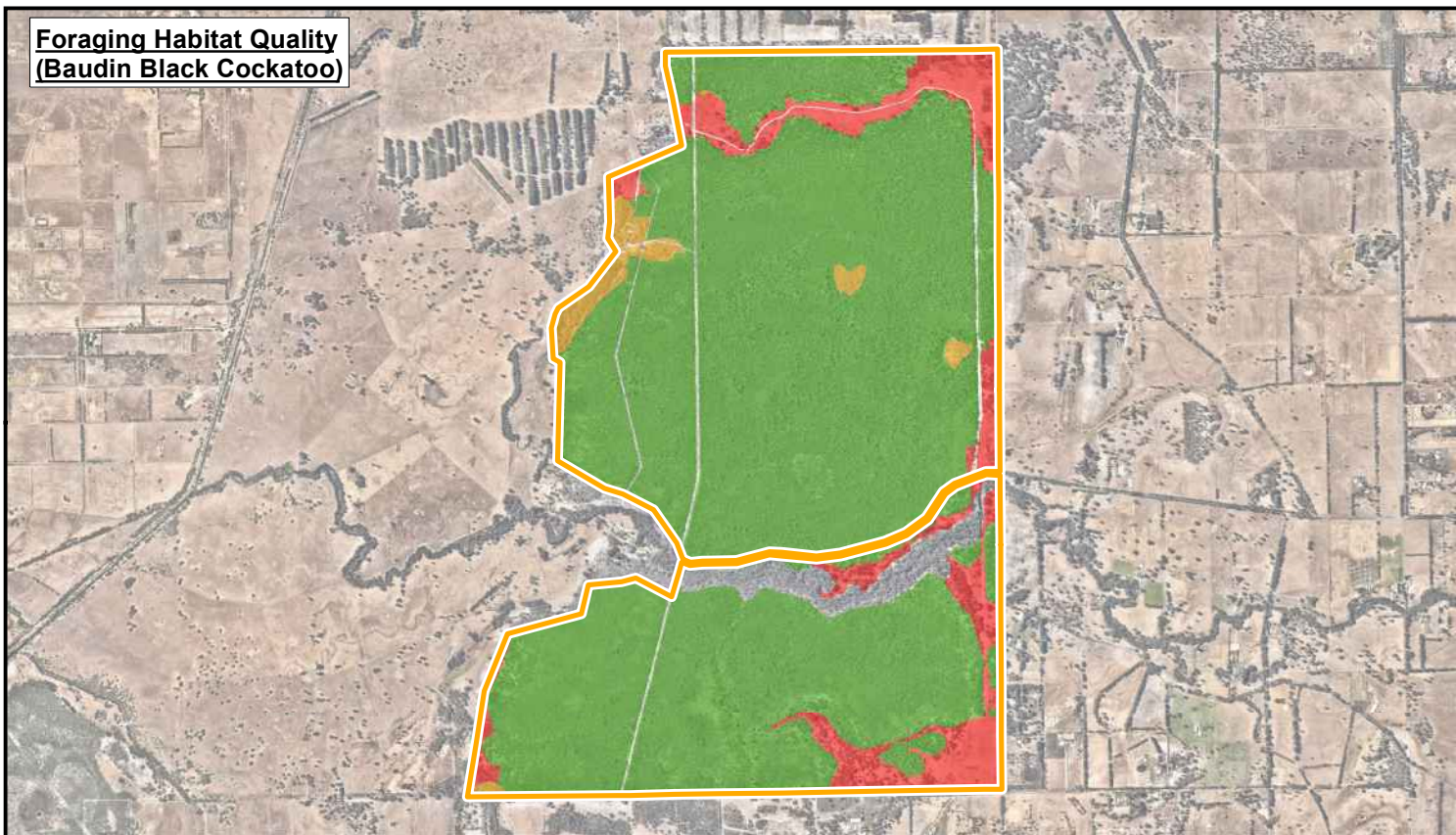
LEX-26321

**Foraging Habitat Quality
(Forest Red-tailed Black Cockatoo)**

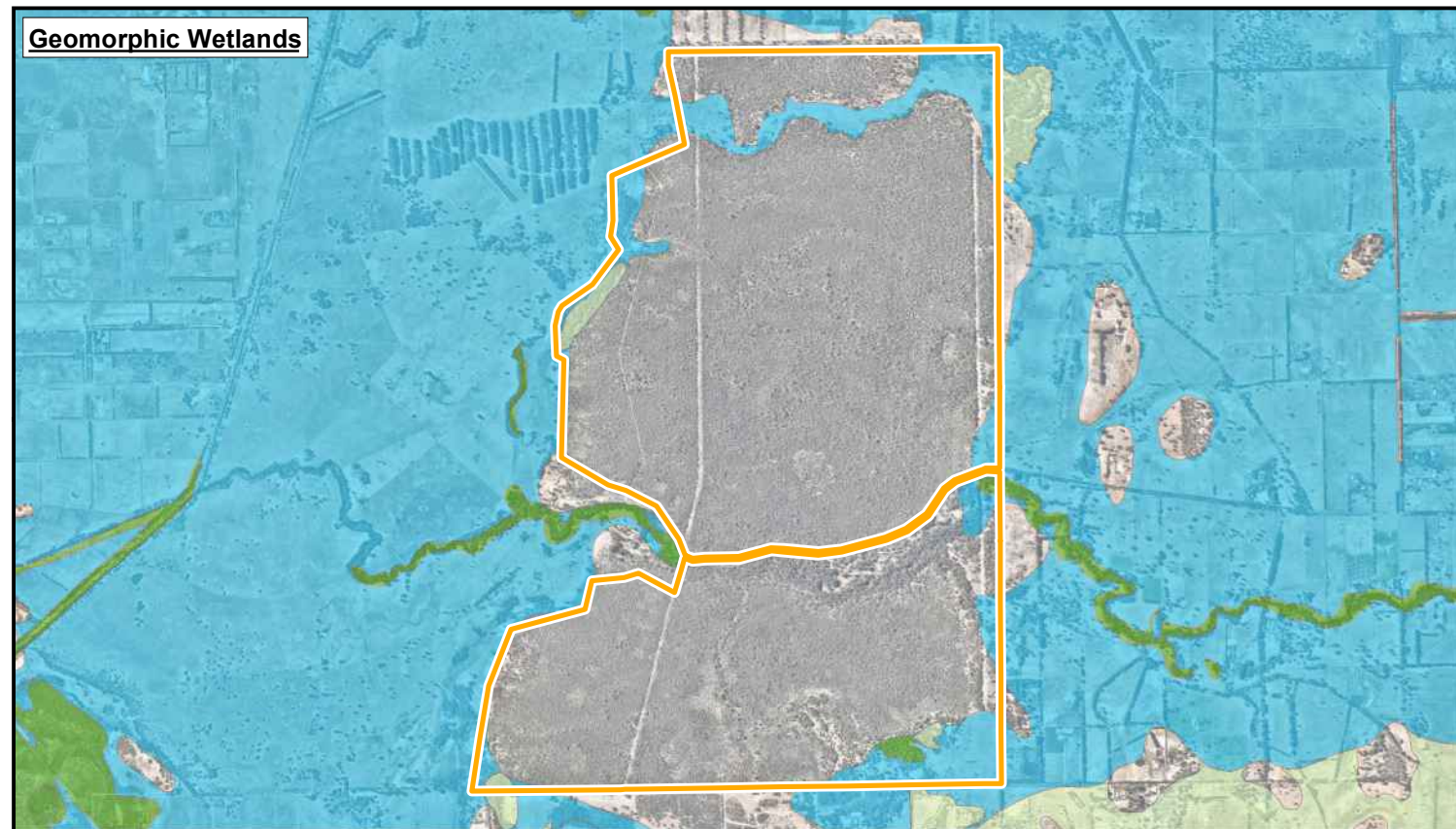


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**Foraging Habitat Quality
(Baudin Black Cockatoo)**



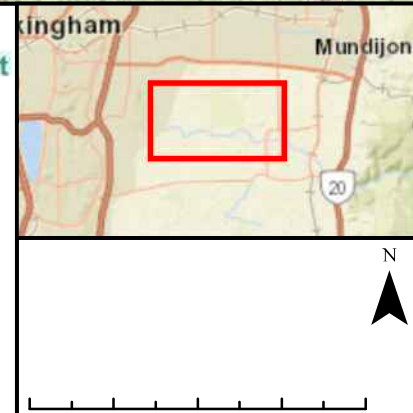
Geomorphic Wetlands



Extent and Condition of Black Cockatoo Habitat

Legend

- CBC - Foraging Habitat Quality (GHD, 2020b)
- FRT - Foraging Habitat Quality (GHD, 2020b)
- BCB - Foraging Habitat Quality (GHD, 2020b)
- Geomorphic Wetlands (DBCA)
-
-
-
-



4. Offset Strategy

4.1. Summary of Offset Strategy

The PTA will provide an advanced direct land acquisition offset, including seven years of on-ground management as follows:

- 100% of the Banksia woodlands TEC;
- At least 90% of the Black Cockatoo foraging habitat; and
- 100% of the Black Cockatoo potential breeding trees.

The PTA will provide an indirect offset in the form of a Black Cockatoo research project to offset not more than 10% of the Black Cockatoo foraging habitat.

4.2. Direct land acquisition and on-ground management

4.2.1. Overview

The advanced direct land acquisition offset will be provided at the Lowlands offset site as outlined in Table 8.

Table 8: Lowlands offset overview

Offset component	Lowlands
Type of offset	Advanced. Direct offset. State acquisition of privately-owned land.
Environmental values being offset	<p>The site will be used to offset:</p> <ul style="list-style-type: none"> • 100% of the Banksia Woodlands TEC ((ncluding the Banksia Woodlands buffer); • 90.45% of the 81.4 ha of Carnaby's Cockatoo foraging habitat; • 90.45% of the 68.1 ha of Forest Red-tailed Black Cockatoo foraging habitat; • 90.45% of the 81.4 ha of Baudin's Cockatoo foraging habitat; and • 100% of the 423 Black Cockatoo potential breeding trees.
Offset objectives	<ul style="list-style-type: none"> • Counterbalance the significant residual impact of the Proposal. • Prevent future loss of and degradation to the existing environmental values at the Lowlands offset site. • Address the threatening processes specific to the Lowlands offset site's environmental values/MNES, identified within the following documents: <ul style="list-style-type: none"> – Carnaby's Black Cockatoo Recovery Plan (Government of Western Australia 2013); – Forest Black Cockatoo (Baudin's Cockatoo <i>Calyptorhynchus baudinii</i> and Forest Red-tailed Black Cockatoo <i>Calyptorhynchus banksii naso</i>) Recovery Plan (Australian Government, 2008); – Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community (TSSC 2016); and – EPA Technical Report: Carnaby's Black Cockatoo in Environmental Impact Assessment in the Perth and Peel Region (Government of WA 2019b).
Security of offset	<ul style="list-style-type: none"> • The State's acquisition of privately-owned land. Acquisition for offset purposes resulted in the direct protection of site's environmental values. • Application as a State and Commonwealth Offset Site, recorded on the WA Offsets Register. • The State of Western Australia is the new landowner with the DBCA the nominated land manager on the Certificate of Title (refer to Appendix A). This ensures long-term protection and management of the site by the DBCA.

Offset component Lowlands	
	<ul style="list-style-type: none"> The site was made a Class A reserve following the State's acquisition.
On-ground management	Provision of funding to the DBCA to provide on-ground management activities for a period of seven years. Management activities propose to: <ul style="list-style-type: none"> Extend the current budget allocated to manage the site. Avert the risk of loss of environmental values over time through on-ground management. Address threatening processes.

4.2.2. Previous use as an offset

The Lowlands site has previously been used as an environmental offset to counterbalance impacts from the TCL Proposal. An overview of the extent and location of environmental values and MNES applied as an offset for the TCL Proposal is provided in Appendix E, demonstrating there is a sufficient quantity of suitable and applicable offset values available to use the Lowlands site as an offset site for this Proposal.

4.2.3. Application of the Commonwealth offsets calculator

Banksia Woodlands TEC

The Lowlands site contains Banksia Woodlands TEC ranging from Excellent to Good condition, while the impacted site contains Banksia Woodlands TEC ranging from Very Good to Degraded condition. As such, the Lowlands site can provide a Banksia Woodlands TEC offset in equivalent or better condition. Based on calculations undertaken by the PTA using the Commonwealth Offsets Calculator, the extent of Banksia Woodlands TEC offset required to meet 100% of the impact is 77.03 ha. This is based on a start quality of 8 for the Lowlands site. The details of the calculator's working is provided in the Start area column in Table 9 and Appendix F.

Table 9: Lowlands site Banksia Woodlands TEC (including the Banksia Woodlands PEC) offset calculations in accordance with the Commonwealth Offsets Calculator (Appendix F)

Criteria	Rating	Explanation
Start area (ha)	77.03	Area of Banksia Woodlands TEC (including the buffer) required calculated to meet 100% of the offset requirement, based on a start quality of 8.
Start quality	8	8 represents the start quality of Banksia Woodland TEC within the Lowlands site with the majority being High value habitat, generally in Very Good to Excellent Condition.
Future quality without offset	7	It is assumed that without active on-ground management measures there will be a small reduction in quality due to weed incursion and other threats.
Future quality with offset	8	Security of the offset and provision of capped funds to the DBCA to provide seven years of on-ground management of the site is expected to maintain the start quality of the offset.
Risk of loss (%) without offset	15	The site was formerly privately owned. This rating has been applied to the site's status prior to being acquired by the State. The 15% acknowledges that that risk is moderated by the known high conservation value of the site limiting the potential for development and that the site has been transferred into conservation estate.
Risk of loss (%) with offset	5	Protection of the offset site will substantially reduce the risk of future loss.

Criteria	Rating	Explanation
Confidence in result (averted loss) (%)	90	The protection mechanisms and proposed management provide a high level of certainty that the offset will be conserved, averting the level of loss that would likely occur should no formal protection measures be implemented.
Confidence in result (habitat quality) (%)	85	There is a high degree of confidence in this prediction based on the DBCA's proposed involvement in providing on-ground management.
Time over which loss is averted (years)	20	Provision of offset for long-term protection.
Time until ecological benefit (years)	7	Although ecological benefit was gained at the time the land was acquired, the overall offset package provided from 7 years on-ground management, therefore the time until ecological benefit has been set to 7 years. The ecological benefit from 7 years of on-ground management includes reduction in weed cover, fencing, feral animal control and dieback management.
Total offset % represented by Lowlands	100.01	100% of the offset requirement will be achieved.

Carnaby's Cockatoo

The Lowlands site contains predominantly High quality Carnaby's Cockatoo foraging habitat, while the impacted site contains High, Moderate and Low quality Carnaby's Cockatoo foraging habitat. As such, the Lowlands site can provide a Carnaby's Cockatoo foraging habitat offset in equivalent or better condition.

Based on calculations undertaken by the PTA using the Commonwealth Offsets Calculator, the extent of Carnaby's Cockatoo foraging habitat required to meet 90.45% of the impact is 358.7 ha. This is based on a start quality of 8 for the Lowlands site. The details of the calculator's working is provided in the Start area column in Table 10 and Appendix F.

An indirect offset is also being applied to offset significant residual environmental impacts to Carnaby's Cockatoo foraging habitat. This will comprise the remaining 9.55% of the offset requirement and is discussed in Section 4.4.

Table 10: Lowlands site Carnaby's Cockatoo foraging habitat offset requirement based on Commonwealth Offset Calculator (Appendix F)

Criteria	Rating	Explanation
Start area (ha)	358.7	Required offset area calculated to meet 90.45% of the offset requirement, based on a start quality of 8. The other 9.55% of the offset requirement will be met through indirect research offsets.
Start quality	8	8 represents the start quality of Carnaby's Cockatoo foraging habitat within the Lowlands site. (High Value 939.8 - ha; Low/Moderate Value - 181.7 ha)
Future quality without offset	7	It is assumed that 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	8	Security of the offset and provision of capped funds to the DBCA to provide seven years of on-ground management of the site is expected to maintain the start quality of the offset.

Criteria	Rating	Explanation
Risk of loss (%) without offset	15	The site was formerly privately owned. This rating applies to the site's status prior to being acquired by the State. The 15% acknowledges that that risk is moderated by the known high conservation value of the site limiting the potential for development.
Risk of loss (%) with offset	5	Protection of the offset site will substantially reduce the risk of future loss.
Confidence in result (averted loss) (%)	90	The protection mechanisms and proposed management provide a high level of certainty that the offset will be conserved, averting the level of loss that would likely occur should no formal protection measures be implemented.
Confidence in result (habitat quality) (%)	85	There is a high degree of confidence in this prediction based on the DBCA's proposed involvement in providing on-ground management.
Time over which loss is averted (years)	20	Provision of offset for long-term protection.
Time until ecological benefit (years)	7	Although ecological benefit was gained at the time the land was acquired, the overall offset package provided from 7 years on-ground management, therefore the time until ecological benefit has been set to 7 years. The ecological benefit from 7 years of on-ground management includes reduction in weed cover, fencing, feral animal control and dieback management.
Total offset % represented by Lowlands	90.47	At least 90% of the offset requirement will be achieved as land acquisition.

Forest Red-tailed Black Cockatoo

The Lowlands site contains predominantly High quality Forest Red-tailed Black Cockatoo foraging habitat, while the impacted site contains High, Moderate and Low quality Forest Red-tailed Black Cockatoo foraging habitat. As such, the Lowlands site can provide a Forest Red-tailed Black Cockatoo foraging habitat offset in equivalent or better condition.

Based on calculations undertaken by the PTA using the Commonwealth Offsets Calculator, the extent of Forest Red-tailed Black Cockatoo foraging habitat required to meet 90.45% of the impact is 263.3 ha. This is based on a start quality of 8 for the Lowlands site. The details of the calculator's working is provided in the Start area column in Table 11 and Appendix F. An indirect offset is also being applied to offset significant residual environmental impacts to Forest Red-tailed Black Cockatoo foraging habitat. This will comprise the remaining 9.55% of the offset requirement and is discussed in Section 4.4.

Table 11: Lowlands site Forest Red-Tailed Black Cockatoo foraging habitat offset requirement based on Commonwealth Offset Calculator (Appendix F)

Criteria	Rating	Explanation
Start area (ha) - requirement to meet 90% of offset	263.3	Required offset area calculated to meet 90.45% of the offset requirement, based on a start quality of 8. The remaining 9.55% of the offset requirement will be met through indirect research offsets.

Criteria	Rating	Explanation
Start quality	8	8 represents the start quality of Forest Red-tailed Black Cockatoo foraging habitat within the Lowlands site. (High Value - 939.8 ha; Low/Moderate Value - 181.7 ha)
Future quality without offset	7	It is assumed that without active on-ground management actions there will be a small reduction in quality due to weed incursion and other impacts.
Future quality with offset	8	Security of the offset and provision of capped funds to the DBCA to provide seven years of on-ground management of the site is expected to maintain the start quality of the offset.
Risk of loss (%) without offset	15	This rating has been applied as the site was formerly privately owned prior to being acquired by the State. The 15% acknowledges that the risk is moderated by the known high conservation value of the site limiting the potential for development.
Risk of loss (%) with offset	5	Protection of the offset site will substantially reduce the risk of future loss.
Confidence in result (averted loss) (%)	90	The protection mechanisms and proposed management provide a high level of certainty that the offset will be conserved, averting the level of loss that would likely occur should no formal protection measures be implemented.
Confidence in result (habitat quality) (%)	85	There is a high degree of confidence in this prediction based on the DBCA's proposed involvement in providing on-ground management.
Time over which loss is averted (years)	20	Provision of offset for long-term protection.
Time until ecological benefit (years)	7	Although ecological benefit was gained at the time the land was acquired, the overall offset package provided from 7 years on-ground management, therefore the time until ecological benefit has been set to 7 years. The ecological benefit from 7 years of on-ground management includes reduction in weed cover, fencing, feral animal control and dieback management.
% of impact offset	90.49	At least 90% of the offset requirement will be achieved as land acquisition.

Baudin's Cockatoo

The Lowlands site contains predominantly High quality Baudin's Cockatoo foraging habitat, while the impacted site contains Moderate to Low quality Baudin's Cockatoo foraging habitat. As such Lowlands can provide a Baudin's Cockatoo foraging habitat offset in equivalent or better condition.

Based on calculations undertaken by the PTA using the Commonwealth Offsets Calculator, the extent of Baudin's Cockatoo foraging habitat required to meet 90.45% of the impact is 337.9 ha. This is based on a start quality of 8 for the Lowlands site. The details of the calculator's working is provided in the Start area column in Table 12 and Appendix F. An indirect offset is also being applied to offset significant residual environmental impacts to Baudin's Cockatoo foraging habitat. This will comprise the remaining 9.55% of the offset requirement and is discussed in Section 4.4.

Table 12: Lowlands site Baudin's Cockatoo foraging habitat offset requirement based on Commonwealth Offset Calculator (Appendix F)

Criteria	Rating	Explanation
Start area (ha) - requirement to meet 90% of offset	337.9	Required offset area calculated to meet 90.45% of the offset requirement, based on a start quality of 8. The remaining 9.55% of the offset requirement will be met through indirect research offsets.
Start quality	6	6 represents the start quality of Baudin's Cockatoo foraging habitat within the Lowlands site. (High Value - 939.8 ha; Low/Moderate Value - 181.7 ha)
Future quality without offset	5	It is assumed that without active on-ground management actions 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 site is expected to maintain the start quality of the offset.
Risk of loss (%) without offset	15	This rating has been applied as the site was formerly privately owned prior to being acquired by the State. The 15% acknowledges that the risk is moderated by the known high conservation value of the site limiting the potential for development.
Risk of loss (%) with offset	5	Protection of the offset site will substantially reduce the risk of future loss.
Confidence in result (averted loss) (%)	90	The protection mechanisms and proposed management provide a high level of certainty that the offset will be conserved, averting the level of loss that would likely occur should no formal protection measures be implemented.
Confidence in result (habitat quality) (%)	85	There is a high degree of confidence in this prediction based on the DBCA's proposed involvement in providing on-ground management.
Time over which loss is averted (years)	20	Provision of offset for long-term protection.
Time until ecological benefit (years)	7	Ecological benefit was immediate following acquisition of land due to the additional protection placed on the site. Additional ecological benefit is attained from seven years of on-ground management by DBCA.
% of impact offset	90.49	At least 90% of the offset requirement will be achieved as land acquisition.

Potential Black Cockatoo breeding trees

The Lowlands site EVA (GHD, 2020a) estimated there were 8,096 potential Black Cockatoo breeding trees at the Lowlands site. Although the Commonwealth calculator provides guidance for calculating the impact of removing breeding trees, a 3:1 ratio was used following consultation with the DWER and DAWE assessing officers. Therefore, it is considered that there is a sufficient number of Black Cockatoo potential breeding trees at the Lowlands site to provide the required offset of 1,269 potential breeding trees.

4.2.4. Protection mechanism

Prior to the WAPC's purchase of the Lowlands site in 2014 as an Advanced offset, the site was a privately-owned Bush Forever site.

Following State purchase of the Lowlands site in 2014, the site was made into a Class 'A' conservation reserve in 2015. Raising the site's protection level reduces the risk of future clearing or risk of the site's environmental values diminishing. The DBCA has been managing the site since 2015.

Without the State purchasing the site as an Advanced offset, these protection mechanisms and DBCA site management would not be in place and the site would be at risk of potential development or degradation.

Under this Offset Strategy, the site will also be listed on the DWER Offsets Register and published on the PTA website as an offset site under the EPBC Act, further increasing the level of protection.

The PTA will provide funding to the DBCA for seven years which will allow the DBCA to extend their current management of the Lowlands site.

4.2.5. Actions undertaken to secure and manage offset

The following actions have been undertaken to secure and manage this offset.

- The PTA has consulted with the DBCA, DWER, EPA and DAWE regarding the suitability of the site to be used as an offset.
- The PTA have completed site investigations which included an environmental values assessment and weed survey.
- A MOU has been executed between the PTA and DBCA regarding on-ground management actions to be funded by the PTA and implemented by the DBCA at the Lowlands site for a period of seven years.
- The PTA has provided the DBCA with the funding allocation for the first year of on-ground management.

4.2.6. Actions to be undertaken to manage offset

The following actions are to be undertaken to implement this offset.

- The PTA, in consultation with the DBCA, is to prepare a weed management plan.
- The DBCA is to commence management actions as outlined in the MOU from 1 January 2021 for a period of seven years.
- The PTA is to make annual payments for the continued on-ground management of Lowlands to the DBCA as set out in the MOU.

4.2.7. Roles and responsibilities

The primary roles and responsibilities of the PTA in the implementation of this Offset Strategy include:

- Provide funding to the DBCA for the management of the site for a period of seven years.
- Report annual compliance to the DWER and DAWE until such time as it is determined that offset reporting requirements have been met.
- Audit the DBCA's management of the site, as required.

The primary roles and responsibilities of the DBCA in the implementation of this Offset Strategy include:

- Implement site management and monitoring as set out in the MOU for a period of seven years.
- Provide annual reports to the PTA for the duration of the on-ground management works, as set out in the MOU.

4.2.8. Management actions and schedule

The PTA will provide funding to the DBCA to undertake on-ground management actions for seven years. The Lowlands site indicative management actions and schedule is provided in Table 13.

Table 13: Lowlands site management actions and schedule

Activity	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
16.0km electrified fencing material (incl. 4 gates) and installation	X	X					
Management access tracks upgrade and maintenance	X		X		X		X
Reserve Management Officer Salary and associated costs	X	X	X	X	X	X	X
Signage - materials and installation	X	X	X	X			
<i>Phytophthora cinnamomi</i> (Dieback) mapping (years 3 and 7) and management plan	X		X	X			X
Weed mapping			X				X
Weed control- materials and program implementation	X	X	X	X	X	X	X
Flora and vegetation survey	X	X	X	X	X	X	X
Rubbish removal	X	X	X	X	X	X	X
Fire management - prescribed burn			X		X		X
Feral animal monitoring and control (cat, fox, rabbit, kangaroos and pigs)	X	X	X	X	X	X	X
Carnaby's Cockatoo watering point establishment			X				

These management actions have been developed to:

- Conserve the significant residual impacts of the environmental values and MNES being offset;
- Result in tangible improvement to the environmental values and MNES being offset; and
- Align with the targets and objectives of relevant recovery plans or area management plans.

This will manage, reduce, minimise and/or mitigate the environmental risks and pressures to the environmental values, MNES and the site from:

- Weeds;
- Unauthorised access;
- Dumping, littering and contamination;
- Fire;

- Feral animal activities; and
- Unauthorised clearing/degradation.

Without these management actions the incidence of weed incursion and spread of dieback is likely to increase. In addition, damage to vegetation may occur due to unauthorised access and feral animals. Therefore, without management actions, the condition of environmental values at the site will be reduced over the next 7 years.

A summary of how the management of the site for conservation purposes aligns with relevant recovery/management plan is provided within Section 4.2.9, with a complete assessment provided in Appendix G.

The DBCA developed the abovementioned management actions in conjunction with the PTA, based on the findings from the EVA (GHD 2020a) and weed mapping completed at the Lowlands site in 2019.

The anticipated tangible improvement experienced at the site will be of a qualitative nature with no extensive monitoring proposed to measure improvements quantitatively. Nonetheless, weeds and Dieback will be mapped throughout the seven years of management and this will provide an opportunity to compare current and future results. Further, high-level flora and fauna surveys will also be undertaken throughout. The DBCA will be required to provide annual reporting to the PTA outlining the management actions carried out, budget spent, projected future works and demonstration of compliance with the MOU. These reports will provide the opportunity to report on the tangible improvements experienced within the site.

4.2.9. Recovery plans

Carnaby's Cockatoo (*Calyptorhynchus latirostris*) Recovery Plan

The Carnaby's Cockatoo Recovery Plan (Australian Government 2013) was developed to provide advice and guidance on management actions to protect the Carnaby's Cockatoo. The protection of the Lowlands site 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 Lowlands site was purchased as an Advanced offset site by the Western Australian Government and allocated to the PTA for METRONET offset purposes. The Lowland site'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 site as an offset site will ensure achievement of Action 1 through further protection and management. Details of proposed site management actions are provided within Section 4.2.8.

A breakdown of the individual actions, targets and objects, timings and completion criteria is provided in Appendix G.

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 (Government of Western Australia 2019b) was developed to provide guidance on habitat restoration and protection of Carnaby's Cockatoo habitat. The protection of the Lowlands site achieves both short and long term management options (detailed in Table 5 of Government of Western Australia 2019b) as outlined in Table 14. Table 14 also includes a breakdown of the individual actions, targets and objects, timings and completion criteria.

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 (Australian Government 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 site aligns with *Section 14.9 Identify and manage important sites and protect from threatening processes* of the Plan.

The Lowlands site was identified as an important site within the region for a range of species, including Baudin's and Forest Red-tailed Black Cockatoos. The land acquisition and management will ensure the site is maintained for conservation purposes. Management actions such as fencing, weed management and fire management will reduce the risks of threatening processes such as dieback and weed spread.

A breakdown of the individual actions, targets and objects, timings and completion criteria has been provided in Appendix G.

Table 14: Lowlands site management alignment with EPA Technical Report: Carnaby's Black Cockatoo in Environmental Impact Assessment in the Perth and Peel Region (Government of Western Australia 2019b)

Management strategy	Management objectives	Management actions	Relevant Lowlands site management actions
Short-term	Habitat management	<ul style="list-style-type: none"> Feral animal and nest competitor control; Disease and pest control (e.g. <i>Phytophthora</i> and Marri Canker); Fire management; Fencing; and Weed control. 	<ul style="list-style-type: none"> Feral animal monitoring and control. <i>Phytophthora cinnamomi</i> (dieback) mapping and management plan. Fire management - prescribed burns. 16km of electrified fencing (including 4 gates). Weed control.
	Habitat enhancement	<ul style="list-style-type: none"> Natural nest hollow repair; Installation of artificial nest boxes (with long-term management); Improve access to drinking water near roosts and breeding sites; and Urban forest planning for cockatoos. 	<ul style="list-style-type: none"> Establishment of Carnaby's Cockatoo watering points. Flora and vegetation survey - these surveys may identify activities to be undertaken including improvements to hollows.
	Increase vital rates	<ul style="list-style-type: none"> Rehabilitation of injured cockatoos to wild; Disease and toxicity prevention; Reduce cockatoo road mortality (road signage, speed limits, appropriate verge planting); and Prevent illegal shooting and poaching. 	<p>Installation of fencing which will reduce illegal access, reducing the risk of illegal shooting and/or poaching.</p> <p>The PTA is also proposing to fund Murdoch University Black Cockatoo research. This research is likely to include recommendations for reduction in disease and toxicity. Details on the funding will be provided under a separate confidential memo to the appropriate Department(s).</p>
Long-term	Retain and protect habitat	<ul style="list-style-type: none"> Avoidance of important habitat and sites; Minimise native vegetation clearing; and Land acquisition of existing important habitat and sites, and inclusion into parks and reserve. 	<p>Acquisition and management of the Lowlands site has protected the existing important habitat, and will prevent clearing. Protection mechanisms over the site are discussed in Section 4.2.4.</p>

Management strategy	Management objectives	Management actions	Relevant Lowlands site management actions
	Rehabilitation and restoration	<ul style="list-style-type: none"> • Improve succession of natural nest hollows; • Increase amount of breeding habitat; and • Increase amount and quality of foraging habitat. 	Management actions propose to provide tangible environmental improvement to environmental values.
	Population monitoring	<ul style="list-style-type: none"> • Population trends; • Breeding rates and juvenile survival; and • Health of breeding populations. 	The PTA is also proposing to fund Murdoch University Black Cockatoo research. This research is likely to include the items listed left. Details on the funding will be provided under a separate confidential memo to the appropriate Department(s).
Information Management		<ul style="list-style-type: none"> • Data sharing (including compliance reporting and monitoring); • Habitat modelling; • Climatic modelling; and • Population viability analysis and modelling. 	

Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community

Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community (TSCC 2016) was developed with the following objective:

To mitigate the risk of extinction of the Banksia Woodlands of the Swan Coastal Plain ecological community, and maintain its biodiversity and function, through the protections provided under the Environment Protection and Biodiversity Conservation Act 1999 and through the implementation of priority conservation action.

The acquisition of the Lowlands site aligns with the following sections (TSCC 2016):

Section 5.2 Priority Protection and Restoration Actions

PROTECT the ecological community to prevent further loss of extent and condition

The acquisition of the Lowlands site will ensure the protection of the community through increased conservation status, management and allocation of the site as an offset under DWER and DAWE legislation, policy and guidance.

Section 5.1.2 Protect

Avoid the requirement for offsetting, by avoiding and mitigating impacts to the ecological community first. Further to 'like-for-like' principles, match offsets to the same sub-community (usually Floristic Community Type), as it is not appropriate to offset losses of one component with other components of the ecological community, given the high local endemism and biodiversity

The Lowlands site has been selected as an offset as it contains the same floristic community type as the impacted type within the Proposal. A breakdown of the individual actions, targets and objectives, timings and completion criteria has been provided in Appendix G.

4.2.10. Risks and contingency measures

Risks and contingency measures for the Lowlands site are summarised in Table 15.

Table 15: Lowlands site risks and contingency measures

Risk/trigger	Contingency measure
Condition/quality of area of environmental values degrades over time despite management actions	<ul style="list-style-type: none"> • Restrict access to affected areas. • Investigate cause and extent of vegetation decline (disturbance, pest, weed, pathogen, climate). • Review vegetation management actions. • Implement control and remedial measures in consultation with regulators, including weed spraying, feral animal control, access management as required. • Monitor success of control and remedial measures and consult with the DBCA.
Land manager deviates from the agreed management actions	<ul style="list-style-type: none"> • The DBCA to provide annual reporting outlining the tasks undertaken on site and future tasks, including deviations from those proposed. • The PTA to review these reports and identify any shortfall in project delivery and/or approve deviations, if appropriate • The PTA to carry out onsite inspections and/or audits as required to ensure management actions are carried out as agreed.

Risk/trigger	Contingency measure
	<ul style="list-style-type: none"> Should actions not be carried out as agreed, the PTA to intervene and withhold funding until the DBCA can assure the PTA appropriate management actions will resume.
Fire impacts the site	<ul style="list-style-type: none"> The DBCA to map the fire. The DBCA to reallocate resources and funds to respond accordingly, in consultation with the PTA. Response, cost, contingency and impacts of the fire to be reported to the PTA annually.

4.2.11. Monitoring, reporting and evaluation

The PTA will monitor and evaluate the DBCA's implementation of management actions through:

- Ad hoc meetings, as required;
- The DBCA's reports, to be submitted annually;
- Audits, as required;
- Site inspections, as required; and
- Conversations with appropriate personnel.

The DBCA will provide annual reports to the PTA, reporting on the compliance with the management actions, budget spent and future projected activities.

The PTA will provide the DBCA reports to the DAWE annually with compliance reports.

4.3. Black Cockatoo research proposal funding

4.3.1. Background

The PTA proposes to contribute funding to Murdoch University to partially finance a Black Cockatoo research project. The research funding will be limited to 9.55% of the overlapping Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo foraging habitat offset requirement, and delivered in addition to the land acquisition component outlined earlier in this Offset Strategy.

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

4.3.2. Overview of offset

Western Australia's three endemic Black Cockatoo species, Carnaby's Cockatoos (*Calyptorhynchus latirostris*), Baudin's Cockatoos (*Calyptorhynchus baudinii*) and Forest Red-tailed Black Cockatoos (*Calyptorhynchus banksii naso*) are threatened and receive special protection as MNES under the EPBC Act. Threats to the survivorship of these black cockatoo species are well documented, and include habitat loss and modification, urban and industrial expansion, disease, displacement by competing species, and climate shifts. Despite significant research to date, key information required to address the National Recovery Plan remains outstanding (Warren et. al. 2019).

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

This research will use remote sensing to produce predictive modelling of black cockatoo population movements and habitat use, in association with existing and emerging threats across key range areas. The Proposal combines satellite/GPS derived movement data; other remotely sensed landscape data (e.g. vegetation, water); and existing fire and climate models, to identify crucial habitat characteristics and regions most resilient to impacts of threatening processes (fire, climate shifts, habitat modification, tree health, disease, urban expansion). The generated data and information will allow collaborators to develop policies and take action to manage land changes, and build resilience into modified landscapes to address black cockatoo declines.

4.3.3. Research project objectives, outcomes and success criteria

The Research Proposal (Warren et al., 2019) objectives, intended outcomes and respective success criteria are provided in Table 16.

The PTA success criteria to meet the offset objective is as follows:

- Contribute partial funding to Murdoch University to conduct their proposed research.
- Murdoch University achieves research proposal objectives and outcomes.
- The State and Commonwealth obtains data and deliverables which contribute to the identification of critical habitat and areas under threat. This will lead to more informed decision making about impact assessments and the identification of potential future offset sites.

Table 16: Research Proposal objectives, outcomes and success criteria

Objectives	Outcomes	Success criteria
1. Characterise black cockatoo movement and habitat use across the Perth-Peel Coastal Plain and in the south-west forest region of Greenbushes for all three black cockatoo species.	<ul style="list-style-type: none"> • Black cockatoo movement and habitat use of all three black cockatoo species is characterised based on GPS and satellite movement mapping collected over four years. • GPS and satellite mapping of all three species' movement and habitat use. 	Satellite and GPS tracking is used to track 16 black cockatoos on the Perth-Peel Coastal Plain and south-west forest region of Greenbushes per annum for four years to model movement behaviour, habitat selections and foraging strategies.
2. Study known Carnaby's cockatoo breeding sites, focussing on characterising habitat suitability, food resource availability and selection, nestling health, specific threatening processes and fledgling dispersal routes.	<ul style="list-style-type: none"> • Carnaby's cockatoo habitat suitability, food resource availability and selection, nestling health, specific threatening processes and fledgling dispersal routes is characterised based on study of known breeding sites. 	<ul style="list-style-type: none"> • Satellite and GPS tracking is used to monitor 6 different Carnaby's cockatoo breeding sites (3 sites per annum for three years) with each site monitored in the subsequent year through field observations by research staff resulting in: • Energetics – combined analysis using GPS accelerometer derived activity budgets and caloric benefit of identified food species determined by Bomb Calorimetry. • Nestling health - 20 nestlings per site - 60 nestlings per year screened for: i) psittacine beak and feather disease (key threatening process), ii) polyoma virus, iii) Chlamydia sp. (present in nestlings in South-Western Australia). • Ground surveys – New nest hollows identified, hollow condition assessed and an inventory of current and potential future threats at each site.
3. Identify new breeding sites in inland or southern areas for all three species based on migratory movement of birds to breeding grounds.	<ul style="list-style-type: none"> • New breeding sites in inland or southern areas identified for all three species based on GPS and satellite movement mapping collected over four years. • GPS and satellite mapping of all three species' migratory movement to breeding grounds. 	Satellite and GPS tracking is used to track 16 black cockatoos on the Perth-Peel Coastal Plain and south-west forest region of Greenbushes per annum for four years to model movement behaviour, habitat selections and foraging strategies.
4. Apply new ecotoxicology methods to investigate Carnaby's cockatoo Hindlimb Paralysis Syndrome (CHiPs) toxicity cases, particularly in the agricultural zone.	Separation Science (e.g. GC-MS) targeting agricultural pesticides, including assessment of environmental samples of eggshells and cadavers (in the event of further mortality events; CHiPs clinical cases) conducted to investigate CHiPs toxicity in Carnaby's cockatoo.	CHiPs toxicity in Carnaby's cockatoo is investigated based on new ecotoxicology methods.

Objectives	Outcomes	Success criteria
<p>5. Predictively model survivorship scenarios for all three species of black cockatoo using movement, habitat use and threats.</p>	<ul style="list-style-type: none"> • Landscape critical for supporting all three species survivorship in the long-term [modelled in 10yr increments for 50-100yrs] is identified. • Movement, habitat use, food and water resources for all three species modelling in a predictive framework (e.g. using Ensemble Species Distribution Modelling) against various perturbation scenarios including: habitat loss, habitat modification due to climate shifts, fire impacts, and forecast land-use transformation through urban and industrial expansion. 	<p>Movement, habitat use, food and water resources for all three species are modelled in a predictive framework (e.g. using Ensemble Species Distribution Modelling) against various perturbation scenarios including: habitat loss, habitat modification due to climate shifts, fire impacts, and forecast land-use transformation through urban and industrial expansion to identify landscape critical for supporting species survivorship in the long-term [modelled in 10yr increments for 50-100yrs]).</p>

4.3.4. Compliance with Commonwealth criteria

Application of Commonwealth criteria for research (Australian Government 2012a) to the research proposal (Warren et. al. 2019) is summarised in Table 17.

Table 17: Consideration of Commonwealth criteria for research (Australian Government 2012a) with respect to the Murdoch University research proposal (Warren et. al. 2019)

Commonwealth criteria for research	Application of criteria to Murdoch University research proposal
<p>A suitable research program must endeavour to improve the viability of the impacted protected matter.</p>	<p>The outcome and success criteria of the research proposal as summarised in Section 4.3.1 will improve the viability of black cockatoos as critical areas of habitat will be identified across the Perth-Peel region, and further information regarding CHIPs toxicity will be obtained.</p> <p>By having access to information on critical black cockatoo habitat in the early stages of Proposal development, Proponents can apply avoidance and mitigation principles to minimise impacts on critical black cockatoo habitat.</p> <p>After following avoid, minimise and rehabilitate principles, where a proposal has significant residual black cockatoo impacts, the Proponent can use the information on critical black cockatoo habitat to inform offsets decisions. That is, Proponents can seek to acquire land identified as critical habitat with a view to adding it into the conservation estate and using the land as a direct land acquisition offset site, in accordance with State and Commonwealth Offset guidelines.</p> <p>Further Proponents seeking to acquire “advanced” offsets, that is, to acquire land containing significant conservation environmental values in advance of developing a proposal, will benefit from understanding which sites contain critical black cockatoo habitat.</p> <p>State agencies whose primary role is the conservation of Western Australian land, flora and fauna, can use information identifying sites that contain critical black cockatoo habitat to acquire the land and move the land into the conservation estate, particularly if critical black cockatoo habitat is identified as being on privately owned land.</p> <p>Given the above the PTA considers that the Research Proposal will provide a positive and long term conservation outcome for Carnaby’s and Forest red-tailed black cockatoos.</p>
<p>A suitable research program must be targeted toward key research as identified in the relevant Commonwealth approved recovery plan, threat abatement plan, conservation advice, ecological character description, management plan or listing document. Where Commonwealth approved guidance documents are not available or are insufficient in detail, the department will consider additional information sources such as state management plans or peer reviewed scientific literature to inform priority offset activities.</p>	<p>The research proposal has been developed in collaboration with DBCA to meet the requirements of the <i>EPBC Act referral guidelines for three black cockatoo species</i> (Australian Government 2012c), <i>MNES Significant Impact Guidelines</i> (Australian Government 2013) and the Consideration of Matters of National Environmental Significance by the WA land use planning system Discussion Paper (Department of Environment, Water, Heritage and the Arts 2009).</p> <p>The research proposal will address and inform all six priority Actions from the Carnaby’s Cockatoo (<i>Calyptorhynchus latirostris</i>) Recovery Plan (Government of Western Australia 2013) and seven of the priority Actions in the <i>Forest Black Cockatoo (Baudin’s Cockatoo Calyptorhynchus baudinii and Forest Red-tailed Black Cockatoo Calyptorhynchus banksii naso) Recovery Plan</i> (Australian Government 2008).</p>

Commonwealth criteria for research	Application of criteria to Murdoch University research proposal
	<p>The research proposal addresses short and long term knowledge gaps; and addresses research questions to address key knowledge gaps and inform Environmental Impact Assessment identified in the Carnaby's Cockatoo Technical Report (WA Government, 2019).</p> <p>The research proposal will meet the recommendations from the MNES Paper as it will address the Government of Western Australia's MNES Discussion Paper recommendations 4-7 to identify key areas within a region to sustain threatened populations, including collecting sufficient spatial information to inform assessments and provide clarification on aspects of MNES guidelines with respect to Carnaby's cockatoo, Baudin's cockatoo and forest red-tailed black cockatoo conservation; and will contribute substantially towards the Government of Western Australia's preferred option for addressing Carnaby's cockatoo, Baudin's Cockatoo and forest red-tailed black cockatoo conservation in line with the EPBC Act, through identification of critical habitat, areas under threat and areas for potential offsets.</p>
<p>A suitable research program must be undertaken in a transparent and scientifically robust and timely manner.</p>	<p>The research will be undertaken in a transparent and scientifically robust and timely manner as follows:</p> <ul style="list-style-type: none"> • Murdoch University will provide interim and annual reported to the PTA; • The results of the research will be shared with government agencies and made publicly accessible. • Murdoch University has conducted similar research programs by the same team since 2015. This includes the successful deployment of 84 tags and production of over 140,000 GPS location fixes, 33,000 km of track movement and over 2.8M accelerometer records. The methodology is proven, and facilitates individual and flock movement characterisation at spatial and temporal scales previously unattainable. • The research will be conducted over a period of five years and is an extension of earlier research programs.
<p>A suitable research program must be undertaken by a suitably qualified individual or organisation in a manner approved by the department</p>	<p>Researchers in the Conservation Medicine Program in the College of Science, Health, Engineering and Education at Murdoch University have been studying the health, ecology and demographics of Western Australia's three species of black cockatoos for over 10 years.</p> <p>The research program will be undertaken by suitably qualified and experienced Murdoch University research scientists including Associate Professor Kristen Warren and Senior Research Fellows Dr Jill Shephard.</p>

Commonwealth criteria for research	Application of criteria to Murdoch University research proposal
A suitable research program must consider best practice research approaches.	The research proposal will adopt a multidisciplinary approach including a proven methodology to obtain data on black cockatoo flock movement at spatial and temporal scales, health assessment using new ecotoxicology methods and predictive data modelling.
The proponent is required to select an institution through an internationally available open tender process or provide evidence that the program can be undertaken in-house. Where appropriate, the tender should complement an existing research institution's work program as it relates to the MNES. This will be the responsibility of the proponent; however, the department will require that the proponents follow the department's guidelines.	The PTA did not use an open market tender to award this work; instead, it will award funding direct to Murdoch University based on its existing successful Black Cockatoo research program and prior experience undertaking similar research and proposal.
The proponent is required to provide updates on progress and key findings to the department through periodic reporting.	Murdoch University will provide the PTA with interim and annual reports. The PTA will provide annual progress reports to regulators, based on the Murdoch University annual reports.
The proponent is required to ensure that funds are managed appropriately and that auditable financial records are kept and maintained.	A Grant Agreement will be signed between the PTA and Murdoch University which will stipulate the use of the funding provided, require that auditable financial records are kept and maintained and that annual progress reports provided to PTA by Murdoch University include distribution and allocation of PTA funding.
The proponent is required to apply a 'no surprises' policy to the publication, whereby research publications and outputs are provided to the department at least five working days before release.	Research publications and outputs will be provided to the department at least five working days before release.
Research programs will be tailored to at least a postgraduate level; however, there will be scope to engage other educational levels in educational programs.	The research proposal research team is run by Associate Professor Kristen Warren and Research Fellows Dr Jill Shephard and will include a research assistant and two PhD students.
Research programs will present findings that can be peer reviewed.	The research proposal will present findings that can be peer reviewed. The Murdoch University research team has previously published results of its earlier research works.
Research programs will publish findings in an internationally recognised peer-reviewed scientific journal or be of a standard that would be acceptable for publication in such a journal. Publications should be submitted to free open access journals. Data and	The research proposal will publish findings in an internationally recognised peer-reviewed scientific journal or be of a standard that would be acceptable for publication in such a journal. Data and information collected will have creative commons licensing and be free and accessible.

Commonwealth criteria for research	Application of criteria to Murdoch University research proposal
information collected should have creative commons licensing and be free and accessible.	
Research outputs should inform future management decisions on the protected matter and, where possible, be readily applicable to other similar matters (species groupings etc.)	The data generated through this project will assist in identifying key habitats and areas for conservation/revegetation, determining threatening processes for black cockatoo species across their range, and informing decision making in relation to conservation and land management planning at both State and Federal government levels. This proposed research project addresses major priority Actions in the Carnaby's Cockatoo Recovery Plan and the Forest Black Cockatoo Recovery Plan, and is fully supported by the Chairs of the Carnaby Cockatoo Recovery Team and the Forest Black Cockatoo Recovery Team (Warren, <i>pers. correspondence</i> , 10 April 2019).

4.3.5. Implementation of the research proposal

The following actions have been undertaken by the PTA and Murdoch University to implement this offset to date:

- The PTA consulted with Murdoch University to understand how the research proposal objectives, methods and outcomes would provide a suitable offset for METRONET proposals; provided comments on the draft research proposal and discussed funding arrangements.
- The PTA met with Main Roads Western Australia, another proponent intending to provide funding to Murdoch University to undertake the proposal to discuss how the funding could be allocated between the co-grantors.
- The PTA liaised with the DWER EPA Services and DAWE regarding the research proposal, with in principle support provided to use it as a component of Black Cockatoo offset packages for METRONET proposals.
- The PTA attended a teleconference hosted by DAWE to discuss the proposed research proposal offset with relevant stakeholders.
- The PTA have executed a Grant Agreement with Murdoch University as part of the Thornlie-Cockburn Link offset package.
- The PTA have provided funding to Murdoch University under the Thornlie-Cockburn Link Grant Agreement.
- The PTA are in the process signing a Grant Agreement with Murdoch University as part of the Yanchep Rail Extension Part 2 offset package.
- The PTA have received the 2020 interim and annual report from Murdoch University and attended the annual meeting in August 2020.

The following actions are yet to be undertaken to implement this offset:

- Execute a Grant Agreement with Murdoch University as part of this proposal's offset package. The document has been drafted and is under review by the PTA.
- Provide funding to Murdoch University under this Proposals Grant Agreement.
- Provide funding to Murdoch University under the Yanchep Rail Extension Part 2 Grant Agreement.
- Murdoch University to continue to provide updates and reporting throughout the duration of the research as required by the Grant Agreement.

4.3.6. Risks and contingency measures

Risks and contingency measures for this offset proposal are summarised in Table 18.

Table 18: Murdoch University research proposal risks and contingency measures

Risk/Trigger	Potential contingency measures
Murdoch University is unable to secure enough funding to commence the research proposal (i.e. funding from other parties falls through or is unable to be obtained in time for/to allow commencement of the research).	The research has commenced. If there is a funding shortfall the PTA will consider future METRONET or other state government proposals that may be able to contribute to funding as part of their offsets strategies. Murdoch University to seek funding from other interested proponents.
Delays to research being undertaken due to COVID-19.	Murdoch University encountered delays in the release of black cockatoos in mid-2020 due to COVID-19 restrictions in place however revised their field schedule to ensure the research program continued as planned. Any further delays in the field

Risk/Trigger	Potential contingency measures
	component of the research program due to COVID-19 will similarly need to be accommodated on an ad-hoc basis following discussions with PTA and co-grantors.
Research results are unavailable for use in future METRONET offset strategies due to delay in obtaining the data.	<p>Murdoch University is committed to providing data annually that can be used by the PTA to inform future METRONET proposals or offset strategies.</p> <p>Where data is delayed or METRONET proposals are brought forward prior to final data becoming available, the PTA will use interim data provided by Murdoch University to inform offset strategies and future planning for Proposals.</p>

5. Consistency with Commonwealth Offset Principles

The described approach to mitigation and proposed offsets is consistent with the ten offset principles outlined in the *Commonwealth Environmental Offset Policy* (Australian Government 2012a). Table 19 summarises how these principles were considered in the development of the offset approach for Banksia Woodlands TEC and Carnaby's, Baudin's and Forest Red-tailed Black Cockatoos.

Table 19: Consideration of the Commonwealth offsets principles against MNES

Principle	Banksia Woodlands TEC	Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo's
Suitable offsets must 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 acquisition of sites that contain existing Banksia Woodlands TEC, Black Cockatoo habitat and potential breeding trees and the provision of funding to the DBCA for seven years of on-ground management will deliver an overall conservation outcome that maintains the viability of MNES being protected.	
Suitable offsets must be built around direct offsets but may include other compensatory measures.	<p>The acquisition of land containing Banksia Woodlands TEC and provision of funding to the DBCA to provide on-ground management measures for seven years is a direct offset.</p> <p>No indirect offsets are proposed as part of the Banksia Woodlands TEC offset package.</p> <p>The minimum area of Banksia Woodlands TEC to be acquired will meet 100% of the offset requirement as calculated using the Commonwealth Offsets Calculator.</p>	<p>The acquisition of land containing Black Cockatoo habitat and potential breeding trees and provision of funding to the DBCA to provide on-ground management measures for seven years is a direct offset. The minimum area of Black Cockatoo habitat to be acquired will meet 90.45% of the offset requirement as calculated using the Commonwealth Offsets Calculator.</p> <p>The remaining 9.55% will be met through other compensatory measures, namely, provision of funding to Murdoch University to conduct Black Cockatoo research. The PTA has enough Black Cockatoo habitat to meet 100% of the offset requirement should the research proposal not proceed.</p>
Suitable offsets must be in proportion to the level of statutory protection that applies to the protected matter.	<p>Total offset requirement was calculated using the Commonwealth Offsets Calculator.</p> <p>This Calculator factors the level of statutory protection into the determination of the area required and nature of offset. As such, the offset is expected to be suitable and in proportion to the level of statutory protection applied to Banksia Woodlands TEC and Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo habitat. Direct offsets have been provided for all MNES, with the minimum 90% of the direct offset requirement being met or exceeded.</p>	

Principle	Banksia Woodlands TEC	Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo's
<p>Suitable offsets must be of a size and scale proportionate to the residual impacts on the protected matter.</p>	<p>The PTA has proposed direct offsets to counterbalance Proposal impacts to Banksia Woodlands TEC. The direct offset will protect Banksia Woodlands TEC with the same vegetation type being impacted by the Proposal.</p> <p>The area and condition of vegetation located within the offset site is proportionate to that being impacted by the Proposal, as calculated using the Commonwealth Offsets Calculator.</p> <p>Direct offsets have been provided with the minimum 90% of the direct offset requirement being exceeded (in this case, the direct offset is 100%).</p>	<p>The PTA has proposed direct offsets to counterbalance Proposal impacts to Black Cockatoo habitat and potential breeding trees. The direct offset will protect the same type of Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo habitat being impacted by the Proposal.</p> <p>The area and condition of Black Cockatoo habitat and potential breeding trees located within the offset site is proportionate to that being impacted by the Proposal, as calculated using the Commonwealth Offsets Calculator. The direct offset will comprise 90.45% of the requirement.</p> <p>Indirect offsets are proposed to comprise the final 9.55% of the Black Cockatoo offset package.</p>
<p>Suitable offsets must effectively account for and manage the risks of the offset not succeeding.</p>	<p>The Lowland offset site have been acquired by the State. The risk of the offset option not succeeding is expected to be very low with a 90% confidence in the result applied within the Commonwealth Offsets Calculator. Following acquisition, it is reasonable to expect that the acquisition and on-ground management of the sites will reduce the risk of loss and prevent degradation of habitat over the long term.</p>	
<p>Suitable offsets must 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).</p>	<p>State acquisition of privately-owned land and provision of funding for active on-ground management by the DBCA presents a conservation outcome beyond what would occur without implementation of this Offsets Strategy. State Government acquisition of privately-owned sites for conservation is initiated by their proposed use as offset sites. Further, conservation and on-ground management of these sites is not required or planned under any other planning or approval process and is entirely instigated as a result of this Offsets Strategy. Management of acquired land will be over and above that which is already conducted onsite.</p>	
<p>Suitable offsets must be efficient, effective, timely, transparent, scientifically robust and reasonable</p>	<p>The proposed acquisition site contains multiple environmental values that require offsetting and land acquisition provides an efficient offset option as there is minimal time-lag in achieving benefits following site purchase.</p> <p>Proposed offsets are effective in meeting and in some cases exceeding the significant residual impacts. Further, land acquisition and management is an effective offset proposal.</p> <p>The offset strategy will be provided to the DAWE and other government agencies as required for review and approval. Offsets are published on the DWER offsets register which provides public transparency. Further, the public were able to comment on the Proposal's Environmental Review Document and the Draft Offsets Strategy.</p>	

Principle	Banksia Woodlands TEC	Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo's
	It is proposed that offset sites will be efficiently managed in a transparent manner by the DBCA. Offsets and associated conservation measures will be reviewed and approved by the DWER, DAWE and other government agencies including the DBCA recognised for applying scientifically robust methods in conservation management.	
Suitable offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.	The PTA have entered into a memorandum of understanding with the DBCA for the management of Lowlands. A Grant agreement with Murdoch University will be signed to implement the research plan. Both documents will include transparent governance and regular reporting on implementation and performance. Regular audits to assess compliance against the site management plans will be conducted.	
Suitable offsets must be informed by scientifically robust information and incorporate the precautionary principle in the absence of scientific certainty.	Offsets will be informed by scientifically robust information and will incorporate the precautionary principle in the absence of scientific certainty.	
Suitable offsets must be conducted in a consistent and transparent manner.	As a State Government Proposal, offsets will be conducted in a consistent and transparent manner, with implementation and performance reported annually to DWER and DAWE.	

6. Offset Proposal Governance

The governance of the Lowlands offset has been agreed between the PTA and the DBCA and is documented in a signed and executed Memorandum of Understanding (MOU). The MOU will be provided to the DAWE independently of this document.

The governance of the Murdoch University research program has been agreed between the PTA and Murdoch University and will be documented in a grant agreement (currently in draft). The Grant Agreement will establish funding allocation and use, key milestones and deliverables, reporting requirements and the publication of data. Once the grant agreement have been agreed, signed and executed it will be provided to the DAWE.

6.1. Timelines and milestones

The MOU states that the DBCA will commence seven years of on-ground management actions on 1 January 2021. Timeline progression, achievement of milestones and budget will be reported annually in accordance with the terms of the MOU.

The Black Cockatoo research project commenced August 2019 and will conclude August 2024. Details of the timelines and milestones can be provided in a separate Black Cockatoo Research Plan.

6.2. Monitoring to assess offset implementation

The PTA will monitor offset delivery, implementation of management measures and overall progress through liaison with the DBCA and Murdoch University and review of monthly or annual reports. This process will be conducted in accordance with the MOUs/Grant Agreements and will include reporting on the completed management measures, those scheduled, those not completed and allocated budget. Specific monitoring results will also be reported.

6.3. Reporting and timing

The PTA will provide an annual Compliance Assessment Report to DAWE (as required) regarding:

- The activities undertaken in the previous 12 months for each offset.
- The activities proposed in the next 12 months for each offset.
- A summary of compliance with the approved Offset Strategy with regard to each offset.
- An evaluation of the results of site assessments and monitoring to identify progress in meeting the success criteria.

6.4. Financial arrangements

The PTA will fully fund the relevant actions proposed under this Offset Strategy including the:

- Provision of funding to DBCA for on-ground management measures that will maintain the environmental values being offset at the Lowlands site. The funding arrangements and payment amount and schedule are stated in the MOU.
- Contribution of funding to Murdoch University for the Black Cockatoo research proposal. The funding arrangements, payment amount and schedule are stated in the MEL Grant Agreement. The funding value was calculated based on 10% of the costs associated with the direct land offset (including capital and management costs) proposed in the draft offsets strategy. The extent of the direct land offset has increased in this Offset Strategy, however the amount of funding provided toward the Black Cockatoo research proposal remains the same. To ensure 100% of the offset requirement is provided, 90.45% of the offset requirement is provided as a

direct land offset, and 9.55% (i.e. less than 10%) of the offset requirement is provided as an indirect research offset. Details of the calculations applied to determine the funding have been provided to the DAWE.

6.5. Review and revision

The Offset Strategy will be revised based on one or more of the following:

- Notification of environmental conditions (under both the EP Act and EPBC Act);
- Confirmation of the final project footprint (if changed);
- Revision of significant environmental impacts (if required); and
- Receipt of information addressing any data gaps (if required and where available).

7. Stakeholder Consultation

Stakeholder consultation in relation to the coordination, development and implementation of this Offset Strategy conducted to date is summarised in Table 21.

Please note that the PTA is progressing multiple offsets strategies for METRONET proposals, and this may be reflected in the below discussions.

Table 20: Offset Strategy stakeholder consultation

Stakeholder ¹	Date	Issues/topics	PTA response/outcome
City of Swan	17/06/2020	Meeting to discuss the Proposal's Draft Offsets Strategy and potential offset opportunities within the City, for future consideration. Included discussion with representative from Friends of Bennett Brook regarding potential on ground offsets.	The PTA to look at the offset site proposed at the meeting and other potential offset sites and methods. The City of Swan to provide any further potential offset options.
MRWA METRONET DWER DBCA DAWE	08/05/2020	Discussed the proposed Malaga to Ellenbrook Rail Works Proposal offsets strategy and the use of State acquired Advanced offset sites.	The PTA is to include information in the Offsets Strategy regarding on-ground management of the Lowlands site. PTA to liaise with DBCA with regards to changes to wetlands mapping dataset.
MRWA METRONET	05/05/2020	Offsets meeting - discussed Offsets Strategy for Malaga to Ellenbrook Rail Works.	Schedule additional offset meetings to further collaborate as required.
EPA Services MU	23/10/2019	Discussed the Black Cockatoo Research Proposal.	Research proposal finalised. Details on which will be provided under separate cover.
DBCA	10/10/2019	Proposed management and funding arrangement for the Lowlands offset proposal discussed.	DBCA to provide proposed management actions and funding requests as discussed in the meeting in writing.
MU	21/08/2019	Discussed the PTA's comments on Murdoch's Black Cockatoo research proposal and the revised proposal prepared to address the PTA's comments.	PTA to provide the revised proposal to the State and Commonwealth and discuss the proposal with all stakeholders including Government in October 2019 teleconference.
DBCA	21/08/2019	Discussed the proposed Lowlands Offsets Strategy and site management.	Schedule further meeting to discuss details, Keysbrook and Ningana Bush Forever Offset Sites.
MRWA	09/08/2019	Offsets meeting - discussed shared offset opportunities.	Schedule additional offset meeting to further collaborate as required.
EPA Services DPC	25/06/2019	Offsets teleconference to discuss the Proposal offsets strategy and the Commonwealth's comments on the draft Offsets Strategy.	The PTA is to provide written evidence to DWER to support the allocation of advanced offset sites to METRONET and to discuss the draft offset Calculator.

Stakeholder ¹	Date	Issues/topics	PTA response/outcome
WAPC	24/05/2019	Discussed the proposed Proposal offsets strategy, the use of State acquired Advanced offset sites and the proposed Bush Forever offset.	The PTA to schedule a further meeting to discuss the proposed Bush Forever offset with all relevant stakeholders.
DWER	23/05/2019	Discussed the proposed Proposal offsets strategy and the use of State acquired Advanced offset sites.	The PTA is to provide written evidence to DWER to support the allocation of advanced offset sites to METRONET.
WAPC	1/05/2019	Discussed WAPC's historical purchase of land for the Strategic Assessment of the Perth and Peel Region (SAPPR) for future offset requirements including METRONET.	A future meeting with EPA Chairman Dr Tom Hatton was scheduled to discuss further, with a discussion paper and briefing notes to the Transport Minister and the Commonwealth Minister of Environment summarising the matter to be prepared.
DPC DBCA METRONET	5/04/2019	<ul style="list-style-type: none"> Coordinated approach to METRONET offsets. Proposed METRONET Offsets Strategy, specifically, land acquisition options and strategy. State and Commonwealth Offsets Strategy timeframes. Use of SAPPR offsets. 	<ul style="list-style-type: none"> PTA scheduled a future meeting with EPA Services to discuss meeting outcomes. The PTA agreed to provide DPC, DBCA, and WAPC with regular METRONET offsets.
DPC DBCA	3/04/2019	Discussed land acquisition offset options for each Proposal significant residual impact including timing, strategy, risks and issues.	The PTA strategised potential sites and agreed to conduct further research prior to presenting them to EPA Services for consideration.
WAPC	27/03/2019	Discussed WAPC purchased advanced offset sites available for METRONET use.	PTA to obtain written authorisation to use the sites for METRONET.
DPC METRONET	27/03/2019	<ul style="list-style-type: none"> Coordinated approach to METRONET offsets. Proposed METRONET Offsets Strategy, specifically, land acquisition options and strategy. State and Commonwealth Offsets Strategy timeframes. Use of (SAPPR) offsets. 	PTA to obtain written authorisation to use the SAPPR offset sites for METRONET.
DBCA	21/03/2019	Discussed land acquisition offset options for each Proposal significant residual impact including timing, strategy, risks and issues. DBCA proposed acquisition sites and strategies.	Schedule further meeting as required.
DPLH	14/03/2019	Discussed cost to manage Bush Forever sites, namely Bush Forever Site north of Roe Highway and WAPC/DBCA reserve management process.	Schedule further meeting as required.

Stakeholder ¹	Date	Issues/topics	PTA response/outcome
MRWA	1/03/2019	Discussed co-funding of Murdoch's Black Cockatoo research proposal offset case studies/experience/examples.	MRWA and the PTA agreed to continue to liaise with regards to co-funding Murdoch Black Cockatoo research.
MU	1/02/2019	Discussed Murdoch's Black Cockatoo research proposal.	Murdoch to provide a Black Cockatoo research proposal to the PTA for consideration and inclusion within the Offsets Strategy.
DBCA ELA	24/10/2018	Discussed land acquisition offset options for each Proposal significant residual impact including timing, strategy, risks and issues. DBCA proposed acquisition sites and strategies.	ELA to prepare an Offsets Strategy.

¹ Stakeholders are identified using the following abbreviations:

DAWE - Department of Agriculture, Water and the Environment (Commonwealth)

DBCA - Department of Biodiversity, Conservation and Attractions (State)

DPC - Department of Premier and Cabinet (Commonwealth)

DPLH - Department of Planning, Lands and Heritage (State)

DWER - Department of Water and Environmental Regulation (State)

ELA - Ecological Australia (Consultant)

EPA Services - Environmental Protection Authority (State)

SSJ - Shire Serpentine Jarrahdale (Local Government)

MRWA - Main Roads Western Australia

MU - Murdoch University

WAPC - Western Australian Planning Commission (State)

8. Conclusion

The PTA calculated the Proposal's significant residual environmental impacts, considering information provided in the Commonwealth guidance documents and tools including the holistic environmental value of an impacted factor and information specific to the Proposal.

The PTA proposes direct (land acquisition) offsets and one indirect (research) offset to counterbalance the Proposal's significant residual impacts. The Lowlands offset site is owned by the State and is managed by the DBCA.

The PTA provides this offset strategy to demonstrate its approach to offsets, to demonstrate offsets are available to counterbalance the significant residual impacts of the Proposal, and that proposed offsets meet Commonwealth requirements.

9. References

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Appendix A – Lowlands Certificate of Title



REGISTER NUMBER 301/DP77559	
DUPLICATE EDITION N/A	DATE DUPLICATE ISSUED N/A

VOLUME **LR3164** FOLIO **969**

**RECORD OF CERTIFICATE
OF
CROWN LAND TITLE**
UNDER THE TRANSFER OF LAND ACT 1893
AND THE LAND ADMINISTRATION ACT 1997
NO DUPLICATE CREATED

The undermentioned land is Crown land in the name of the STATE OF WESTERN AUSTRALIA, subject to the interests and Status Orders shown in the first schedule which are in turn subject to the limitations, interests, encumbrances and notifications shown in the second schedule.



REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 301 ON DEPOSITED PLAN 77559

**STATUS ORDER AND PRIMARY INTEREST HOLDER:
(FIRST SCHEDULE)**

STATUS ORDER/INTEREST: RESERVE UNDER MANAGEMENT ORDER

PRIMARY INTEREST HOLDER: CONSERVATION COMMISSION OF WESTERN AUSTRALIA OF CARE OF DEPARTMENT OF PARKS AND WILDLIFE OF LOCKED BAG 104, BENTLEY DELIVERY CENTRE

(XE M845092) REGISTERED 26/3/2015

**LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)**

- EASEMENT BENEFIT CREATED UNDER SECTION 136C T.L.A. FOR RIGHT OF CARRIAGEWAY PURPOSES - SEE DEPOSITED PLAN 77559.
- F854772 EASEMENT TO ELECTRICITY CORPORATION. SEE SKETCH ON DEPOSITED PLAN 77559. REGISTERED 13/4/1995.
- M950769 CLASS A RESERVE 51784 FOR THE PURPOSE OF CONSERVATION OF FLORA AND FAUNA LIMITED TO A DEPTH OF 200 METRES FROM THE NATURAL SURFACE. REGISTERED 26/3/2015.
M845092 MANAGEMENT ORDER. CONTAINS CONDITIONS TO BE OBSERVED. REGISTERED 26/3/2015.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required. Lot as described in the land description may be a lot or location.

-----END OF CERTIFICATE OF CROWN LAND TITLE-----

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

END OF PAGE 1 - CONTINUED OVER

ORIGINAL CERTIFICATE OF CROWN LAND TITLE

REGISTER NUMBER: 301/DP77559

VOLUME/FOLIO: LR3164-969

PAGE 2

SKETCH OF LAND:

DP77559

PREVIOUS TITLE:

1089-276, 2040-535

PROPERTY STREET ADDRESS:

NO STREET ADDRESS INFORMATION AVAILABLE.

LOCAL GOVERNMENT AUTHORITY:

SHIRE OF SERPENTINE-JARRAHDALE

RESPONSIBLE AGENCY:

DEPARTMENT OF BIODIVERSITY, CONSERVATION AND
ATTRACTIONS (SCLM)

NOTE 1: M950769 CORRESPONDENCE FILE 00013-2014-01RO

Appendix B – Lowlands Environmental Values Assessment Report



Public Transport Authority
METRONET Potential Offset Sites
Lowlands Environmental Values Assessment

February 2020

Executive summary

METRONET is the State government's program of projects to increase the size of Perth's railway network, whilst also supporting the planning of integrated station precincts, to support growth of the Perth metropolitan region.

Where required, METRONET projects will be assessed by the Environmental Protection Authority (EPA) under Section 38 of the *Environmental Protection Act 1986* (EP Act) and/or by the Commonwealth Department of the Environment and Energy (DEE) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

As part of the State and Federal environmental approvals processes, the Public Transport Authority (PTA) is required to offset significant residual environmental impacts of assessed projects through the implementation of an Offsets Strategy. Through liaison with other State government agencies, a number of potential offset sites have been identified containing suitable environmental values to offset the potential METRONET project impacts.

GHD Pty Ltd (GHD) was engaged by the PTA to undertake Environmental Values Assessments (EVAs) for six potential offset sites. The purpose of the EVAs is to identify the key environmental values of each site, as well as opportunities for on-ground management works to enable an assessment of their suitability as land acquisition offset sites. This report presents an EVA of a potential offset site located in Mardella, Western Australia.

The potential offset site (the survey area) is approximately 1,140 hectares (ha) and is located at Lot 301 Lowlands Road in the suburb of Mardella within the Shire of Serpentine-Jarrahdale.

Key findings for vegetation

Ten broad vegetation types as well as dirt tracks were mapped by GHD within the survey area. Nine of the vegetation types were represented by remnant native vegetation, the eighth vegetation type, scattered natives over weeds, describes highly modified vegetation that has been altered by partial clearing, dieback and weeds.

The vegetation types were split into four upland vegetation types that predominately occurred on Bassendean sands and five lower lying vegetation types were mapped primarily on Pinjarra Plain soils. The vegetation types are considered to be representative of the Southern River, Guilford and Bassendean Complex-Central and South Complexes and Floristic Community Types (FTCs) 4, 5, 11, 21a, 21c, 22 and 23a.

The vegetation condition ranged from Excellent to Degraded across the survey area. Areas mapped in Degraded condition have been historically cleared/partially cleared to support grazing by livestock. Whilst there is no grazing of domestic animals today, native species such as kangaroos maintain grazing at a high level and contribute to weed spread (as well as keeping weed loads low). Dieback is present at localised spots throughout the survey area and has contributed to a decline in vegetation condition.

Based on the results of the desktop searches, previous literature, dominant species present, landform features and field observations, four conservation significant ecological communities were considered likely to occur within the survey area:

- *Banksia* woodlands of the Swan Coastal Plain, listed as a Threatened Ecological Community (TEC) under the EPBC Act.
- Low lying *Banksia attenuata* woodlands or shrublands (SCP21c), listed as a Priority 3 Priority Ecological Community (PEC) by the Department of Biodiversity, Conservation and Attractions (DBCA)

- *Banksia* dominated woodlands of the SCP IBRA region, listed as a Priority 3 PEC by the DBCA
- Tuart (*Eucalyptus gomphocephala*) woodlands of the SCP PEC, listed as a Priority 3 PEC by the DBCA.

Key findings for fauna and black cockatoos

Four broad fauna habitats were described within the survey area based on the mapped vegetation types, including Mixed Eucalyptus Banksia woodland, Flooded Gum Melaleuca woodlands, Riparian and pasture with scattered trees.

The survey area is an intact area of native vegetation mostly surrounded by cleared land with low density semi-rural residential properties and has limited connectivity to other areas of bushland. The Serpentine River intersects the central part of the survey area and there is some connectivity along this river.

During the one day field visit, Carnaby's Cockatoos were seen and heard calling over the survey area. Forest Red-tailed Black Cockatoos were also observed feeding at two locations during the subsequent two day field assessment. Foraging evidence (chewed Marri, Jarrah, Banksia and Allocasuarina nuts) was recorded extensively throughout the Mixed Eucalyptus Banksia and Scattered native tree habitat types with both Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo distinctive mandible marks evident. The survey area contains suitable foraging and potential breeding habitat for both Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo. No foraging evidence of Baudin's Cockatoo was located within the survey area, however the survey area is considered to contain suitable foraging and potential roosting habitat.

Other conservation significant fauna recorded from the site include Chuditch, Rakali, Pouched lamprey, Carter's Freshwater Mussel, Quenda and South-western Brush-tailed Phascogale.

This report is subject to, and must be read in conjunction with, the limitations set out in section 1.5 and the assumptions and qualifications contained throughout the Report.

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1. Introduction

1.1 Background

METRONET is the State government's program of projects to increase the size of Perth's railway network, whilst also supporting the planning of integrated station precincts, to support growth of the Perth metropolitan region.

METRONET projects will be assessed by the Environmental Protection Authority (EPA) under Section 38 of the *Environmental Protection Act 1986* (EP Act) and/or by the Commonwealth Department of the Environment and Energy (DEE) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) where required.

As part of the State and Federal environmental approvals processes, the Public Transport Authority (PTA) is required to offset significant residual environmental impacts of assessed projects through the implementation of an Offsets Strategy. Through liaison with other State government agencies, a number of potential offset sites have been identified containing suitable environmental values to offset the potential METRONET project impacts.

1.2 Purpose of this report

GHD Pty Ltd (GHD) was engaged by the PTA to undertake Environmental Values Assessments (EVAs) for a number of potential offset sites. The purpose of the EVAs are to identify the key environmental values of each site, as well as opportunities for on-ground management works to enable an assessment of their suitability as land acquisition offset sites. This report presents an EVA of a potential offset site located in Mardella, Western Australia.

1.3 Location

The potential offset site (the survey area) is located at Lot 301 Lowlands Road in the suburb of Mardella within the Shire of Serpentine-Jarrahdale Local Government Area (LGA). The survey area covers 1,139 hectares (ha) and is mapped in Figure 1, Appendix A

The survey area is part of the Department of Biodiversity, Conservation and Attractions (DBCA) managed Lowlands Nature Reserve (also known as Lowlands), which includes Lots 300 and 301 Lowlands Road.

1.4 Scope of works

The scope of works for this EVA includes:

- A desktop review of existing information relating to the survey area
- A one-day site visit to confirm access requirements, hygiene protocols and to meet with relevant stakeholders
- A two day reconnaissance vegetation and fauna survey with targeted assessment of values requiring offset
- The preparation of a report documenting the findings of the desktop assessment, anecdotal observations (from stakeholders), field survey and opportunities for on-ground management works
- The provision of all mapping and spatial data.

1.5 Limitations and assumptions

This report has been prepared by GHD for PTA and may only be used and relied on by PTA for the purpose agreed between GHD and the PTA as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than PTA arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by PTA and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the access, hygiene management and the location of vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

This report has assessed the flora, vegetation and fauna values within the survey area, as shown in Figure 1, Appendix A. Should the survey area location change or be refined, further assessment may be required.

2. Methodology

2.1 Desktop assessment

A desktop assessment was undertaken to identify relevant environmental information pertaining to the survey area. The desktop assessment included a review of:

- Previous flora and fauna surveys and mapping of the survey area, including:
 - Rivers 2 Ramsar: Connecting River Corridors for Landscape Resilience at Lowlands Nature Reserve (Sheenan et al. 2017)
 - Floristics of Lowlands (Keighery et al. 1995)
 - Vegetation association, condition and known threatened flora and ecological communities mapping provided by the DBCA (updated in 2017)
- The DBCA Threatened and Priority Ecological Communities (TECs and PECs), Threatened/Priority Flora and Threatened/Priority Fauna Database Searches (5 km buffer of the survey area)
- The DBCA *NatureMap* database for conservation significant flora and fauna species previously recorded within 5 km of the survey area (DBCA 2007–) (Appendix B)
- Regional vegetation complex mapping (e.g. Heddle *et al.* 1980, Webb *et al.* 2016)
- Bush Forever (Government of Western Australia (GoWA) 2000)
- Aerial imagery of the survey area.

2.2 Site visit and field survey

GHD ecologists completed a one day site visit on 26 June 2019. The purpose of the site visit was to meet with representatives from the DBCA, Shire of Jarrahdale Serpentine and landowners to discuss access, hygiene protocols and the biological values of survey area. During the site visit, GHD ecologists accessed the survey area via Lowlands Roads (accompanied by the DBCA) and the southern part of a north-south orientated track. From these roads/tracks limited observations on the vegetation and fauna habitat were recorded. All other access throughout the survey area was restricted due to the wet soil conditions and subsequent dieback risk at the time of the visit.

GHD ecologists completed a two day field survey of the survey area on 6 and 7 November 2019. The survey was completed in November due to rainfall across the survey area during winter and early spring that restricted access due to hygiene and dieback risk. The survey was completed in November during dry soil conditions in line with DBCA stipulated access requirements.

2.2.1 Vegetation and flora

The vegetation and flora component of the field survey was a reconnaissance level and was undertaken to verify the information obtained from the desktop assessment and assess and characterise the broad vegetation types and vegetation condition throughout the survey area. Preliminary assessment of occurrence and approximate extent of potential TEC/PECs (including indicative floristic community types (FCTs)) was also completed.

Field survey methods involved a combination of sampling relevés located in identified vegetation units and traversing the survey area by vehicle and foot. The survey methodology was undertaken with reference to the EPA Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016a).

Broad vegetation types

Broad vegetation types were identified and boundaries delineated using a combination of aerial photography, topographical features, field data/observations and mapping from Keighery *et al.* (1995) and the DBCA (2017). Data recorded at relevé sites included dominant flora taxa from each structural layer (i.e. upper, mid and ground) as well as other observable flora taxa (to assist with FCT identification); full floristics at each relevé site were not recorded. Vegetation data recorded from the survey area is provided in Appendix C.

The vegetation types were described based on structure, dominant taxa and cover characteristics. The broad vegetation type description is consistent with National Vegetation Information System (NVIS) Level IV or V, where the dominant species for the three traditional strata (upper, mid and ground) are used to describe the association (NVIS Technical Working Group 2017).

Vegetation condition

The vegetation condition mapping from Keighery *et al.* (1995) and the DBCA (2017) was reviewed in the field, and where applicable updated. The vegetation condition was mapped in accordance with the vegetation condition rating scale for the South West and Interzone Botanical Provinces of WA (devised by Keighery (1994) and adapted by EPA (2016)). The scale recognises the intactness of vegetation and consists of six rating levels. The vegetation condition rating scale is outlined in Table 1.

Table 1 Vegetation condition rating scale

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

Preliminary assessment of TECs and PECs

Preliminary identification of potential TECs and PECs within the survey area was based on vegetation association and condition mapping by Keighery *et al.* (1995) and DBCA (2017). Keighery *et al.* (1995) identified floristic community types (FCTs) for the mapped vegetation associations and this information was used to identify potential TECs and PECs within the survey area.

During the field survey, areas of vegetation representative of potential TECs and PECs were visited and preliminary identification confirmed or made based on vegetation structure, typical

and common species, and observations on soils, landforms etc. Where areas of potential TECs or PECs were identified, the occurrence was noted and the approximate extent mapped using a GPS enabled handheld tablet.

Flora nomenclature

Nomenclature used in this report follows that used by the WA Herbarium as reported on *FloraBase* (WA Herbarium 1998–). The conservation status of flora was compared against the current lists available on *FloraBase* and the EPBC Act Threatened species database provided by DEE (2019).

2.2.2 Fauna

The fauna component of the field survey was undertaken to verify the information obtained from the desktop assessment, describe the key fauna habitat values and identify suitable habitat for conservation significant fauna species. A black cockatoo habitat assessment was also completed.

Field methodology included traversing the survey area by vehicle and foot. The survey methodology was undertaken with reference to the EPA Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna Surveys (EPA 2016b) and EPA Technical Guidance – Terrestrial Fauna Surveys (EPA 2016c).

Broad fauna habitats

Broad fauna habitats were described and boundaries delineated using a combination of aerial photography, mapping from Keighery *et al.* (1995), DBCA (2017), and site visit observations. Site characteristics include vegetation type and structure, substrate, topography, and hydrology. Fauna habitats were also aligned with the vegetation types delineated during the vegetation and flora assessment of this current survey. Anecdotal observations from stakeholders were incorporated into the broad habitat type descriptions where possible.

Black cockatoo assessment

A desktop black cockatoo habitat assessment was undertaken and included an evaluation of presence and approximate extent of foraging, breeding and roosting habitat within the site. Habitat suitability was based on the mapping from Keighery *et al.* (1995) and DBCA (2017), and broad fauna habitats described by GHD. Foraging, breeding and roosting habitat was defined as per the EPBC Act referral guidelines for three threatened black cockatoo species: Carnaby's Cockatoo (endangered) *Calyptorhynchus latirostris*, Baudin's Cockatoo (vulnerable) *Calyptorhynchus baudinii*, Forest Red-tailed Black Cockatoo (vulnerable) *Calyptorhynchus banksii naso*, (Department of Sustainability, Environment, Water, Populations, and Communities (DSEWPac) 2012).

A black cockatoo habitat assessment was undertaken in conjunction with the broad habitat assessment. The black cockatoo habitat assessment included:

- Evaluation of presence and approximate extent of foraging, breeding and roosting habitat (individual mapping of potential breeding tree locations was not undertaken). Foraging, breeding and roosting habitat was defined as per the EPBC Act referral guidelines for three threatened black cockatoo species: Carnaby's Cockatoo (endangered) *Calyptorhynchus latirostris*, Baudin's Cockatoo (vulnerable) *Calyptorhynchus baudinii*, Forest Red-tailed Black Cockatoo (vulnerable) *Calyptorhynchus banksii naso*, (Department of Sustainability, Environment, Water, Populations, and Communities (DSEWPac) 2012)
- Characterisation of the broadly mapped vegetation types for suitability as black cockatoo foraging, breeding and roosting habitat

- Foraging habitat values were quantified and a rating assigned based on the type, approximate and relative density and variety of known food plant species for black cockatoos.
- Potential breeding habitat values were quantified based on the density of potential breeding trees of known Black Cockatoo breeding tree species. Potential breeding tree density was calculated within a series of 50 x 50 m plots randomly located within each broad habitat type. Within each plot the Diameter at Breast Height (DBH) measured for all trees having DBH greater than 50 cm. A list of all plots and locations is included in Appendix D.
- Roosting habitat values were assessed based on presence of potentially suitable emergent tall trees, proximity of freshwater bodies, and on the local occurrence of any known roost sites (BirdLife Australia, unpublished data).
- Recording and mapping black cockatoo observations of foraging evidence, breeding and roosting activity.

Fauna nomenclature

Fauna nomenclature used in this report follows that used by the WA Museum and the DBCA *NatureMap* database (DBCA 2007–) with the exception of birds, where by Christidis and Boles (2008) was used.

2.3 Limitations

2.3.1 Desktop limitations

The records from the DBCA searches and *NatureMap* database provide generally accurate information for the general area. However, some records of collections, sightings or trappings cannot be dated or have plain language locality descriptions and may misrepresent the current range of a species (flora and fauna).

2.3.2 Field limitations

The EPA technical guidance recommend flora and fauna survey reports for environmental impact assessment in WA should contain a section describing the limitations of the survey methods used. The limitations and constraints associated with this field component are discussed in Table 2. Based on this assessment, the field component has been subject to constraints that have affected the thoroughness of the assessment and the conclusions which have been formed.

Table 2 Field limitations

Aspect	Constraint	Comment
Sources of information and availability of contextual information.	Nil	Adequate information is available for the survey area including a previous vegetation and flora survey (Keighery <i>et al.</i> 1995) and vegetation association, condition and known threatened flora and ecological communities mapping provided by the DBCA (2017).
Scope (what life forms were sampled etc.)	Nil	Vascular flora and terrestrial vertebrate fauna were sampled during the survey. Non-vascular flora, invertebrate and aquatic fauna were not surveyed. This survey focused on dominant flora and conservation significant fauna species.
Proportion of flora collected and identified (based on sampling, timing and intensity) Proportion of fauna identified, recorded and/or collected	Nil	The reconnaissance vegetation survey was undertaken in November, which is within the recommended timing for flora surveys in the South West Botanical Province (September – November) (EPA (2016a)). The vegetation survey was focused on describing broad vegetation types and their condition. The survey timing was considered appropriate for the purpose of the assessment. The reconnaissance fauna survey was also undertaken in November 2019. The fauna assessment sampled those species that can be easily seen, heard or have distinctive signs, such as tracks, scats, diggings, etc. Many cryptic species would not have been identified during a reconnaissance survey and seasonal variation within species often requires targeted surveys at a particular time of the year. Of the fauna species recorded during the survey, all were identified to species level. The fauna assessment was aimed at identifying broad habitat types and conservation significant terrestrial vertebrate fauna utilising the survey area. The survey timing was considered appropriate for the purpose of the assessment
Flora determination	Minor	Flora determination was undertaken by the GHD botanist in the field and at the WA Herbarium. Two taxa could only be identified to family level only, eight taxa could be identified to genus level only, and three taxa could be tentatively identified to species level, due to lack of flowering and/or fruiting material required for identification. The collecting and identification of flora taxa was considered appropriate for the purpose of the assessment.
Completeness and further work which might be needed (e.g. was the relevant area fully surveyed)	Nil	The survey area was accessible via vehicle and foot (during dry soil conditions). All areas of the survey area were adequately surveyed for the purpose of the assessment.
Mapping reliability	Minor	The vegetation was mapped using high-resolution ESRI aerial imagery obtained from Landgate, topographical features, previous broad scale mapping (Keighery <i>et al.</i> (1995), (DBCA (2017)) and field data. Data was recorded in the field using hand-held GPS tools (e.g. Samsung tablet and Garmin GPS). Certain atmospheric factors and other sources of error can affect the accuracy of GPS receivers. The Garmin GPS units used for this survey are accurate to within ± 5 metres on average. Therefore the data points consisting of coordinates recorded from the GPS may contain inaccuracies.
Timing/weather/season/cycle	Nil	The field survey was conducted on 6 and 7 November 2019. In the three months prior to the flora survey (August to October), Serpentine weather station (Bureau of Meteorology (BoM) 2019) recorded a total of 208.8 mm of

Aspect	Constraint	Comment
		rainfall. This rainfall total is slightly lower than the long term average for the same period (August - October 285.4 mm) (BoM 2019). The weather conditions recorded during the survey are within the observed climatic conditions previously recorded for November 2019 (years 1899 to 2019) at the Serpentine weather station (BoM 2019). The weather conditions recorded during the survey were considered unlikely to have impacted the survey results. The survey timings were considered appropriate for the field survey.
Disturbances (e.g. fire, flood, accidental human intervention)	Nil	No significant sources of disturbance were present during the survey. There was no recent evidence of fire or flood throughout the survey area
Intensity (in retrospect, was the intensity adequate)	Nil	The survey area was sufficiently covered by the survey team during the survey. The purpose of the survey was a reconnaissance level survey with a focus on conservation significant vegetation and fauna. The survey intensity was sufficient for the survey purpose.
Resources	Nil	Adequate resources were employed during the field survey. Four person days were spent undertaking the survey using suitably qualified personnel.
Access restrictions	Minor	Access was restricted to the survey area during wet soil conditions. No access problems were encountered during the November survey which occurred during dry soils conditions.
Experience levels	Nil	The botanist and zoologist who executed the survey are practitioners suitably qualified and experienced in their respective fields. Botanist Angela Benkovic has over 13 years' experience in undertaking flora and vegetation surveys within WA. Zoologist Robert Browne-Cooper has over 15 years' experience undertaking fauna surveys in WA.

3. Desktop assessment

3.1 Literature review

A floristic assessment by Keighery et al. (1995) has been completed at Lowlands, which reported on environmental features, vegetation and flora. Mapping from this assessment has been reviewed and updated by the DBCA to provide maps of the vegetation associations, condition and conservation significant vegetation and flora (DBCA 2017). In addition an article produced by Sheenan et al. (2017) (from the Department of Parks and Wildlife, DPaW – now the DBCA) details the management works being undertaken at Lowlands as part of the Rivers 2 Ramsar: Connecting River Corridors for Landscape Resilience Project.

A summary of the results from Keighery et al. (1995) and Sheenan et al. (2017), as well as background on the Lowlands site compiled by the PTA is provided below.

Lowlands site background (provided by the PTA)

In 2014, Lots 300 and 301 Lowlands Road Mardella were purchased by the Western Australian Planning Commission (WAPC) through funding provided by both the WAPC and Main Roads Western Australia (Main Roads). The lots were purchased for the purposes of using the site to offset impacts from future government projects.

Lot 300 Lowlands Road Mardella was applied to Main Roads Gateway project in 2015. In 2015, initiated by the Main Roads Gateway project offset, both lots were ceded to the then DPaW, now DBCA for conservation and proposed protection as an 'A' Class conservation reserve. Lowlands Class 'A' conservation reserve status was also applied for urgent management reasons and to honour the agreement made with the former landowner.

In 2019, the balance of Lowlands, i.e. the entirety of Lot 301 Lowlands Road Mardella, 1,138 ha, was allocated to METRONET. Allocation of the remainder of Lowlands to offset residual significant environmental impacts of METRONET rail infrastructure projects aligns with the original intention and proposed future use of Lowlands as a State Government advanced offset, as agreed to in principle by the State and Commonwealth.

Floristics of Lowlands (Keighery et al. 1995)

The survey work at Lowlands covered two areas, Lot 300 and the Lot 301 and was completed over three flowering seasons in 1992, 1993 and 1994. Twenty-three 100 m² sites were used to sample the range of plant communities within the Lowlands with a further two sites located in the unmade road reserve south of Lowlands. Of the 25 sites, 23 were permanently located using steel pegs to enable resampling. Opportunistic plant collections were made during foot and vehicular transects of the bushland areas at various times of the three years of survey. It was considered that approximately 95% of the flora within Lowlands has been documented.

Nine vegetation associations were mapped by Keighery et al. (1995) which could be grouped into three broad units:

- *Banksia* Woodlands
 - *Banksia* Woodlands to Forests with scattered emergent eucalypts (ebW)
 - *Banksia*, Sheoak (*Allocasuarina fraseriana*) and/or Paperbark (*Melaleuca preissiana*) Woodlands to Forests (baW and bmW)

- Tuart Woodland (tW)
- *Jacksonia sternbergiana* Low Woodland (jLW)
- *Banksia* Woodland or scattered *Banksia* over Spearwood (*Kunzea ericifolia*) Closed Tall Shrubland (bkW)
- Ephemeral Wetlands
 - Freshwater Paperback (*Melaleuca raphiophylla*) Woodland to Shrubland (mrW)
 - Woodlands over Sedgeland (WS)
 - Claypans
 - Other Sumplands
- River – Creekline
 - Flooded Gum (*Eucalyptus rudis*) Forest to Woodland (rF).

The mapped vegetation associations were broadly related to floristic units mapped by Gibson et al. (1994) including 21a, 23a, 21c, 5, 11 and 4.

Keighery et al. (1995) reported that the majority of native vegetation at Lowlands was in Very Good to Good condition. There is considerable disturbance associated with the transitional areas between the pasture and the bushland. The most severe weed invasion is associated with wetland areas.

The survey recorded 438 flora taxa, of which 334 were native taxa and 104 were introduced (exotic) taxa. The most species diverse families included Orchidaceae (33 taxa), Cyperaceae (23 taxa) and Myrtaceae (22 taxa). Seven conservation or other significant flora taxa were recorded from Lowlands, these included *Caladenia huegelii* (Threatened), *Drakaea elastica* (Threatened), *Eryngium pinnatifidum* subsp. Palustre (G.J. Keighery 13459) (Priority 3), *Parsonsia diaphanophleba* (Priority 4), *Conostephium minus* (now delisted), *Stylidium longitubum* (Priority 4) and *Stylidium mimeticum* (now *S. calcaratum* and not listed). Other significant taxa recorded during the survey included: *Dillwynia dillwynioides* (now Priority 3), *Gnephosis angianthoides*, *Lagenophora huegelii*, *Johnsonia* aff. *pubescens* and *Eucalyptus gomphocephala*.

The assessment by Keighery et al. (1995) concluded that the bushland at Lowlands is of very high conservation value as it contains mature *Banksia* Woodlands, has a diversity of floristic community types (FCTs) in a unique combination, contains significant areas of *Banksia* Woodland FCTs 21a and 21c, is a rare example of intact riverine communities, and contains populations of conservation and other significant flora.

Rivers 2 Ramsar; Connecting River Corridors for Landscape Resilience at Lowlands Nature Reserve (Sheenan et al. 2017)

The DBCA has managed Lowlands (Lot 300 and 301) since 2015, which contains 1,310 ha of intact remnant bushland and a portion of the Serpentine River. According to Sheen et al. (2017), threats to Lowlands include Phytophthora dieback, altered hydrological regimes on the riverine system, introduced weeds, invasive animal species, unmanaged access and potential impacts of wildfire. Therefore on ground works at Lowlands for the Rivers 2 Ramsar: Connecting River Corridors for Landscape Resilience Project have focused on dieback mapping and control, weed and feral animal control, revegetation, fencing and collection and establishment of a seedbank for the reserve.

Sheen et al. (2017) reports that Lowlands contains significant areas of mature *Banksia* woodland as well as wetland vegetation. The wetland vegetation along the Serpentine River comprises herblands, sedgeland and shrublands and contains flora rarely found on the Swan Coastal Plain (SCP) including Lowlands creeper (*Parsonsia*

diaphanophleba) and Maidenhair fern (*Adiantum aethiopicum*). Weed mapping and control has focused on infestations along the Serpentine River and within revegetation sites targeting Arum lily (*Zantedeschia aethiopica*), Blackberry (*Rubus fruticosus*), Bridal creeper (*Asparagus asparagoides*), Cotton bush (*Gomphocarpus fruticosus*), Freesia (*Freesia alba x leichtinii*), Black flag (*Ferraria crispa*) and Watsonia (*Watsonia meriana*).

The riverine system at Lowlands retains a diversity of freshwater fish and provides spawning grounds for Carters freshwater mussel (*Westralunio carteri*) and Pouched lamprey (*Geotria australis*). The river also provides important habitat for threatened mammals including Rakali (*Hydromys chrysogather*) and Quenda (*Isodood obesulus fusciventer*). Sheen et al. (2017) reports introduced fauna including foxes and cats are a threat to native fauna at Lowlands and 1080 fox baiting has also been carried out.

Dieback interpretation shows that *Phytophthora cinnamomi* is present although most of the Reserve is dieback free. A Hygiene Management Plan has been developed and dieback vehicle wash-down bays and signage has been installed on the reserve along major access tracks.

3.2 Wetlands

There are eight wetlands as described by Hill et al. (1996), which are within or intersect the survey area (Table 3 and Figure 2, Appendix A). Of these, two are Conservation Category wetlands (CCWs).

Table 3 Geomorphic wetlands within or intersecting the survey area

Name	UFI	Classification	Evaluation
Unknown	7244	Palusplain	Resource Enhancement
Unknown	7296	Palusplain	Conservation
Unknown	14744	Sumpland	Resource Enhancement
Unknown	14749	Sumpland	Resource Enhancement
Unknown	14846	Palusplain	Resource Enhancement
Unknown	14848	Palusplain	Conservation
Unknown	15250	Palusplain	Multiple Use
Unknown	16021	Palusplain	Multiple Use

3.3 Land use

3.3.1 DBCA legislated lands

The survey area is part of a Nature Reserve (R 51784, Class A), which is known as Lowlands Nature Reserve (Figure 3, Appendix A).

3.3.2 Bush Forever

The majority of the survey area is covered by Bush Forever Site no. 368, Lowlands Bushland – Eastern Block Peel Estate. Bush Forever Site no. 371, Serpentine River, Peel Estate to Serpentine also intersects the eastern boundary of the survey area (Figure 3, Appendix A).

3.3.3 Environmentally Sensitive Areas

The majority of the survey area lies within an Environmentally Sensitive Area (ESA). This ESA likely aligns with the presence of Bush Forever sites, CCWs, TECs and their buffer zones (Figure 3, Appendix A).

3.4 Regional vegetation complexes

Regional vegetation has been mapped by Heddle et al. (1980) with updates from Webb et al. (2016) based on major geomorphic units on the SCP. The mapping indicates that four vegetation complexes are present within the survey area, the Dardanup Complex, the Guildford Complex, the Southern River Complex and the Bassendean Complex – Central and South (Figure 4, Appendix A). These complexes occur on the Pinjarra Plain and Bassendean Dunes landform units as well as combinations of both units. The vegetation complexes 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 raphiophylla*
- Southern River Complex: Open-woodland of *Corymbia calophylla*, *Eucalyptus marginata*, *Banksia* on the elevated areas and a fringing woodland of *E. rudis*, *Melaleuca raphiophylla* along the streams. South of the Murray River *Agonis flexuosa* occurs in association with the *E. rudis* and *Melaleuca raphiophylla*
- Bassendean Complex-Central and South: Vegetation ranges from woodland of *Eucalyptus marginata* - *Allocasuarina fraseriana* - *Banksia* species to low woodland of *Melaleuca* species, and sedgeland on the moister sites. This area includes the transition of *Eucalyptus marginata* to *E. todtiana* in the vicinity of Perth.

3.5 Conservation significant communities

A desktop search of the DBCA TEC and PEC database identified nine TECs and three PECs potentially occurring within the survey area. One additional TEC was also considered as potentially occurring within the survey area, the *Banksia* Woodlands of the SCP TEC. Details on all of these communities, based on a 5 km search buffer are provided in Table 4 and Figure 5, Appendix A.

Table 4 TECs and PECs identified in the desktop search that may occur within the survey area

Community	EPBC Act	BC Act/DBCA	Description
<i>Banksia</i> woodlands of the SCP TEC	Endangered		The ecological community is a woodland associated with the SCP. A key diagnostic feature is a prominent tree layer of <i>Banksia</i> , with scattered eucalypts and other tree species often present among or emerging above the <i>Banksia</i> canopy. The understorey is a species rich mix of sclerophyllous shrubs, graminoids and forbs. The ecological community is characterised by a high endemism and considerable localised variation in species composition across its range (TSSC 2016).
<i>Banksia</i> dominated woodlands of the SCP IBRA Region PEC	A component of the <i>Banksia</i> TEC	Priority 3	Canopy is most commonly dominated or co-dominated by <i>Banksia attenuata</i> and/or <i>B. menziesii</i> . Other <i>Banksia</i> species that can dominate in the community are <i>B. prionotes</i> or <i>B. ilicifolia</i> . It typically occurs on well drained, low nutrient soils on sandplain landforms, particularly deep Bassendean and Spearwood sands and occasionally on Quindalup sands; it is also common on sandy colluvium and aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau and can occur in other less common scenarios (DBCA 2019)
<i>Corymbia calophylla</i> – <i>Kingia australis</i> woodlands on heavy soils (SCP3a) TEC	Critically Endangered	Endangered	A woodland community located on heavy soils of the eastern side of the Swan Coastal Plain between Capel and Hazelmere. Typical and common native taxa in the community are: <i>Corymbia calophylla</i> ; the shrubs <i>Banksia nivea</i> , <i>Philotheca spicata</i> , <i>Kingia australis</i> and <i>Xanthorrhoea preissii</i> ; herbs, rushes and sedges, <i>Cyathochaeta avenacea</i> , <i>Dampiera linearis</i> , <i>Haemodorum laxum</i> , <i>Desmocladius fasciculatus</i> , <i>Mesomelaena tetragona</i> and <i>Tetraria octandra</i> . The introduced grass <i>Briza maxima</i> is also common in the community.
<i>Corymbia calophylla</i> - <i>Eucalyptus marginata</i> woodlands on sandy clay soils of the southern Swan Coastal Plain (SCP3b) TEC		Vulnerable	No description available.
<i>Corymbia calophylla</i> - <i>Xanthorrhoea preissii</i> woodlands and shrublands, Swan Coastal Plain (SCP3c) TEC	Critically Endangered	Endangered	The community is located on heavy soils of the eastern side of the SCP between Bullsbrook, and Waterloo near Bunbury. Dominant species in the community are the trees <i>Corymbia calophylla</i> and occasionally <i>Eucalyptus wandoo</i> ; the shrubs <i>Xanthorrhoea preissii</i> , <i>Acacia pulchella</i> , <i>Dryandra nivea</i> , <i>Gompholobium marginatum</i> , and <i>Hypocalymma angustifolia</i> and the herbs <i>Burchardia umbellata</i> , <i>Cyathochaeta avenacea</i> and <i>Neurachne alopecuroidea</i> .

Community	EPBC Act	BC Act/DBCA	Description
Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain) TEC		Endangered	The habitat of this community is characterised by continuous discharge of groundwater in raised areas of peat. The peat and surrounds provide a stable, permanently moist series of microhabitats. Intact vegetated tumulus springs are only found at four locations. Typical and common native vascular plant species associated with the tumulus springs are the trees <i>Banksia littoralis</i> , <i>Melaleuca preissiana</i> and <i>Eucalyptus rudis</i> , and the shrubs <i>Agonis linearifolia</i> , <i>Pteridium esculentum</i> , <i>Astartea fascicularis</i> and <i>Cyclosorus interruptus</i> .
<i>Banksia attenuata</i> and/or <i>Eucalyptus marginata</i> woodlands of the eastern side of the Swan Coastal Plain (SCP20b) TEC	Endangered	Endangered	Most of the occurrences of this community type are <i>Eucalyptus marginata</i> – <i>Banksia attenuata</i> woodlands but the community also occurs as <i>Banksia</i> woodlands and heaths. A diverse shrub layer comprising <i>Hakea stenocarpa</i> , <i>Conostylis setosa</i> , and <i>Johnsonia</i> aff. <i>pubescens</i> differentiates this community type from the other two subgroups. The community is found on a range of soils on the base of the Darling Scarp from Yarloop to Byford. Soils are mainly yellow orange and yellow sands.
Herb rich saline shrublands in clay pans (SCP07) TEC	Critically Endangered TEC (part)	Vulnerable	This vegetation community type occurs on heavy clay soils that are generally inundated from winter to mid-summer. Structurally this vegetation community type is quite variable ranging from woodlands to herblands, the most common overstorey taxa being <i>Melaleuca viminea</i> , <i>M. uncinata</i> , <i>M. cuticularis</i> or <i>Casuarina obesa</i> . Aquatic species are common in this vegetation community early in the growing season. Typical species in the understorey include the common herbs <i>Brachyscome bellidioides</i> , <i>Centrolepis polygyna</i> , <i>Pogonolepis stricta</i> and <i>Cotula coronopifolia</i> .
Herb rich shrublands in clay pans (SCP08) TEC	Critically Endangered TEC (part)	Vulnerable	Occurs in low lying flats with a clay impeding layer allowing seasonal inundation. Dominated by one or more of the shrubs: <i>Viminaria juncea</i> , <i>Melaleuca viminea</i> , <i>M. lateritia</i> , <i>Kunzea micrantha</i> or <i>K. recurva</i> with occasional emergents of <i>Eucalyptus wandoo</i> . Species such as <i>Hypocalymma angustifolium</i> , <i>Acacia lasiocarpa</i> var. <i>bracteolata</i> long peduncle variant (G. J. Keighery 5026) and <i>Verticordia huegellii</i> occur at moderate frequencies.
Dense shrublands on clay flats (SCP09) TEC	Critically Endangered TEC (part)	Vulnerable	This vegetation community type is shrublands or low open woodlands on clay flats that are inundated for long periods because it usually occurs very low in the landscape. Sedges are more apparent in this ecological community and include <i>Chorizandra enodis</i> , <i>Cyathochaeta avenacea</i> , <i>Lepidosperma longitudinale</i> and <i>Meeboldina coangustata</i> . Shrubs include <i>Hakea varia</i> and <i>Melaleuca viminea</i> and occasionally <i>Xanthorrhoea preissii</i> , <i>Xanthorrhoea drummondii</i> and <i>Kingia australis</i> .