



Main Roads Western Australia

Tonkin Highway Grade Separated Interchanges, Hale Road
and Welshpool Road

EPBC 2019/8529 Preliminary Documentation

March 2021

GHD scope and limitations

Main Roads Western Australia (Main Roads) commissioned GHD Pty Ltd (GHD) to develop the Preliminary Documentation for EPBC 2019/8529 Tonkin Highway Grade Separated Interchanges for submission to the Department of Agriculture, Water and the Environment.

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Executive summary

Main Roads Western Australia (Main Roads) proposes to upgrade Tonkin Highway from the south of Roe Highway to approximately 1 km north of Kelvin Road (the Proposed Action) within the City of Kalamunda. The Proposed Action consists of a single fly-over and grade-separated interchange at the existing intersections of Tonkin Highway and Hale Road in Forrestfield, and Tonkin Highway and Welshpool Road in Wattle Grove, respectively. The Proposed Action will also involve the reconstruction of approximately 4.5 km of Tonkin Highway into a six-lane dual carriageway. The Proposed Action will improve accessibility, travel times and road safety as well as sustaining jobs and enabling regional development in Perth's south eastern suburbs.

As the Proposed Action may have a significant impact on Matters of National Environmental Significance (MNES), Main Roads was required to prepare Preliminary Documentation to inform the assessment of the relevant impacts of the Proposed Action. This Preliminary Documentation was prepared in response to a request by Department of Agriculture, Water, and Environment (DAWE) on 5 December 2019 for additional information to support assessment of impacts for the Proposed Action (EPBC 2019/8529) under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Proposed Action will result in significant residual impacts to Banksia Woodlands of the Swan Coastal Plain Threatened Ecological Community (BWSCP TEC), Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*), Forest Red Tailed Black Cockatoo (FRTBC) (*Calyptorhynchus banksia naso*), Baudin's Cockatoo (*Calyptorhynchus baudinii*), Wavy-Leaved Smokebush (*Conospermum undulatum*), Slender Andersonia (*Andersonia gracilis*), and Summer Honeypot (*Banksia mimica*), due to the following impacts:

- Clearing of up to 3.99 ha of BWSCP TEC
- Clearing of up to 141 potential breeding trees (> 500 mm Diameter at Breast Height) for Black Cockatoo species, none of which contain hollows suitable for nesting by Black Cockatoos
- Clearing of up to 18.7 ha of moderate to low quality foraging habitat for Carnaby's Cockatoo
- Clearing of up to 7.9 ha of high to moderate quality foraging habitat and 11.3 ha of moderate to low quality foraging habitat for FRTBC and Baudin's Cockatoo (total 19.1 ha of foraging habitat)
- Loss of up to 62 individuals of *Conospermum undulatum* and 7.45 ha of suitable habitat
- Loss of up to 11 individuals of *Andersonia gracilis*
- Loss of three individuals of *Banksia mimica*.

The Proposed Action will not result in impacts to known or potential nesting hollows or roosting sites of threatened Black Cockatoo species.

The Proposed Action is not expected to result in significant indirect impacts to BWSCP TEC, Carnaby's Cockatoo, FRTBC, Baudin's Cockatoo, *Conospermum undulatum*, *Andersonia gracilis* or *Banksia mimica*. The Proposed Action will not fragment TEC or threatened species habitat, with clearing being limited to the edges of existing disturbed corridors along Tonkin Highway, Hale Road and Welshpool Road.

The Proposed Action will occur over and adjacent to areas of dieback infestation and will incorporate hygiene management to prevent the spread of dieback into uninfested areas.

The Proposed Action is not expected to result in significant impacts (direct or indirect) to Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain ecological community, King Spider-orchid (*Caladenia huegelii*), Purdie's Donkey-orchid (*Diuris purdiei*) or Glossy-leaved Hammer Orchid (*Drakaea elastica*), a short-tongued bee (*Leioproctus douglasiellus*) and the Australian Bittern (*Botaurus poiciloptilus*) which were identified by DAWE as potentially impacted by the Proposed Action.

Main Roads proposes an offset to counterbalance the potential significant residual impacts to BWSCP TEC, Carnaby's Cockatoo, FRTBC, Baudin's Cockatoo, Wavy-leaved Smokebush, Slender Andersonia and Summer Honeypot.

Implementation of the Proposed Action:

- Is consistent with the Regional Road reserve under the Metropolitan Region Scheme
- Provide substantial social and economic benefits
- Has been developed with consideration to appropriate stakeholder consultation
- Incorporates substantial impact avoidance and mitigation, and established, effective construction management measures
- Includes design and construction measures that protect and enhance the integrity of adjacent Bush Forever sites and Class A reserves (Hartfield Park and Greater Brixton Street Wetlands)
- Is not inconsistent with the Objects of the EPBC Act and principles of economically sustainable development (ESD) including the precautionary principles
- Is not inconsistent with relevant Commonwealth Conservation Advice, Recovery Plans and Threat Abatement Plans
- Includes an offset to counterbalance significant residual impacts.

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Appendix C	Biological Survey and Targeted Black Cockatoo Habitat Assessment
Appendix D	Hale Road Vegetation Assessment
Appendix E	Targeted Flora Survey and Black Cockatoo Hollow Assessment
Appendix F	Phytophthora Dieback Occurrence Assessment
Appendix G	Risk Assessment
Appendix H	Action Management Plan
Appendix I	Draft Offset Strategy

1. Introduction

1.1 Overview of Proposed Action

Main Roads Western Australia (Main Roads) proposes to upgrade Tonkin Highway from south of Roe Highway to approximately 1 km north of Kelvin Road, within the City of Kalamunda (the Proposed Action). Figure 1 presents the Proposed Action location and Development Envelope (DE). The DE comprises an area of approximately 51.5 ha and represents the preliminary impact footprint.

Tonkin Highway is a major arterial highway in the Perth metropolitan area that links Perth Airport and Kewdale with south-eastern and north-eastern suburbs. Welshpool Road is a major arterial road intersecting Tonkin Highway in Wattle Grove. Hale Road is a minor arterial road that currently provides access to Tonkin Highway from Forreestfield.

The Proposed Action consists of construction and operation of a dual carriageway (three lanes in each direction, with provision for four lanes in the future), a fly-over at the intersection with Hale Road and a grade separated interchange at the intersection with Welshpool Road.

The Proposed Action aims to improve the efficiency of Tonkin Highway by grade separating Hale and Welshpool Roads allowing a continuous flow of traffic. The Proposed Action will alleviate the pressure on the existing transport network, as both the intersections of Welshpool Road and Hale Road experience significant volumes of heavy freight traffic. The Proposed Action also aims to improve pedestrian safety, and reduce congestion and potential vehicular conflict.

The Proposed Action includes:

- Construction of a 4.2 km six lane dual carriageway from south of Roe Highway to approximately 1 km north of Kelvin Road
- Single fly-over (half diamond with North facing ramps) at the intersection with Hale Road
- Grade separated (egg-about) interchange at Welshpool Road
- Principal Shared Path (PSP) on the eastern side of the Tonkin Highway for the full length and grade separation at interchanges
- Concrete footpath on side roads with link to the PSP
- Single span bridges for grade separation interchanges
- Installation of associated road infrastructure, such as lighting, noise and retaining walls, safety barriers, stopping bays and traffic monitoring devices, signs and landscaping
- Drainage basins, drains and other associated infrastructure.

1.2 Purpose and scope of this documentation

On 19 November 2019, a delegate of the Minister for the Environment determined the Proposed Action was a controlled action to be assessed by Preliminary Documentation. The relevant controlling provisions were listed threatened species and communities (sections 18 & 18A).

On December 5, 2019, the Department of Agriculture, Water, and Environment (DAWE) requested additional information to inform the assessment of the relevant impacts of the Proposed Action. In making the request, DAWE considered the Proposed Action may impact Matters of National Environmental Significance (MNES) including, but not limited to:

- Baudin's Cockatoo (*Calyptohynchus baudinii*)

- Forest Red-Tailed Black Cockatoo (FRTBC, *Calyptorhynchus banksia naso*)
- Carnaby's Cockatoo (*Calyptorhynchus latirostris*)
- Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain ecological community
- Wavy-Leaved Smokebush (*Conospermum undulatum*)
- Australian Bittern (*Botaurus poiciloptilus*)
- A short tongued bee (*Leioproctus douglasiellus*)
- King Spider-orchid (*Caladenia huegeli*)
- Purdie's Donkey-orchid (*Diuris purdie*)
- Glossy-leafed Hammer Orchid (*Drakaea elastica*).

This Preliminary Documentation presents the additional information requested by DAWE, to support the assessment of the Tonkin Highway Grade Separated Interchanges, Wattle Grove, WA (EPBC 2019/8529, the Proposed Action) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The structure and content of this Preliminary Documentation has been prepared in accordance with DAWE's request for additional information.

Additional MNES not identified in request for documentation

Further to the MNES identified by DAWE, a biological survey conducted by Woodman Environmental (Woodman) (2021) over the DE identified a number of additional MNES:

- Banksia Woodlands of the Swan Coastal Plain ecological community (BWSCP TEC)
- Slender Andersonia (*Andersonia gracilis*)
- Summer Honeypot (*Banksia mimica*).

These additional MNES are also addressed in the Preliminary Documentation.

1.3 Proponent

The proponent for the Proposed Action is the Commissioner of Main Roads. Formal contact details are listed in Table 1.

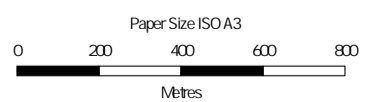
Table 1 Proponent and Proposed Action key contact

Proponent/Contact	Contact details
Proponent	Commissioner of Main Roads Main Roads Western Australia PO Box 6202 East Perth WA 6002 ABN/CAN 50 860 676 021
Proposed Action Key Contact	Laura Zimmermann Environment Officer Infrastructure Delivery Directorate Main Roads Western Australia



Legend

- Major Road
- Minor Road
- Track
- ▭ Development Envelope



Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50



Main Roads
Tonkin Grade Separated Interchanges

Proposal location and
Development Envelope

Project No. 12523571
Revision No. 0
Date 28/10/2020

FIGURE 1

2. Preliminary Documentation

Table 2 presents a summary of the information requested as part of the Preliminary Documentation and the corresponding section in this report. The full list of required information and corresponding sections is provided in Appendix A.

Table 2 Summary of information requested for Preliminary Documentation and corresponding section in this report

Information Requested	Section
Description of the Action	Section 3
Environment and Matters of National Environmental Significance	Section 4
Assessment of Impacts	Section 5
Avoidance and mitigation measures	Section 6
Application of Recovery Plans	Section 7
Offsets	Section 8
Economic and social considerations	Section 9
Ecologically sustainable development	Section 10
Environmental records	Section 11
Other approvals and conditions	Section 12

3. Description of the Action

3.1 Overview

Appendix B presents a concept design layout of the Proposed Action (Arup 2020). The Proposed Action includes:

- Construction and operation of a 4.2 km six lane dual carriageway from south of Roe Highway to approximately 1 km north of Kelvin Road
- Single fly-over (half diamond with North facing ramps) at the intersection with Hale Road
- Grade separated (egg-about) interchange at Welshpool Road
- PSP on eastern side of the Tonkin Highway for the full length and grade separation at interchanges
- Concrete footpath on side roads with link to the PSP
- Single span bridges for grade separation interchanges
- Installation of associated road infrastructure, such as lighting, noise and retaining walls, safety barriers, stopping bays and traffic monitoring devices, signs and landscaping
- Drainage basins, drains and other associated infrastructure.

3.2 Pre-construction

On-ground pre-construction activities will include the ongoing maintenance of the existing Tonkin Highway (as required) and investigations to inform the design of this Proposed Action. Investigations are likely to include survey pick up and geotechnical investigations that do not impact on native vegetation or MNES.

The design of the Proposed Action will continue to be refined during the pre-construction phase in order to reduce the environmental impacts and improve safety and usability. Consequently the disturbance from the Proposed Action is expected to be less than is proposed in this Preliminary Documentation.

3.3 Construction

Construction of the Proposed Action is planned to commence in late 2021 with construction expected to be completed in 2024. The commencement of the Proposed Action is subject to approvals and refinement of the preferred design option.

The works associated with the Proposed Action will be managed in accordance with an Action Management Plan to mitigate potential impacts associated with the Proposed Action. Construction of the road will be undertaken using conventional earth-moving and paving equipment and construction techniques. The road formation will be built using both imported fill and cut-to-fill materials from the DE.

Laydown areas for road-building material will be established by the Construction Contractor in consultation with Main Roads and the Local Government Authorities.

Temporary groundwater dewatering may be required for the construction of bridge piers, abutment footings and drainage structures. Construction water may be abstracted by bores in the superficial aquifer within the DE.

3.4 Operation

Traffic modelling of the highway intersections was used to inform the road and bridge design with forecast volumes based on the Main Roads ultimate network planning which extends to 2041. Tonkin Highway will operate as a controlled access highway (freeway standard), with access onto Tonkin Highway restricted to specific interchange locations. Traffic will generally be free flowing on the six lane dual carriageway (three lanes each direction). Tonkin Highway will be subject to normal routine, recurrent and periodic maintenance during operation of the highway. The maintenance operations will be confined to the road corridor and the road itself, typically including maintenance of vegetation, drainage, lighting, road markings, signs and the road pavement.

3.5 Location and boundaries

The DE of the Proposed Action is 51.5 ha and lies along the existing road corridor of Tonkin Highway, Hale Road and Welshpool Road and adjacent lands.

The DE is located in the City of Kalamunda, within the suburbs of Wattle Grove and Forrestfield. The following land uses are adjacent to the DE (Figure 2):

- Hartfield Park, comprising a Class A Recreation Reserve, golf course and other recreation facilities, and forming Bush Forever site 320. Hartfield Park lies adjacent to much of the DE between Hale Road and Welshpool Road. The Class A Recreation Reserve is vested in the City of Kalamunda and has several recreational organisations as interested stakeholders
- Greater Brixton Street Wetlands, also known as the Kenwick Wetlands, comprising a corridor to the south-west of the Welshpool Road intersection, forming Bush Forever site 387. The corridor comprises predominantly freehold properties with some areas of Class A Conservation Reserve
- Forrestfield and Wattle Grove suburbs, including residential and commercial land to the north and west, industrial land to the south-west and rural land to the south-east.

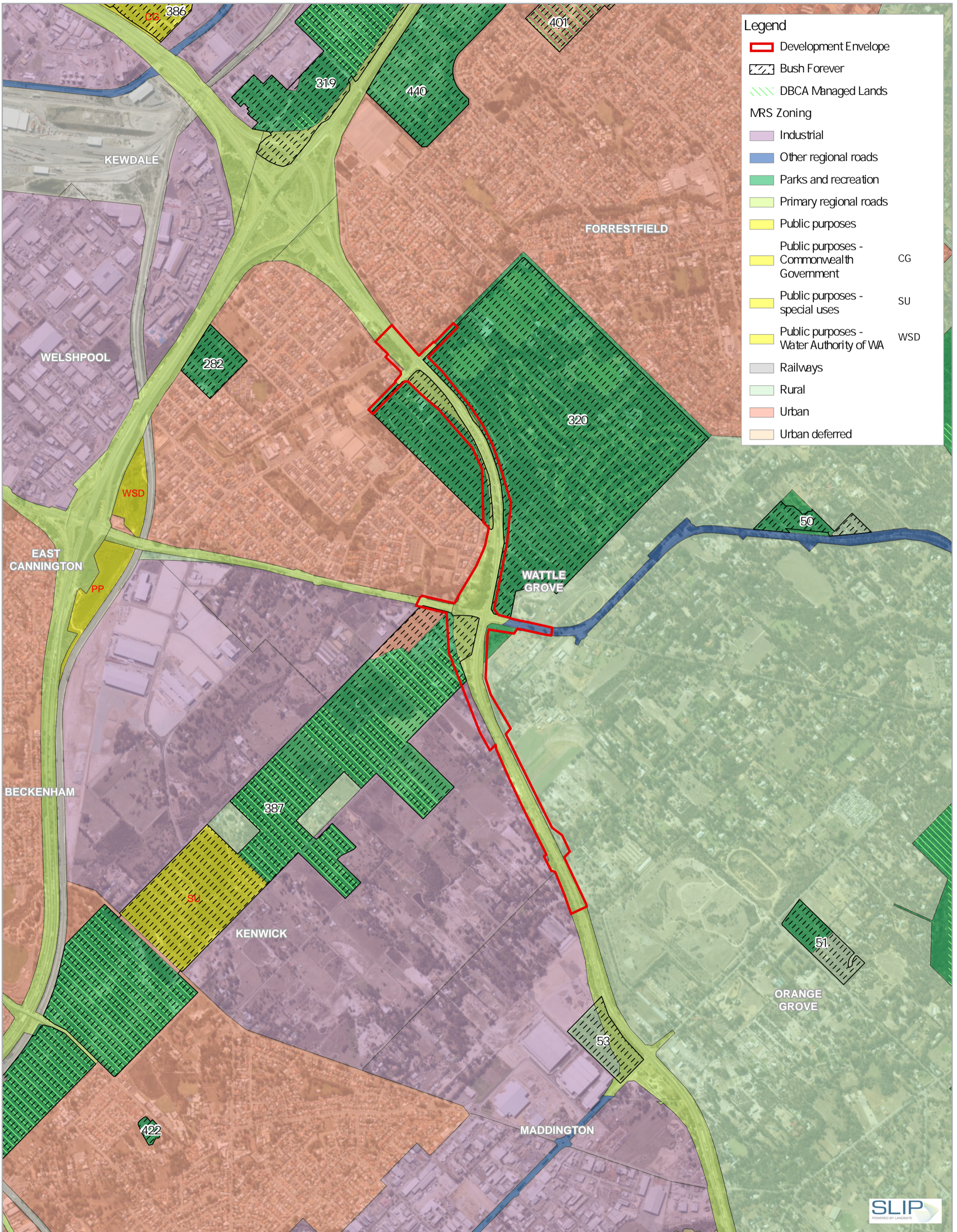
3.6 Revegetation activities

Revegetation within the DE will be undertaken in accordance with *MRWA Vegetation Placement within the Road Reserve* Doc. No. 6707/022 (Main Roads WA 2003). This guide defines the recommended setbacks and clearance requirements that apply to all revegetation or landscaping associated with new road construction.

Revegetation will be undertaken in the first winter following the completion of construction and will be monitored and maintained over a three year period or until the revegetation meets completion criteria.

Revegetation will utilise locally native plant species designed to be self-sustaining, resilient, and structurally and species diverse. Opportunities to use species of foraging habitat for Black Cockatoos, including but not limited to *Banksia* spp., *Hakea* spp., *Grevillea* spp. and *Eucalyptus* spp. will be investigated as part of the landscaping and revegetation works.

Placement of vegetation near road infrastructure is restricted to maintain road safety. These requirements minimise ongoing maintenance and maintain a standard amenity and safety level for road users. Revegetation will incorporate these restrictions when undertaking planting, in particular, the need for roadside maintenance and clear zones. Revegetation will not be undertaken over areas required for ongoing operations such as drainage basins, road embankments and median strips. Black cockatoo foraging species will not be planted within 10 m of the edge of the road in order to reduce the possibility of vehicle strike.



Legend

- Development Envelope
- Bush Forever
- DBCA Managed Lands

MRS Zoning

- Industrial
- Other regional roads
- Parks and recreation
- Primary regional roads
- Public purposes
- Public purposes - Commonwealth Government CG
- Public purposes - special uses SU
- Public purposes - Water Authority of WA WSD
- Railways
- Rural
- Urban
- Urban deferred

Paper Size ISO A3
 0 100 200 300 400
 Metres

Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 50



Main Roads
 Tonkin Grade Separated Interchanges

Land Uses

Project No. 12523571
 Revision No. 0
 Date 28/10/2020

FIGURE 2

3.7 Feasible alternatives

Hale Road intersection

Main Roads' early planning indicated a flyover was the preferred solution with Hale Road travelling under Tonkin Highway, to connect Wattle Grove and Forrestfield. However, in response to community and stakeholder feedback, Main Roads sought to investigate and develop an option that also connected Tonkin Highway to and from Hale Road.

Main Roads' investigations identified a new preferred option as a half diamond interchange with north facing signalised ramps and access to Tonkin Highway through Roe Highway Interchange (Tonkin Highway and Roe Highway access).

The option for no-access (single fly over) was considered but discarded in response to community and stakeholder demand for access to Tonkin Highway from Hale Road.

The option for including south facing ramps was considered however traffic monitoring and analysis indicated that over 80% of Hale Road users were accessing Tonkin Highway to travel north, with less than 20% travelling south. Accordingly, the south facing ramps were discarded to avoid additional land acquisition and to minimise native vegetation clearing and impacts to Hartfield Park Bush Forever site 320 and registered Aboriginal heritage sites that lie adjacent and south of Hale Road.

Welshpool Road intersection

Main Roads undertook a multi-criteria analysis for the interchange at Welshpool Road, which considered a range of interchange options to identify an optimal design that balanced environmental considerations with the need to reduce the number of severe crashes. Options considered for the Welshpool Road interchange included:

- Conventional roundabout interchange
- Single Point Urban Interchange
- Diverging Diamond Interchange and Conventional Diamond Interchange
- Dog-bone Interchange
- Egg-about Interchange.

Following a comprehensive review which aimed to reduce overall environmental footprint, cost and land reclamation, Main Roads presented the egg-about interchange as the preferred option in the Infrastructure Australia submission (the Proposed Action).

4. Matters of National Environmental Significance

4.1 Description of protected matters within the Proposed Action Area

This Preliminary Documentation describes the following MNES listed under the EPBC Act that are, or have the potential to be, in the DE and surrounds:

Listed ecological communities

- Banksia Woodlands of the Swan Coastal Plain ecological community (Endangered) (BWSCP TEC)
- Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain ecological community (Critically Endangered).

Listed species

- Forest Red-tailed Black Cockatoo (FRTBC, *Calyptorhynchus banksii naso*) (Vulnerable)
- Carnaby's Cockatoo (*Calyptorhynchus latirostris*) (Endangered)
- Baudin's Cockatoo (*Calyptorhynchus baudinii*) (Endangered)
- Australasian Bittern (*Botaurus poiciloptilus*) (Endangered)
- Short-Tongued Bee (*Leioproctus douglasiellus*)
- Wavy-Leaved Smokebush (*Conospermum undulatum*) (Vulnerable)
- Slender Andersonia (*Andersonia gracilis*) (Endangered)
- Summer Honeypot (*Banksia mimica*) (Vulnerable)
- King Spider-orchid (*Caladenia huegeli*) (Endangered)
- Purdie's Donkey-orchid (*Diuris purdie*) (Endangered)
- Glossy-leafed Hammer Orchid (*Drakaea elastic*) (Endangered).

4.2 Biological Surveys

Main Roads commissioned Woodman Environmental (Woodman 2021) to complete a biological survey over the DE and its vicinity. The biological survey included:

- Detailed flora and vegetation survey in accordance with WA Environmental Protection Authority (EPA) guidance (EPA 2016a)
- Level 1 terrestrial fauna survey in accordance with WA EPA guidance (EPA 2016b)
- Targeted Black Cockatoo habitat assessment in accordance with EPBC Act referral guidelines (DSEWPaC 2012).

Appendix C presents the biological survey report.

The biological survey covered an area of 193.64 ha which included the DE and surrounding land that was considered accessible and contained remnant vegetation similar to that found in the DE (Woodman 2021). This area is referred to as the 'Assessed Area' in the biological survey report (Woodman 2021) and the 'Survey Area' in this Preliminary Documentation. The biological survey incorporated a desktop review over a study area comprising a 5 km buffer from

the DE. The Survey Area beyond the DE enabled identification of potential indirect impacts to surrounding areas, and definition of the wider extent and condition of patches of BWSCP TEC that occur within the DE.

Subsequent to the Woodman survey, Main Roads engaged GHD (2020) to conduct an in-fill survey of 0.73 ha to address gaps in flora, vegetation and Black Cockatoo habitat mapping in three small areas in the vicinity of the Tonkin Highway/Hale Road intersection. The survey was conducted in July 2020. This provided complete coverage of the DE. Appendix D presents the Hale Road in-fill survey report.

Subsequent to the Woodman survey, Main Roads engaged GHD (2021) to conduct a targeted flora survey and black cockatoo hollow assessment. The survey focussed on three orchid species (*Caladenia huegelii*, *Diuris purdiei* and *Drakaea elastica*) and assessed two trees identified by Woodman (2021) as containing potentially suitable hollows. Appendix E presents the GHD (2021) report.

4.3 Threatened ecological communities

4.3.1 Banksia Woodlands of the Swan Coastal Plain Threatened Ecological Community

Description

The BWSCP TEC is listed as Endangered under the EPBC Act and a Priority Ecological Community (PEC) by the Department of Biodiversity, Conservation and Attractions (DBCA).

The BWSCP TEC is a woodland restricted to Western Australia's SCP and adjacent areas including Dandaragan Plateau in the north and Darling Scarp in the east. The current state-wide extent of Banksia Woodlands TEC as of 2015 is estimated to be approximately 336,490 ha (TSSC 2016). The TEC has ongoing threats predominantly through clearing and fragmentation for urban development, as well as mining, fire regime and climate change, invasive species and *Phytophthora dieback* (TSSC 2016).

A key diagnostic feature of the TEC is a prominent tree layer of *Banksia* species, 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 canopy is commonly dominated by *Banksia attenuata* and / or *B. menziesii*. Other *Banksia* species that dominate include *B. prionotes* or *B. ilicifolia*. The patch must include at least one of these diagnostic species (TSSC 2016). The TEC is characterised by a high level of endemism and considerable localised variation in species composition across its range (TSSC 2016).

Habitat considered critical for the survival of the BWSCP TEC includes vegetation which meets the key diagnostic characteristics and condition thresholds for the ecological community, plus the buffer zones, particularly where this comprises surrounding native vegetation. This ecological community occurs in a landscape that has often been very heavily cleared and modified, and now exists as mostly very small and highly fragmented patches (TSSC 2016).

The TEC listing covers approximately 20 sub-communities or Floristic Community Types (FTCs), some of which are more common while others are highly restricted and listed as Threatened or Priority ecological communities (PEC) in Western Australia (TSSC 2016). Banksia Woodlands provide habitat for nationally threatened flora/fauna species including Carnaby's Cockatoo, Baudin's Cockatoo and FRTBC (TSSC 2016). Carnaby's Cockatoo and Baudin's Cockatoo are expected to forage on the canopy and understorey of the community, whereas FRTBC is expected to forage on eucalypts, where these are present in the community.

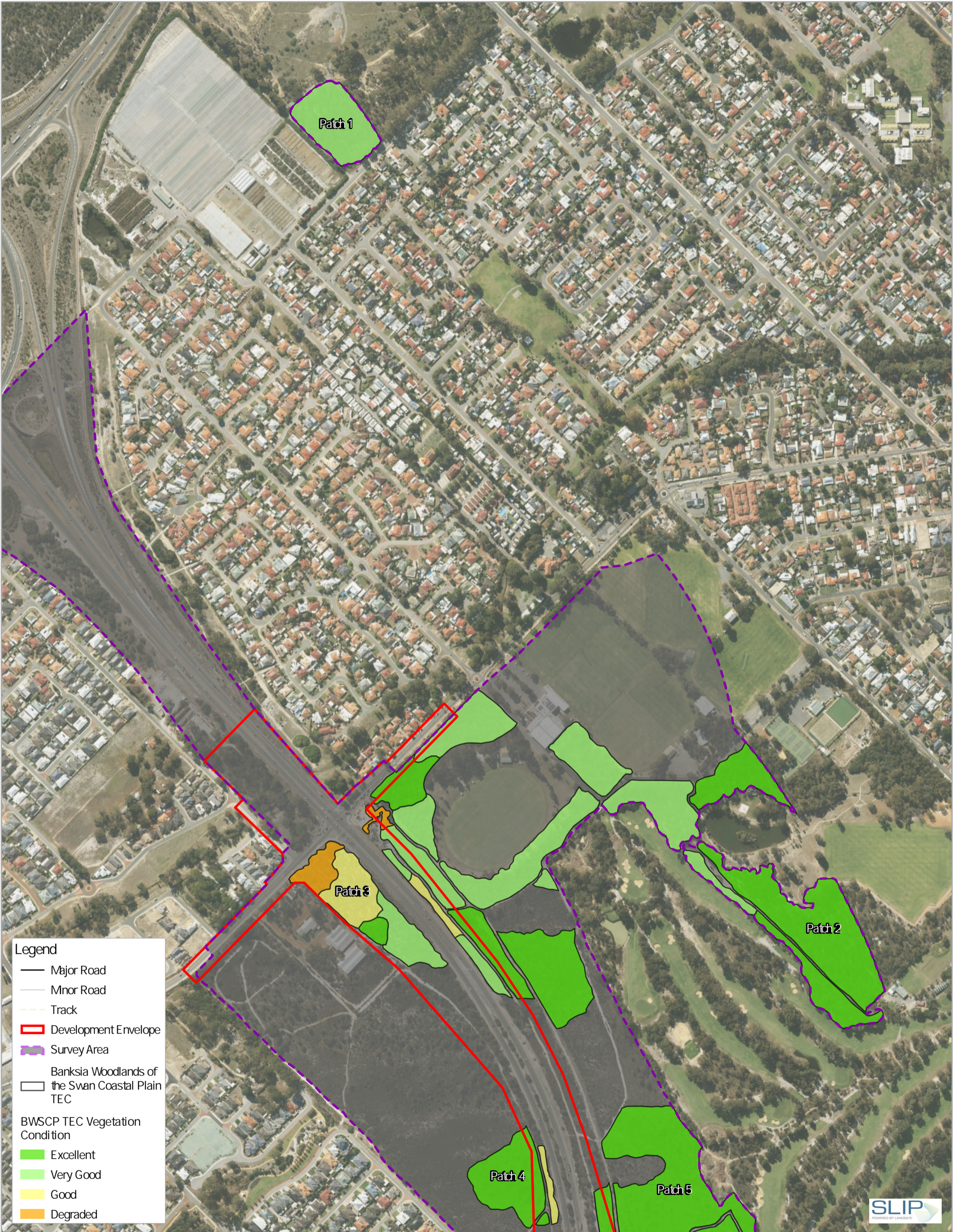
Habitat assessment

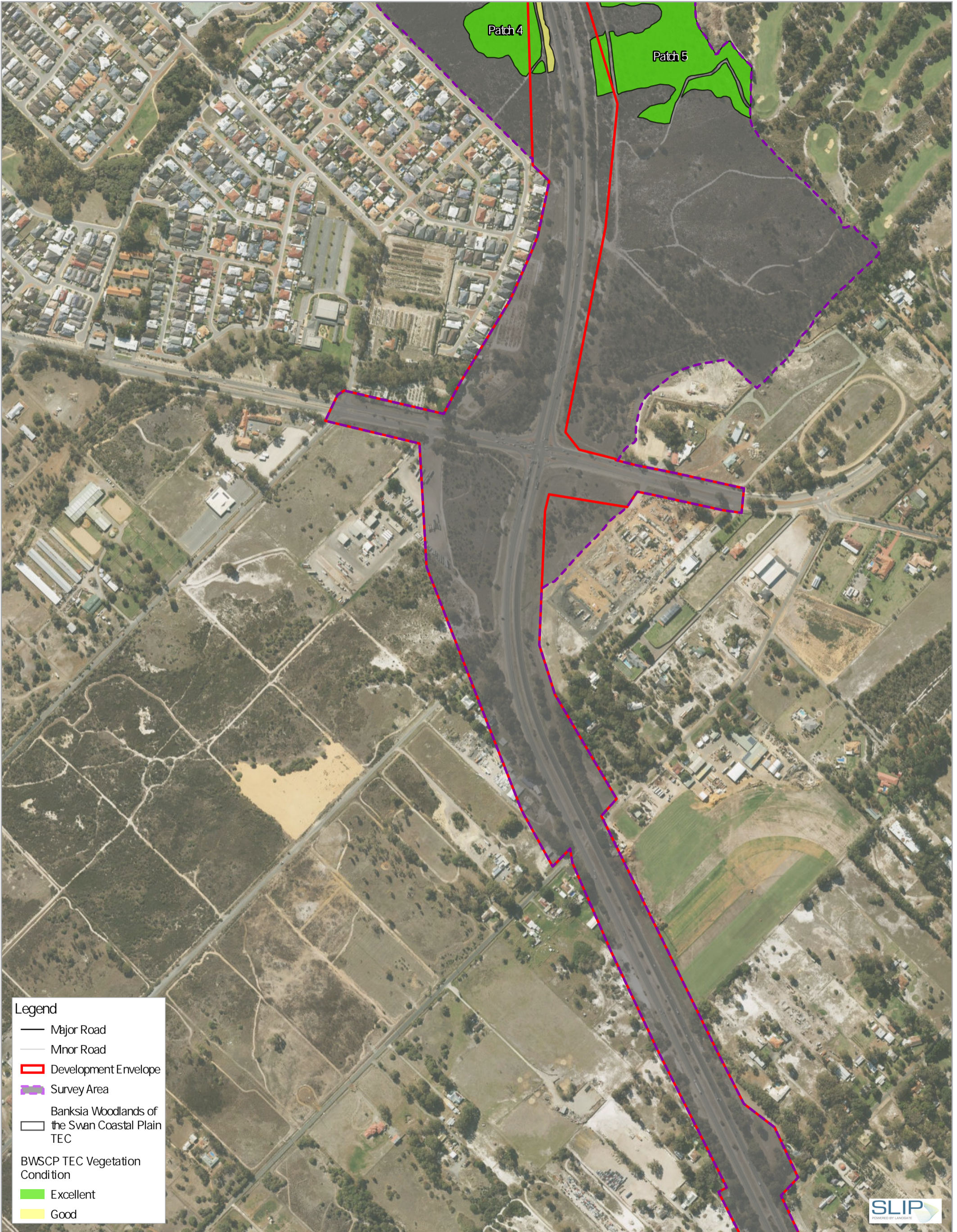
Woodman (2021) identified eight native vegetation types (VTs) over the Survey Area. Woodman (2021) determined one of the vegetation types, VT1, was representative of the BWSCP TEC and consistent with FCT 20a '*Banksia attenuata* woodland over species rich dense shrublands'.

Figure 3, Table 3 and Table 4 present the extent and condition of patches of BWSCP TEC within the Survey Area and DE. These patches meet the diagnostic criteria for the TEC including patch size and condition, using the condition rating scale devised by Keighery (1994) and adapted by the EPA (2016a).

The BWSCP TEC covers approximately 27.93 ha over seven patches within the 193.64 ha Survey Area, and approximately 3.99 ha over four patches (Patches 2 to 5) within the DE. Patch 1 lies approximately 1 km to the north of the DE. Patches 2 to 5 lie within the Hartfield Park Bush Forever site, within or adjacent to the DE. Patches 6 and 7 lie approximately 0.5 km to the south of the DE. Half of the TEC area (13.8 ha) is contained within Patch 2, which is located within Hartfield Park. The remaining patches are smaller in size, ranging from approximately 1 to 4 ha.

The 3.99 ha of TEC within the DE is relatively degraded compared to the TEC in the wider Survey Area. Within the DE, 42% of the TEC is in Good to Degraded condition, while in the Survey Area outside the DE, the vegetation is in much better condition with only 16% in Good to Degraded condition (refer to Table 3 and Table 4). The relatively degraded condition of the TEC within the DE is expected given the DE lies over and is adjacent to existing disturbed areas along road corridors.





Legend

- Major Road
- Minor Road
- ▭ Development Envelope
- ▭ Survey Area
- ▭ Banksia Woodlands of the Swan Coastal Plain TEC

BWSCP TEC Vegetation Condition

- Excellent
- Good

Paper Size ISO A3
 0 50 100 150 200
 Metres

Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 50



Main Roads
 Tonkin Grade Separated Interchanges

Banksia Woodlands of the
 Swan Coastal Plain TEC

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Table 3 Banksia Woodlands of the Swan Coastal Plain TEC – patches within the Survey Area

Patch No.	Vegetation Condition - Area (ha)				Total extent of Patch (ha)	Patch area within DE (ha)	Proportion of Patch to be cleared
	Excellent	Very Good	Good	Degraded			
1	–	1.39	–	–	1.39	0	0%
2	7.41	6.09	0.18	0.12	13.80	1.19	8.6%
3	0.17	0.68	0.87	0.43	2.15	2.15	100.0%
4	1.46	–	0.15	–	1.61	0.43	26.6%
5	4.34	–	–	–	4.34	0.22	5.0%
6	1.10	0.07	0.02	–	1.18	0	0%
7	3.15	0.31	–	–	3.46	0	0%
TEC extent within Survey Area (ha) by condition	17.63	8.54	1.22	0.55	27.93	3.99	-
Proportion of TEC within Survey Area	63.1%	25.6%	4.4%	2.0%	100%		
Proposed extent of clearing (DE area) by condition (ha)	0.97	1.34	1.21	0.47	3.99		
Proportion of total to be potentially cleared	5.5%	18.7%	99.0%	85.2%	14.3%		
TEC within Survey Area remaining outside of DE (ha)	16.66	5.81	0.01	0.08	23.94		
Proportion of TEC remaining outside DE	94.5%	81.2%	1.0%	14.8%	85.7%		

Table 4 Banksia Woodlands of the Swan Coastal Plain TEC – patches within the Development Envelope

Patch No.	Extent of TEC within DE (ha)	Vegetation Condition - Area (ha)			
		Excellent	Very Good	Good	Degraded
2	1.19	0.31	0.66	0.18	0.04
3	2.15	0.17	0.68	0.87	0.43
4	0.43	0.27	0	0.15	0
5	0.22	0.22	0	0	0
Total (ha)	3.99	0.97	1.34	1.21	0.47
Proportion of TEC within DE		24%	34%	30%	12%

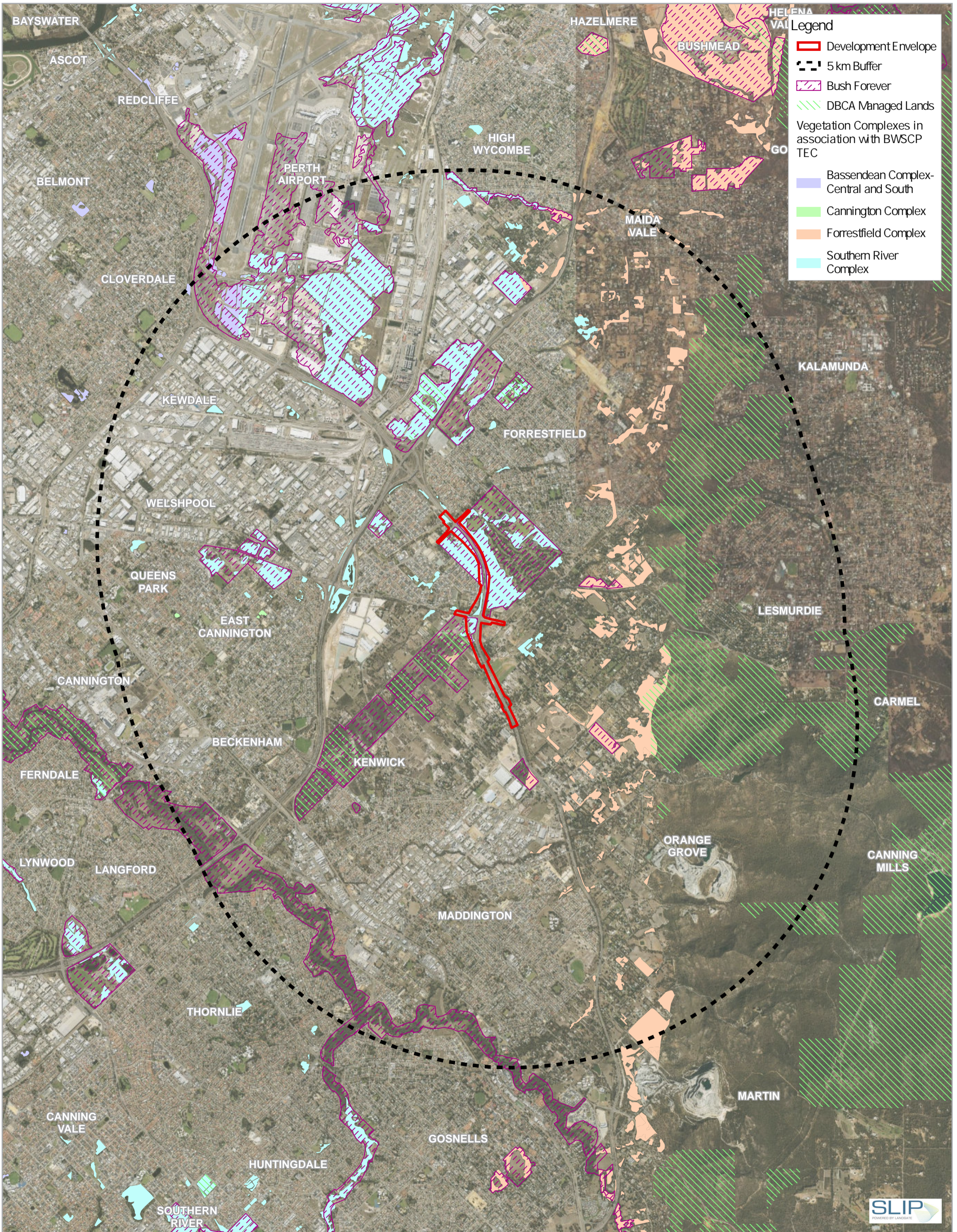
Local context

The local context for the BWSCP TEC was assessed through mapping of remnant vegetation complexes (Hedde *et al.* 1980) associated with the TEC, as identified in the Conservation Advice (TSSC 2016). The results of the assessment are presented in Table 5 and Figure 4.

Table 5 Banksia Woodlands of the Swan Coastal Plain TEC – local context

Complex	Association with TEC as per TSSC (2016)	Extent remaining within DE (ha)	Extent remaining within 5km of DE (ha)	Extent within 5km and within DBCA lands and/or Bush Forever	Proportion within 5km and within DBCA lands and/or Bush Forever	DE as a proportion of extent within 5km
Bassendean Complex – Central and South	Strong	–	21	17	81%	–
Cannington Complex	Moderate	–	2	–	–	–
Forrestfield Complex	Moderate	–	225	34	15%	–
Southern River Complex	Moderate	12	421	353	84%	2.8%
Total		12	667	404	60%	1.80%

As presented in Table 5 and Figure 4, there are areas of remnant vegetation complexes that may or are likely to contain TEC in the vicinity of the DE. Of the 667 ha of remnant vegetation that may contain TEC mapped within 5 km of the DE, approximately 404 ha (60%) lies within reserved lands.

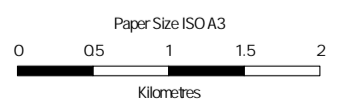


Legend

- Development Envelope
- 5 km Buffer
- Bush Forever
- DBCA Managed Lands

Vegetation Complexes in association with BWSCP TEC

- Bassendean Complex-Central and South
- Cannington Complex
- Forrestfield Complex
- Southern River Complex



Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 50



Main Roads
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Banksia Woodlands of the
 Swan Coastal Plain TEC - local context

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FIGURE 4

Adequacy of surveys undertaken

Woodman (2021) conducted the survey consistent with EPA (2016a) guidance and the Conservation Advice for BWSCP TEC (TSSC 2016) including:

- Spring survey with early and late sampling periods
- Identification of the surrounding context of patches.

The 193.64 ha Survey Area comprised 78.97 ha of native vegetation and the remainder comprised cleared or developed areas. Within the 78.97 ha of native vegetation Woodman (2021) established 33 quadrats and 48 relevés in all preliminary vegetation patterns discernible by initial aerial photograph interpretation, both to adequately sample variation in vegetation throughout the Survey Area and to ensure adequacy of sampling for vascular plant taxa. Woodman (2021) considered the number of quadrats and relevés established in the Survey Area to be an acceptable number given the limited amount of intact vegetation present. Woodman (2021) identified no major limitations to the survey within the 193.64 ha Survey Area, though they noted the lack of access within the wider area (outside the DE).

The GHD (2020) in-fill survey at Hale Road did not identify any Banksia woodland vegetation in the 0.73 ha Survey Area that could comprise the BWSCP TEC.

4.3.2 Tuart Woodlands and Forests of the Swan Coastal Plain Threatened Ecological Community

Description

The Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain (TWFS CP) is listed as Critically Endangered under the EPBC Act. The TEC is a woodland restricted to the SCP between Jurien in the north and Busselton in the South, including some remnant in the Perth metropolitan area. It is usually restricted to the Quindalup and Spearwood Dune formations close to the coast, but is found in some locations within the Bassendean Dunes (DEE 2019). An estimated 80-86% of this TEC has been lost, with the remaining fragments subject to ongoing threats due to land clearing (for urban development and mineral extraction), changes to climate and availability of water, invasion from weed species, and unsuitable burning regimes.

A key diagnostic feature of this TEC are the prominent Tuart trees within the canopy of the woodland. Other species which often present in association with the Tuart are Peppermint, Candlestick Banksia and Jarrah (DEE 2019).

Assessment of habitat and presence of community

The vegetation and flora surveys undertaken over the 193.64 Survey Area did not identify the TWFS CP TEC within or adjacent to the DE (Woodman 2021). Within the Survey Area, two Tuart trees were identified however these did not form continuous canopy cover and were not the dominant overstorey in any of the vegetation types described. TWFS CP TEC is not typically found on the Bassendean Dunes on the eastern fringe of the SCP, and is not expected to occur within the DE. No TWFS CP TEC is considered likely to be directly or indirectly impacted by the Proposed Action.

4.4 Threatened fauna

4.4.1 Black Cockatoos

Description of species

Carnaby's Cockatoo

Carnaby's Cockatoo (*Calyptorhynchus latirostris*) is listed as Endangered under the EPBC Act and is endemic to the south-west of Western Australia. Its range and abundance has significantly reduced due to land clearing for agriculture, forestry and urban development. It faces continuing threats on the SCP as important feeding habitat is cleared. The total population of Carnaby's Cockatoo has been estimated at a maximum of 60,000 (Saunders et al 1985) and more recently at around 40,000 (Department of Parks and Wildlife 2013). The population of the Perth-Peel region is estimated at about 13,000 birds (Peck et al. 2019).

Carnaby's Cockatoos breed in eucalypt woodlands between the Stirling Range and Three Springs. The Proposed Action is within the known breeding range of the species (DSEWPac 2012). The species nests in hollows in live or dead trees of *Eucalyptus salmonophloia* (Salmon Gum), *E. wandoo* (Wandoo), *E. gomphocephala* (Tuart), *E. marginata* (Jarrah), *E. rudis* (Flooded Gum), *E. loxophleba* subsp. *loxophleba* (York Gum), *E. accedens* (Powderbark), *E. diversicolor* (Karri) and *Corymbia calophylla* (Marri). Breeding occurs mainly from July to mid-December.

The breeding range of this species has undergone a shift since the middle of the last century to the west and south, with a more rapid shift in the past 10 to 30 years, moving into the Tuart forests of the SCP and the Jarrah Marri forests of the Darling Scarp (Johnstone and Kirkby 2009). The closest confirmed breeding site is located approximately 15 km to the south-east of the DE, in Jarrah forest at Canning National Park (T. Kirkby, pers. comm.).

Breeding success for Carnaby's Cockatoo is largely dependent on suitable feeding habitat adjacent to the nest site, to provide the necessary food for the survival of the chick. As breeding individuals forage no more than approximately 20 km from their nesting hollows, the presence of sufficient foraging resources close to breeding areas (particularly within a 12 km radius) is critical to its breeding success.

The species is a post-nuptial nomad with many individuals spending the non-breeding season on the SCP (including the Perth metropolitan region) from December to July. Some non-breeding individuals (usually juveniles) will remain on the SCP during the breeding season. The species feeds in the canopy and understorey. On the SCP, important foraging species consist of *Banksia attenuata*, *B. menziesii*, *B. grandis*, *B. ilicifolia*, *B. sessilis*, *B. prionotes*, Marri, Jarrah and non-native *Pinus* species (Valentine and Stock 2008, Higgins 1999).

Forest Red-tailed Black Cockatoo

The Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) (FRTBC) is listed as Vulnerable under the EPBC Act and is endemic to the southwest of Western Australia. This species is considered likely to be a regular migrant to the DE (Woodman 2021). The FRTBC occurs in one population of approximately 15,000 birds (DEWHA 2009).

FRTBC display erratic breeding activity in the summer and winter seasons, peaking from April to June and August to October (Johnston et al., 2013). The species primarily nests in hollows of large, mature Marri trees and to a lesser extent Jarrah, Blackbutt Bullich and Wandoo (Johnstone, Kirkby and Sarti 2013). Key breeding areas are within the Jarrah-Marri forest of the Darling Scarp/Plateau or adjacent areas of the SCP, with limited records on the western extent of the SCP (e.g. at Murdoch University and possibly Perry Lakes) (Johnstone et al., 2017). The

closest confirmed breeding site is approximately 7.5 km to the north-east of the DE, in Jarrah forest in Kalamunda National Park (T. Kirkby, pers. comm.)

The FRTBC is a canopy feeder, with a diet primarily consisting of seeds of Marri and Jarrah and, in recent times, the seeds of *Melia azedarach* (Cape Lilac) (Johnstone, Kirkby and Sarti 2017). Other, less important foods include *E. patens* (Blackbutt), Karri, *Allocasuarina fraseriana* (Sheoak), *Persoonia longifolia* (Snotty Gobble), *Hakea* spp., Tuart and *E. decipiens* (Johnstone, et al., 2017).

Baudin's Cockatoo

The Baudin's Cockatoo (*Calyptorhynchus baudinii*) is listed as Endangered under the EPBC Act and is endemic to the southwest of Western Australia. This species is generally found in woodland or forest habitat, but can be found in fragmented forests. The total population of the Baudin's Cockatoo is estimated at 12,500 individuals, and the species occurs mainly in flocks (up to 300 individuals) and occasionally larger aggregations (up to 1,200 individuals) at roosts (DPC 2015). They primarily nest in hollows of live or dead Karri (*Eucalyptus diversicolor*) Marri, Wandoo, and Tuart trees. This species breeds from August to March in the eucalypt forests of the south west (DSEWPac 2012). From March, the species flies north to the central and northern parts of the Darling Scarp for the non-breeding season. The species roosts in or near riparian environments or other permanent water sources. The closest confirmed breeding site is approximately 27 km to the south-east of the DE, in Jarrah forest in the Wungong catchment (T. Kirkby, pers. comm.).

The species forages in eucalypt species of mainly Jarrah, Marri and Karri, and proteaceous woodland and heath. They also feed on nectar, buds and flowers and strips bark from dead trees to search for beetle larvae.

Habitat assessment

Observation of presence

No Carnaby's Cockatoo or Baudin's Cockatoo were observed during the biological survey, however several Marri nuts and pine cones with chew marks consistent with Carnaby's Cockatoo were found along the road reserve and there were chew marks typical of Baudin's Cockatoo found adjacent to Tonkin Highway (Woodman 2021).

Several family groups of FRTBC were seen and heard during the biological survey, as well as evidence of chew marks on Marri nuts (Woodman 2021).

Breeding habitat

Black Cockatoo breeding habitat is considered to consist of tree species known to support breeding within the range of the species, which either have a suitable nest hollow or are of a suitable diameter at breast height (DBH) to develop a nest hollow (being greater than 500 mm DBH for most Eucalypts or 300 mm in the case of Wandoo and Salmon Gum) (DSEWPac 2012). The suitable DBH trees are referred to within this Preliminary Documentation as 'potential breeding trees', however this does not mean that such trees contain hollows or suitable hollows for nesting.

Woodman (2021) identified 139 potential breeding trees within the DE, based on suitable DBH (> 500 mm) and species known to support breeding. In addition, GHD (2020) identified two potential breeding trees along Hale Road. The 141 potential breeding trees identified in the DE are summarised in Table 6 and presented in Figure 5, Figure 6 and Figure 7.

Table 6 Potential Black Cockatoo breeding trees within the DE

Tree species	Number of potential breeding trees within DE (DBH > 500)	Number of trees with suitable hollows	Number of suitable hollows
Marri	91	-	-
Jarrah	5	-	-
Flooded Gum	31	-	-
Coastal Blackbutt	6	-	-
Stag	8	-	-
Total	141	0	0

Hollows within trees were assessed using a pole camera during October 2019, which coincides with the breeding period of the three species. Hollows were assessed for activity, evidence of chew-marks and suitable size/orientation. Woodman (2021) did not record any evidence of active nests or breeding. GHD (2020) recorded two potential habitat trees along Hale Road, both of which did not have hollows suitable for use.

Woodman (2021) recorded two trees within/adjacent to the DE that had hollows suitable for nesting. The northern of the two trees (a stag) lies within the western part of Hartfield Park and contains two hollows, one of which was one too shallow and the other was inaccessible (Woodman 2021). GHD (2021) later inspected the stag tree using a pole camera and determined that it does not contain any suitable hollows for Black Cockatoo nesting (Tree ID 281). This tree has numerous spouts that are blocked or in too small a limb to be suitable for Black Cockatoo use, and no evidence of hollow use by Black Cockatoos was recorded during the assessment (GHD 2021). The southern of the two trees (Coastal Blackbutt, Tree ID 204) lies at the south western end of the DE (south of Victoria Road in Kenwick) and contains one hollow, which was not able to be inspected by Woodman (2021). GHD (2021) inspected this tree and found that it was suitable for nesting by Black Cockatoos, however there was no evidence of hollow use (i.e. entrance chews or internal feature chews). The trunk of the southern tree (ID 204) lies just outside the DE boundary however its canopy and root zone lie within the DE and so it is mapped in Figure 5, Figure 6 and Figure 7. However, Main Roads will implement the Proposed Action to avoid any impacts to the tree hollow, root zone and canopy and so the southern tree (ID 204) is not included in the impact assessment.

The DE is not known breeding habitat for Black Cockatoos. The DE represents potential breeding habitat for Carnaby's Cockatoo and FRTBC, given the presence of potential breeding trees (mostly Marri) although no trees have hollows suitable for nesting, the presence of foraging habitat, and the proximity to the Darling Scarp which is known to support breeding by these species. The DE is unlikely to be current breeding habitat for the two species, given the lack of breeding recorded in the DE or in the eastern Perth Metropolitan Region on the SCP. The DE may potentially provide breeding habitat at some point in the future if Carnaby's Cockatoo and FRTBC breeding patterns change and move from the Jarrah forest onto woodland remnants in the eastern SCP, although this is considered unlikely.

The DE is unlikely to provide breeding habitat for Baudin's Cockatoo. Although the species uses the northern Jarrah forest and eastern fringes of the Perth Metropolitan Region for foraging during the winter, the species' known breeding areas and predicted breeding range predominantly lie within the southern Jarrah, Marri and Karri forests in the South-West region of WA (Johnstone et al., 2008). The closest breeding record for Baudin's Cockatoo is 27 km to the south-east at the Wungong catchment, where the species has been observed breeding in low numbers (T. Kirkby, pers. comm.).

Foraging habitat

The survey (Woodman 2021) recorded foraging residues from all three species of Black Cockatoo, with foraging predominantly on Marri nuts. Key foraging species were present including Marri, Jarrah, Sheok and *Banksia* spp,. The survey assigned foraging habitat value as a score out of six, as presented in Table 7 for all three species, and each species separately in Figure 5, Figure 6 and Figure 7.

The survey (Woodman 2021) indicated the DE comprises approximately 18.7 ha of moderate to low value (score 2 to 4) foraging habitat for Carnaby's Cockatoo, and 7.9 ha of high to moderate value (score 5) foraging habitat and 11.3 ha of moderate to low value (score 2 to 4) foraging habitat for Baudin's Cockatoo and FRTBC. The remainder of the DE (score 0 to 1) is not assessed as foraging habitat for Black Cockatoos.

Table 7 Black Cockatoo foraging habitat

Habitat score / value	Carnaby's Cockatoo		Forest Red-tailed Black Cockatoo		Baudin's Cockatoo	
	(ha)	Proportion	(ha)	Proportion	(ha)	Proportion
6: High	0.0	0.0%	0.0	0.0%	0.0	0.0%
5: High to moderate	0.0	0.0%	7.9	15.3%	7.9	15.3%
4: Moderate	15.0	29.2%	6.4	12.5%	6.4	12.5%
3: Moderate to low	1.9	3.8%	2.7	5.3%	2.7	5.2%
2: Low	1.8	3.4%	2.1	4.1%	2.2	4.2%
1: Negligible	2.8	5.4%	2.4	4.6%	2.4	4.6%
0: Nil	30.0	58.2%	30.0	58.2%	30.0	58.2%
Total	51.5	100.0%	51.5	100.0%	51.5	100.0%

Roosting habitat

Roosting habitat is defined as a suitable tree (generally the tallest) or a group of tall trees, native or introduced, usually close to an important water source, and within an area of quality foraging habitat within the range of the species (DSEWPaC 2012). Any areas with tall trees (particularly eucalypts, pines, in association with water bodies) may provide roost sites for Black Cockatoos.

No known roosting sites were recorded within the DE (Woodman 2021), despite observations of FRTBC throughout the day and evidence of recent foraging. One potential roost site was identified within the Survey Area in the vicinity of the Hartfield Golf Club.

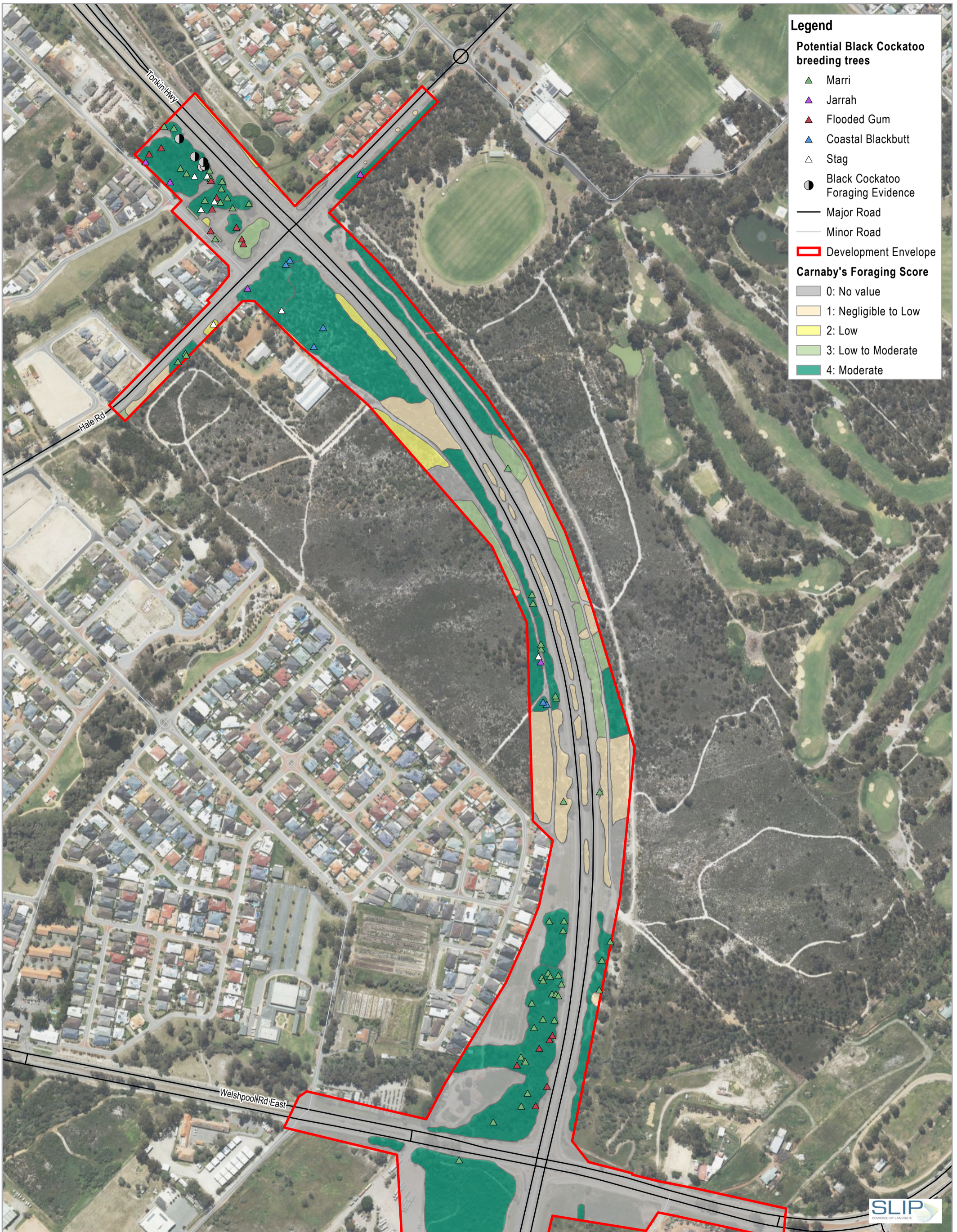
Figure 8 presents GPS tracking data for Baudin's Cockatoo and FRTBC collected by Murdoch University over a two month period in 2015. Night roosting was inferred from tracking data coordinates recorded over the period of 6:00pm to 6:00am. As presented in Figure 8, there were numerous inferred Baudin's Cockatoo night roosting records within 5 km (740 records) to 12 km (945 records) of the DE, however there were no night roosting records within or adjacent to the DE. The closest record for Baudin's Cockatoo was one location approximately 0.5 km south of the DE, and two locations at 1.2 km and 1.5 km east of the DE.

No inferred FRTBC night roosting was recorded within 5 km of the DE, however more than 820 records of FRTBC roosting were within 12 km of the DE, lying to the west in the vicinity of the Canning River and Swan-Canning Estuary.

Figure 8 presents potential roosting sites and confirmed roosting sites from the Great Cocky Count (DBCA 2019a). As presented, there are four confirmed roosting sites and approximately 15 un-confirmed or potential roosting sites within 5 km of the DE. The closest confirmed roosting site recorded from the Great Cocky Count lies in the Jarrah forest of the Darling Scarp to the

east. The closest potential roosting site recorded from the Great Cocky Count lies in Hartfield Park to the east of the DE.

Based on the survey results, Murdoch University GPS tracking data and the Great Cocky Count, the DE is not expected to comprise important roosting habitat for Black Cockatoos. Black Cockatoos that utilise habitat within the DE during the day are expected to return to established roosting sites on the Darling Scarp or elsewhere on the SCP.



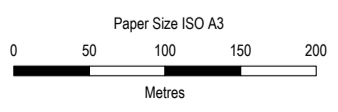
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Potential Black Cockatoo breeding trees

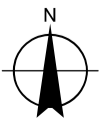
- ▲ Marri
- ▲ Jarrah
- ▲ Flooded Gum
- ▲ Coastal Blackbutt
- ▲ Stag
- Black Cockatoo Foraging Evidence
- Major Road
- Minor Road
- ▭ Development Envelope

Carnaby's Foraging Score

- 0: No value
- 1: Negligible to Low
- 2: Low
- 3: Low to Moderate
- 4: Moderate



Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 50



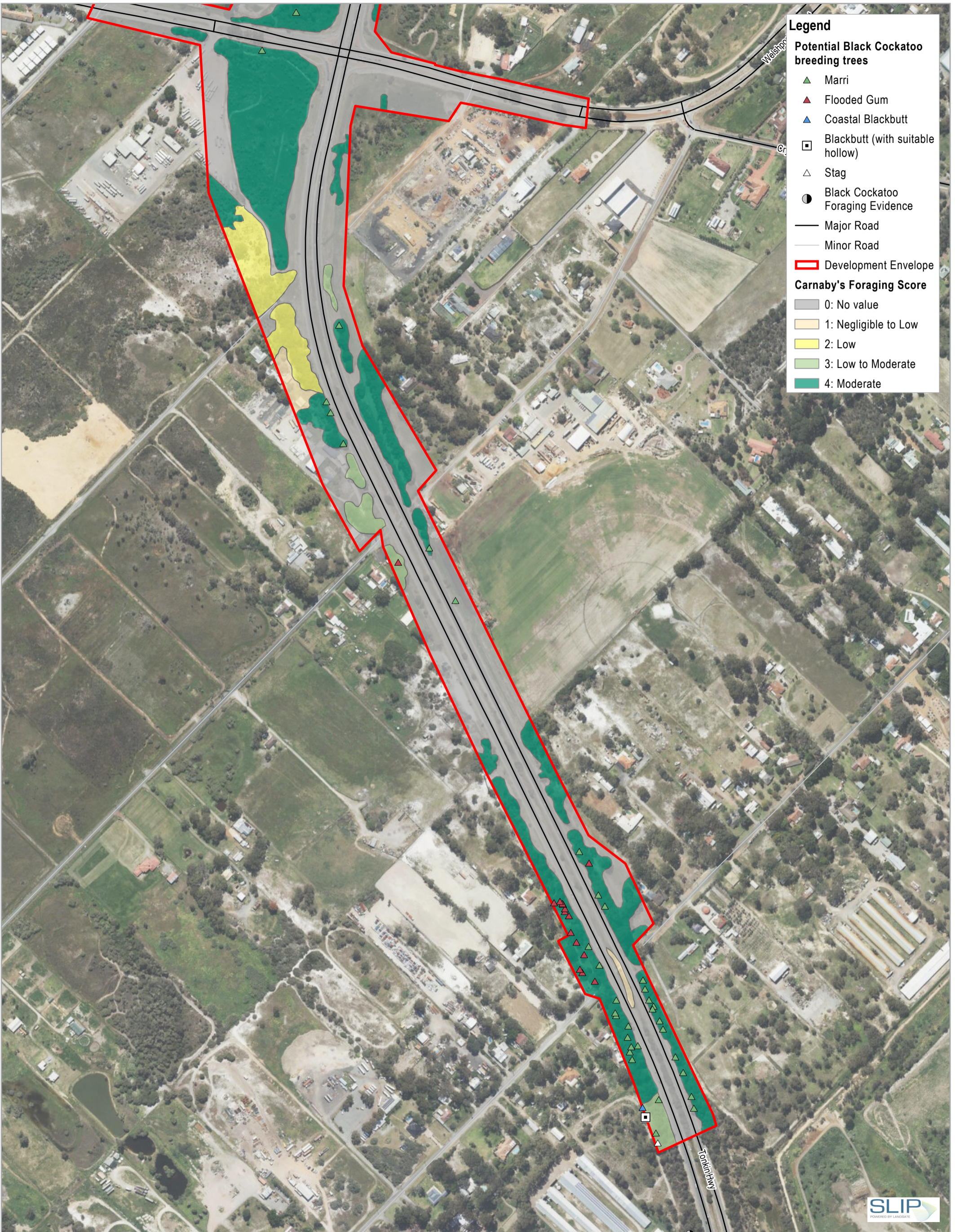
Main Roads
 Tonkin Grade Separated Interchanges

Carnaby's Cockatoo Foraging and Breeding Habitat

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 Print date: 18 Feb 2021 - 10:07

Data source: Landgate_Subscription_Imagery\WAnow: Landgate / SLIP; Woodman: Black cockatoo observations, trees and habitat ratings - 2020. Created by: mczeckaj



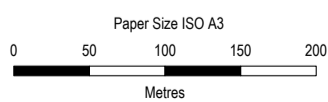
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Potential Black Cockatoo breeding trees

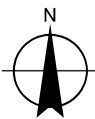
- ▲ Marri
- ▲ Flooded Gum
- ▲ Coastal Blackbutt
- Blackbutt (with suitable hollow)
- △ Stag
- Black Cockatoo Foraging Evidence
- Major Road
- Minor Road
- ▭ Development Envelope

Carnaby's Foraging Score

- 0: No value
- 1: Negligible to Low
- 2: Low
- 3: Low to Moderate
- 4: Moderate



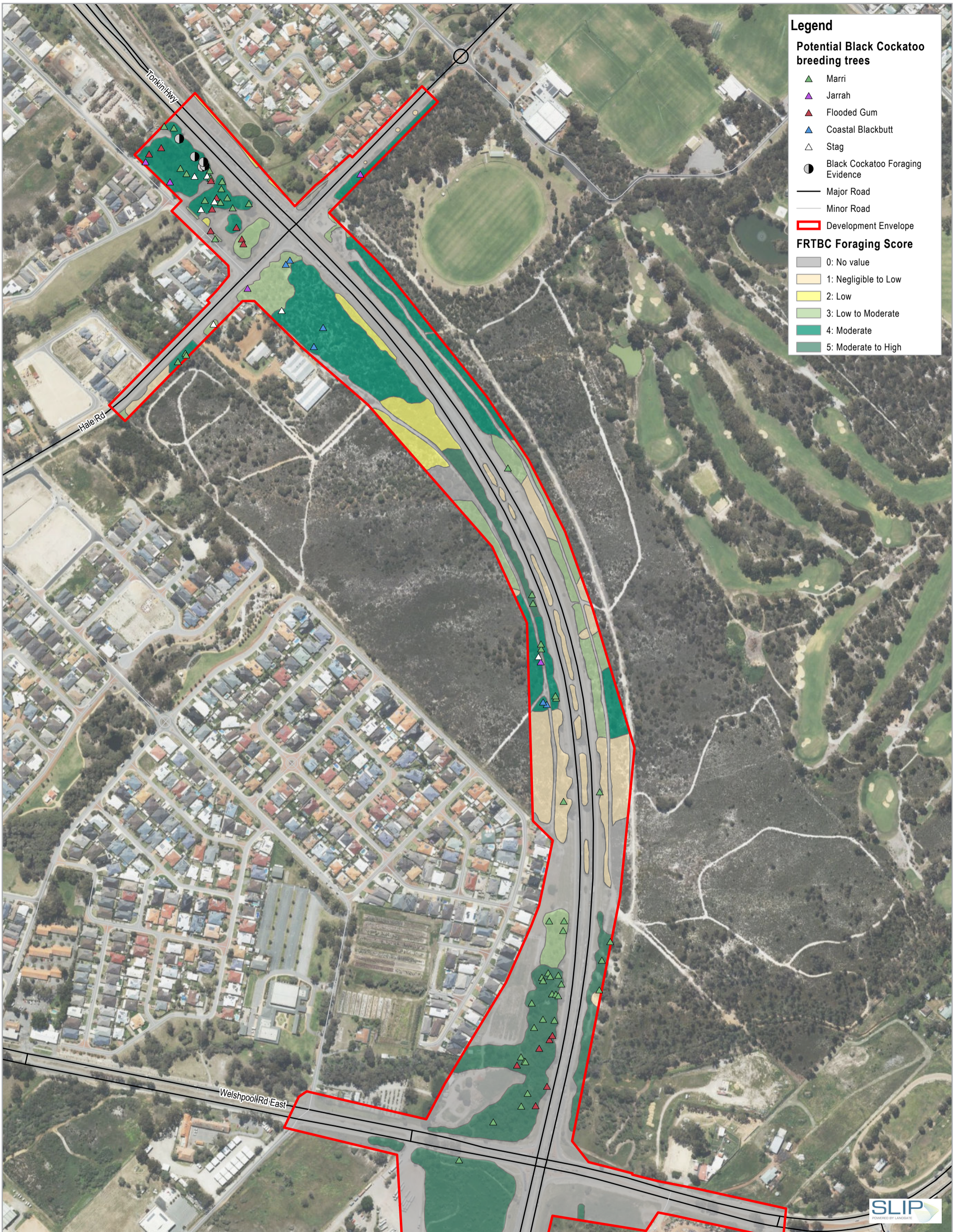
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Main Roads
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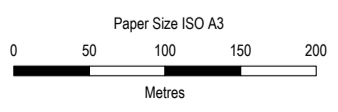
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Potential Black Cockatoo breeding trees

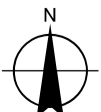
- ▲ Marri
- ▲ Jarrah
- ▲ Flooded Gum
- ▲ Coastal Blackbutt
- △ Stag
- Black Cockatoo Foraging Evidence
- Major Road
- Minor Road
- ▭ Development Envelope

FRTBC Foraging Score

- 0: No value
- 1: Negligible to Low
- 2: Low
- 3: Low to Moderate
- 4: Moderate
- 5: Moderate to High



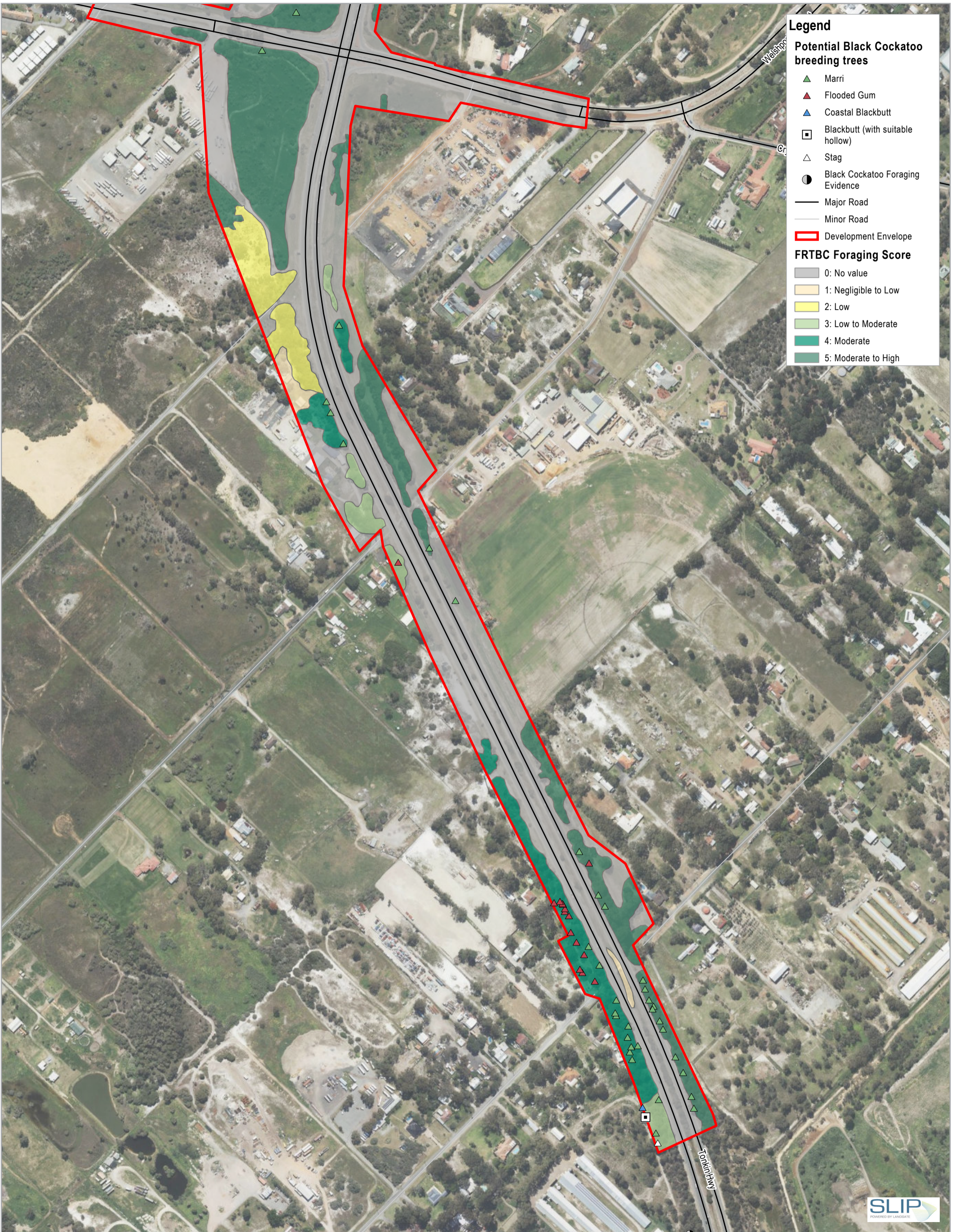
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 Grid: GDA 1994 MGA Zone 50



Main Roads
 Tonkin Grade Separated Interchanges

Forest Red-tailed Black Cockatoo Foraging and Breeding Habitat

Project No. 12523571
 Revision No. 0
 Date 2/18/2021



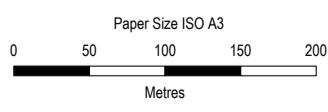
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Potential Black Cockatoo breeding trees

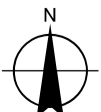
- ▲ Marri
- ▲ Flooded Gum
- ▲ Coastal Blackbutt
- Blackbutt (with suitable hollow)
- △ Stag
- Black Cockatoo Foraging Evidence
- Major Road
- Minor Road
- ▭ Development Envelope

FRTBC Foraging Score

- 0: No value
- 1: Negligible to Low
- 2: Low
- 3: Low to Moderate
- 4: Moderate
- 5: Moderate to High



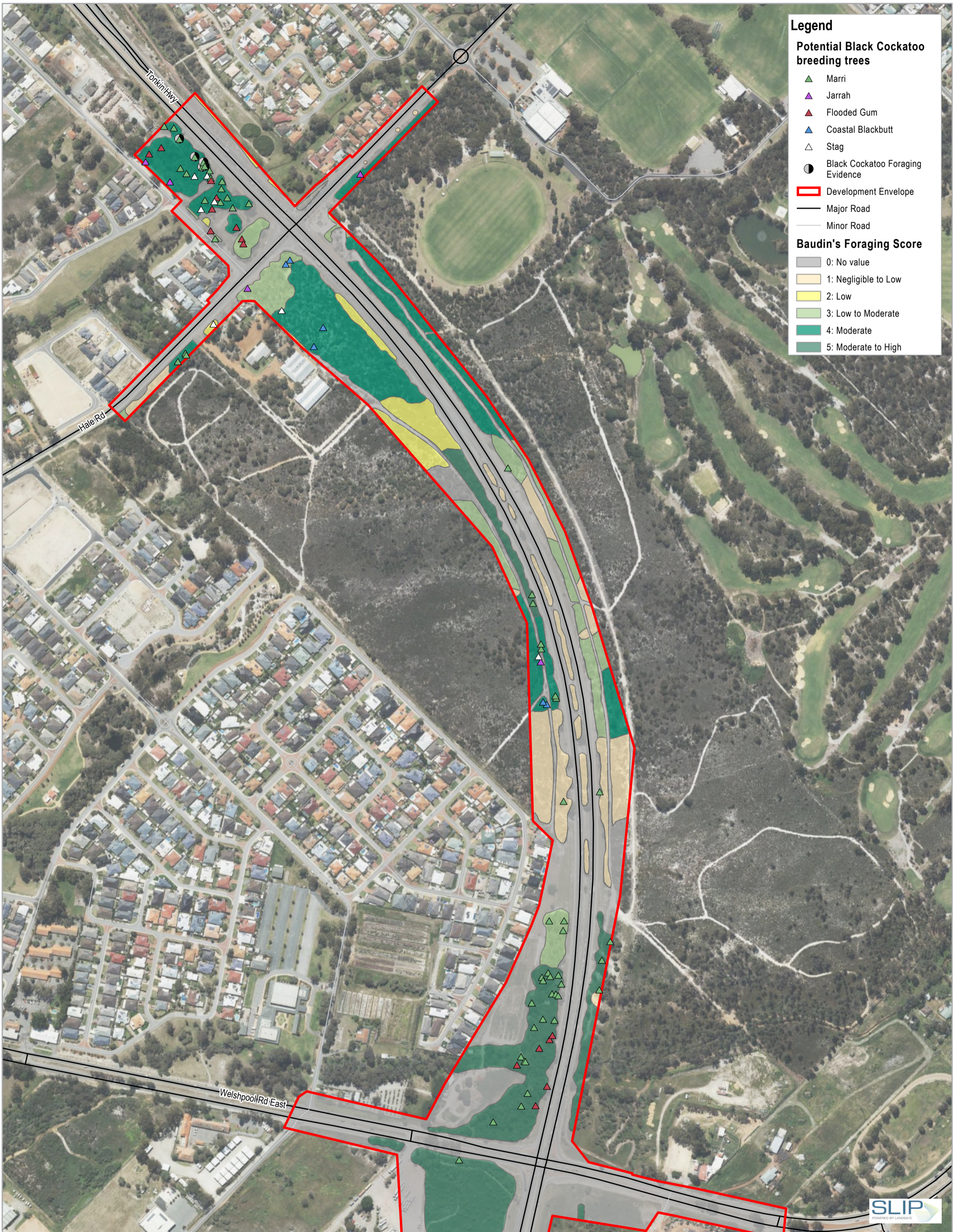
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Main Roads
 Tonkin Grade Separated Interchanges

Forest Red-tailed Black Cockatoo Foraging and Breeding Habitat

Project No. 12523571
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 Date 2/18/2021



Legend

Potential Black Cockatoo breeding trees

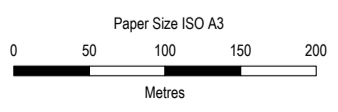
- ▲ Marri
- ▲ Jarrah
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- ▲ Coastal Blackbutt
- △ Stag
- Black Cockatoo Foraging Evidence

Development Envelope

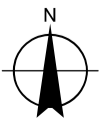
- Major Road
- Minor Road

Baudin's Foraging Score

- 0: No value
- 1: Negligible to Low
- 2: Low
- 3: Low to Moderate
- 4: Moderate
- 5: Moderate to High



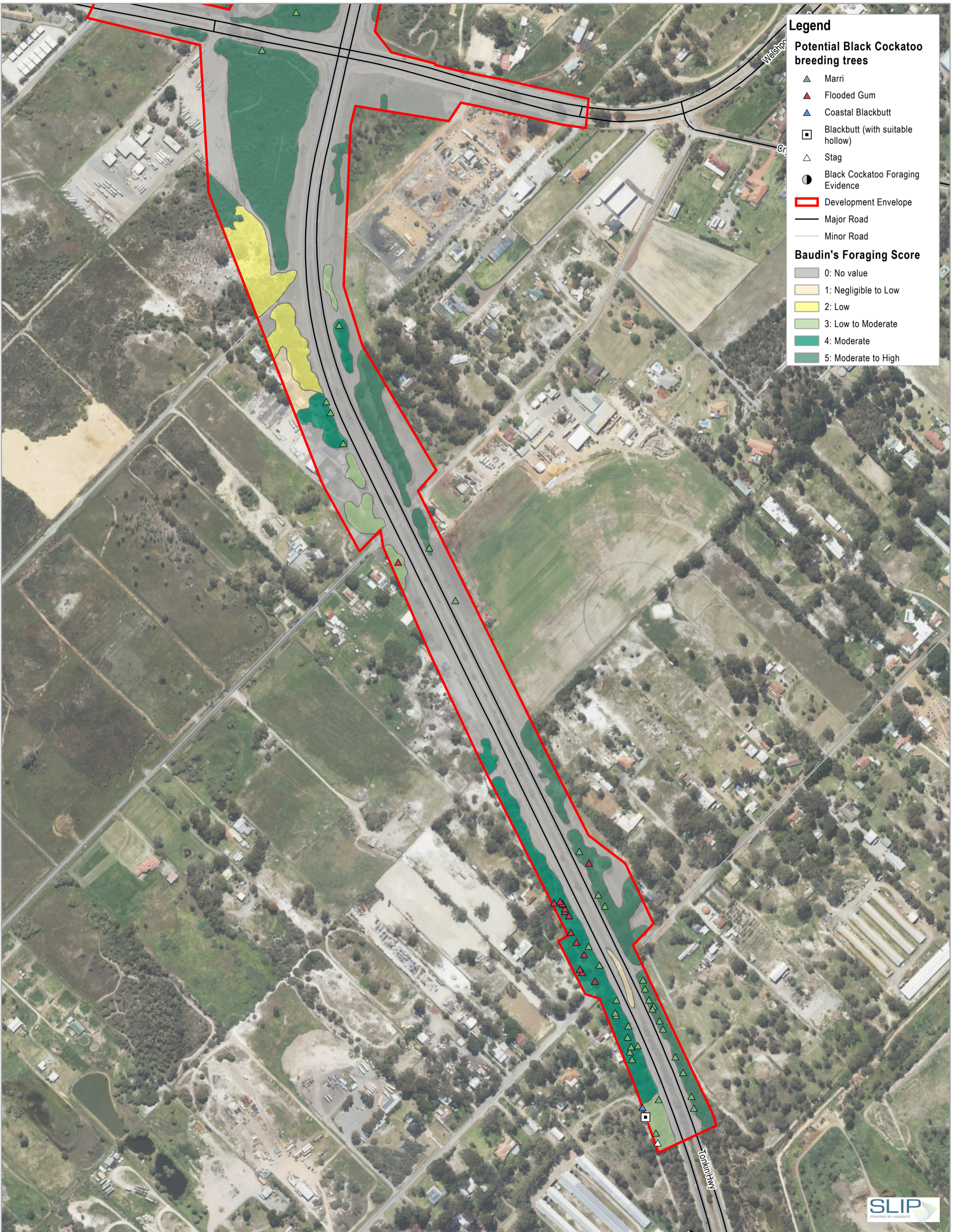
Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 50



Main Roads
 Tonkin Grade Separated Interchanges

Baudin's Black Cockatoo Foraging and Breeding Habitat

Project No. 12523571
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Legend

Potential Black Cockatoo breeding trees

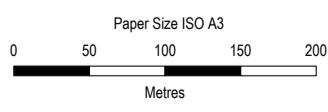
- ▲ Marri
- ▲ Flooded Gum
- ▲ Coastal Blackbutt
- Blackbutt (with suitable hollow)
- △ Stag
- Black Cockatoo Foraging Evidence

Development Envelope

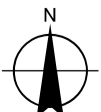
- Major Road
- Minor Road

Baudin's Foraging Score

- 0: No value
- 1: Negligible to Low
- 2: Low
- 3: Low to Moderate
- 4: Moderate
- 5: Moderate to High



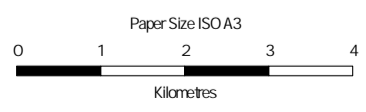
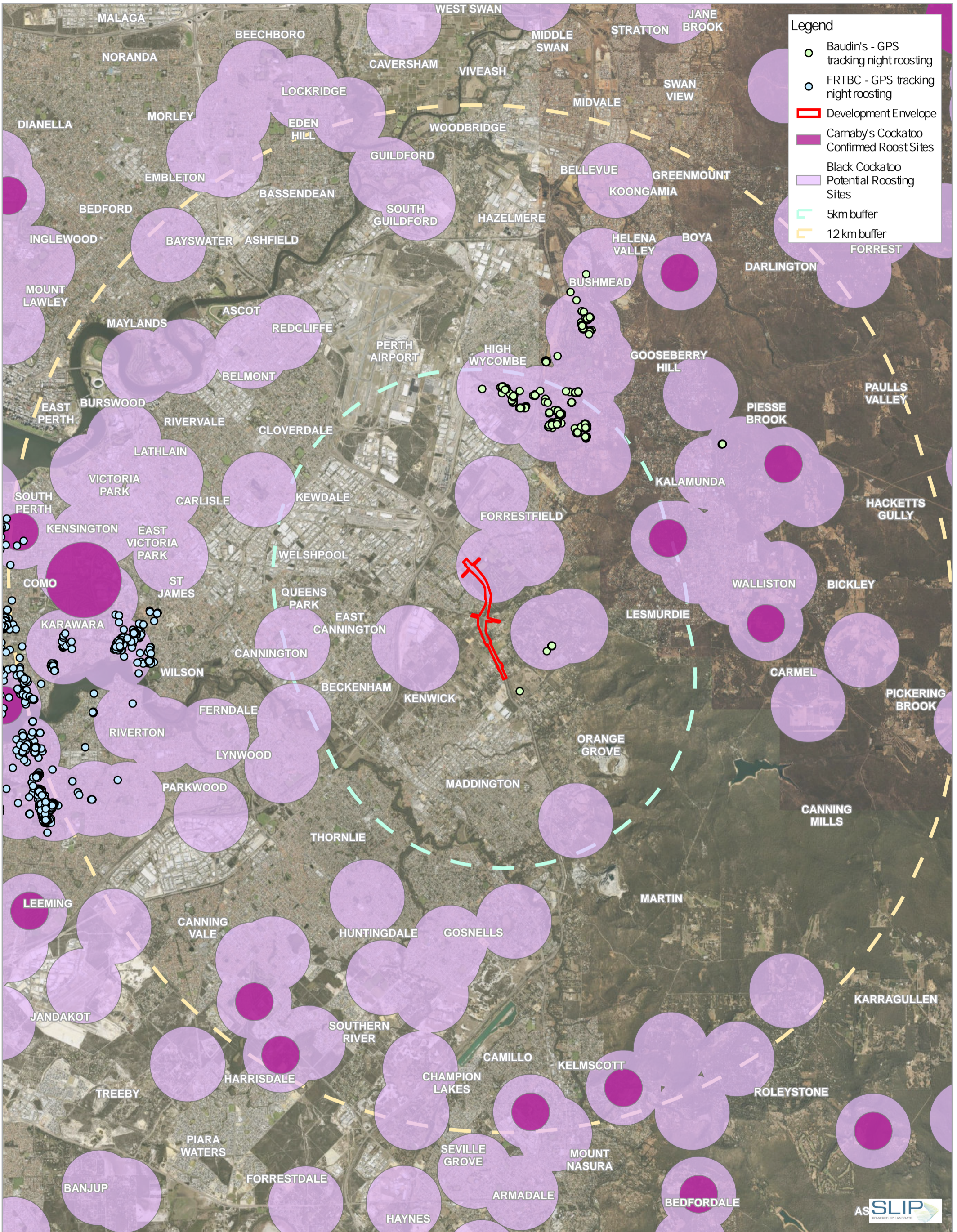
Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 50



Main Roads
 Tonkin Grade Separated Interchanges

Baudin's Black Cockatoo Foraging and Breeding Habitat

Project No. 12523571
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Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 50



Main Roads
 Tonkin Grade Separated Interchanges

Black Cockatoo Roosting

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FIGURE 8

Local and regional context

The Department of Parks and Wildlife (now DBCA) mapped potential Black Cockatoo habitat on the SCP as part of the Strategic Assessment of Perth and Peel Regions (SAPPR) (DPC 2015). The mapping for SAAPR identified Black Cockatoo habitat over the SCP as follows (DPC 2015):

- Carnaby's Cockatoo: 529,893 ha
- FRTBC: 205,647 ha
- Baudin's Cockatoo: 79,050 ha.

Figure 9 presents the local context for the Proposed Action, including potential foraging habitat for Black Cockatoos mapped for SAPPR (DPC 2015) and reserved areas within a 5 km distance. This indicates a potential habitat of 2582 ha within a distance of 5 km from the DE, of which 884 ha is on the SCP and 1698 ha on the Jarrah forest. Of the 2582 ha of Black Cockatoo habitat mapped within 5km of the DE, approximately 1421 ha (55%) lies within reserved lands.

Table 8 presents the impact of the Proposed Action on habitat loss at a local scale (within 5 km of the DE) and a regional scale (within the SCP), to enable an assessment of the cumulative impact of the Proposed Action with urbanisation on the SCP.

Table 8 Local and regional context habitat loss

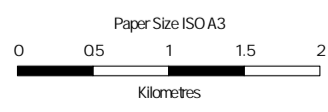
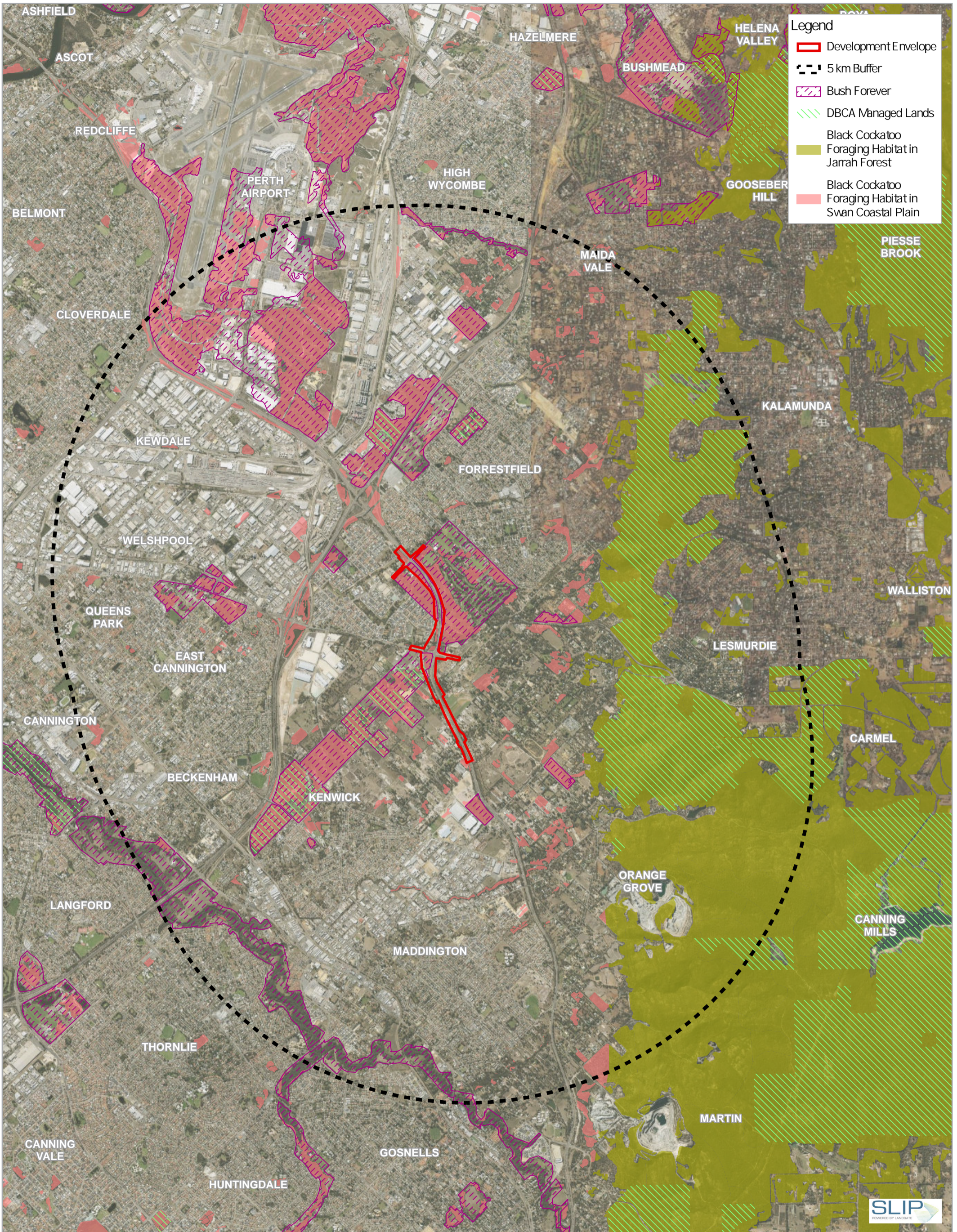
Species	Habitat loss due to Proposed Action	Proportion of habitat loss at a local scale ¹	Proportion of habitat loss at a regional scale ²
Carnaby's Cockatoo	Clearing of 18.7 ha moderate to low quality (score 2-4) foraging habitat 141 potential breeding trees, none of which have suitable hollows	0.73% of 2582 ha	0.004%
Forest Red-tailed Black Cockatoo	Clearing of 19.1 ha, including: <ul style="list-style-type: none"> • 7.9 ha high to moderate quality (score 5) foraging habitat • 11.3 ha of moderate to low quality (score 2-4) foraging habitat 141 potential breeding trees, none of which have suitable hollows	0.74% of 2582 ha	0.009%
Baudin's Cockatoo	Clearing of 19.1 ha, including: <ul style="list-style-type: none"> • 7.9 ha high to moderate quality (score 5) foraging habitat • 11.3 ha of moderate to low quality (score 2-4) foraging habitat 141 potential breeding trees, none of which have suitable hollows	0.74% of 2582 ha	0.024%

¹ Local scale represents Carnaby's Cockatoo habitat within 5 km, mapped under the Strategic Assessment of Perth and Peel Regions (DPC 2015).

² Regional scale represents Black Cockatoo habitat on the SCP, mapped under the Strategic Assessment of Perth and Peel Regions (DPC 2015).

Adequacy of surveys undertaken

The biological survey undertaken for the DE and its vicinity included a targeted Black Cockatoo habitat assessment in accordance with the EPBC Act referral guidelines (DSEWPac 2012). The field survey was undertaken in October and November 2019 during the breeding season and included observations of occupancy (visual and aural), foraging residues, foraging species, potential roosting trees, potential breeding trees and investigation of hollows. The entire DE was surveyed and mapped for habitat quality and breeding habitat.



Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50



Main Roads
Tonkin Grade Separated Interchanges

Black Cockatoo context

Project No. 12523571
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Date 28/10/2020

FIGURE 9

4.4.2 Australasian Bittern

Description

The Australasian Bittern (*Botaurus poiciloptilus*) is a large, partially nocturnal heron that reaches up to 75 cm in length and is listed as Endangered under the EPBC Act. The species has a mottled brown upper surface and buff under-surface, with dark brown stripes, except for a pale throat. The species favours permanent fresh to moderately brackish wetlands, with tall, dense beds of reeds and rushes, including bulrushes (*Typha* spp.) and spike-rushes (*Eliocharis* spp.). The species hides during the day amongst dense reeds and feeds mainly nocturnally on frogs, fish, yabbies, spiders and insects.

The species breeds in areas with shallow water (less than 30 cm deep) with a low to medium density of mixed water plants. The species is under threat from altered hydrology due to land use changes, climate change, bushfire and inappropriate fire regimes, habitat damage and predation. It is found in coastal and sub-coastal areas of the south-west of Western Australia. The population is likely to be less than 150 individuals (Pickering 2010, Silcocks 2010), and the population is dispersed over a large area.

Assessment of habitat and presence of species

Biological surveys have not identified this species within or adjacent to the DE (Woodman 2021, AECOM 2015, 360 Environmental 2018). The species was determined likely to occur within the area based on a desktop EPBC PMST search, however there are no records of this species within 5 km of the DE (Woodman 2021, DBCA 2018). The DE contains no suitable habitat for this species and no targeted surveys for the species were conducted.

The Greater Brixton Street wetlands that lie adjacent to the Tonkin Highway and Welshpool Road intersection comprise a Palusplain (seasonal waterlogged flats) rather than wetlands with standing water, and are not expected to provide important habitat for the species.

The Proposed Action is highly unlikely to cause significant impacts (either direct or indirect) to the species.

4.4.3 Short-tongued Bee

Description

The Short-Tongued Bee (*Leioproctus douglasiellus*) is listed as Critically Endangered under the EPBC Act. The species is a small black bee, with females 8 mm in length and with a wing length of almost 5 mm. The Short-Tongued Bee has a very restricted geographic distribution, only thought to occur in three locations within the Perth Metropolitan Region ranging from Cannington to Forrestdale (DSEWPac 2013). The species is thought to make burrows within clay soils in winter wet depressions, often in association with the plant species *Goodenia pulchella* or *Anthotium junciforme*.

The current extent of occurrence of the species is 24.3 km² (DSEWPac 2013). Due to significant alteration of a large portion of the SCP from threatening processes such as land clearance and inappropriate fire regimes, there has been an inferred decline in the area of suitable habitat for this species.

Assessment of habitat and presence of species

There have been three historical recorded sightings of this species within 5 km of the DE, the nearest of which is approximately 3 km to the south-west of the DE (1981 – 2006) (DBCA 2019b). The record 3 km to the south-west is within the southern end of the Greater Brixton Street Wetlands and is associated with clay pans and records of *Goodenia pulchella* and *Anthotium junciforme*. This suggests that portions of the Greater Brixton Street Wetlands closer

to the DE may potentially provide habitat for the bee species if claypans exist, though regional geology mapping suggests the wetlands are generally on sandy soils of the Bassendean Sands rather than clayey soils (Jordan 1986).

Biological surveys did not identify this species within the DE (Woodman 2021, AECOM 2015). Neither clay wetland habitat nor the associated *Goodenia pulchella* and *Anthnotium junciforme* flora species have been identified in the DE. Woodman (2021) did identify some clay soil areas within Hartfield Park (north-east section) however these soils are more associated with *Corymbia calophylla* and *Acacia pulchella* rather than typical winter wet depressions that favour the clay wetland habitat likely to support the Short-Tongued Bee. As the DE does not contain suitable habitat for this species, it is considered unlikely to occur and no targeted surveys for the species were conducted (Woodman 2021).

The Proposed Action is highly unlikely to cause significant direct impacts to the Short-tongued Bee and unlikely to cause significant indirect impacts.

4.5 Threatened flora

Three EPBC Act listed flora species were identified within the DE during the biological survey:

- Wavy-leaved Smokebush (*Conospermum undulatum*) - Vulnerable
- Slender Andersonia (*Andersonia gracilis*) – Endangered
- Summer Honeypot (*Banksia mimica*) – Endangered.

An additional three flora taxa were deemed potentially to occur and included in the request for Preliminary Documentation additional information but were not found during biological surveys:

- Purdie's Donkey Orchid (*Diuris purdiei*) – Endangered
- Glossy-leaved Hammer Orchid (*Drakaea elastica*) – Endangered
- King Spider Orchid (*Caladenia huegelii*) – Endangered.

4.5.1 Wavy-leaved Smokebush

Description

Conospermum undulatum is a long-lived erect shrub growing 1.5-2 m tall with distinctive fibrous stems and hairless leaves (WA Herbarium 1998–). The leaves taper towards the base and have three distinct, parallel veins. The species produces white wholly flowers in inflorescences between August and October. Although the species is a mass-flowering species, it has a low seed set and poor seed dispersal, evident by the frequent clumping of plants in populations (Delnevo *et al.* 2019). The species has high levels of seed infertility, perhaps due to a lack of pollinators. The germination rate for untreated fresh seed is 11%, resulting in a low translocation or germination success rate.

C. undulatum prefers sandy clay soils over laterite, or on flat or gently sloping sites in association with *Banksia* or jarrah and marri woodland between the Swan and Canning Rivers. Some plants have been recorded within slightly swampy habitats. Although the species is highly susceptible to habitat clearance, individuals have been recorded in degraded natural habitat.

C. undulatum is known from 29 populations occurring in fragmented remnant bushland, three of which occur within DBCA managed tenure including Kalamunda National Park and Korung National Park (DBCA 2007–). The estimated total population was 10,580 individuals in 2015 (DPC 2015).

The species is geographically restricted due to a loss of suitable habitat and is only found in fragmented remnant bushland in an area of approximately 72 km², including the foothills of the Darling Scarp.

Assessment of habitat and presence of species

The survey (Woodman 2021) identified approximately 7.45 ha of suitable habitat for *C. undulatum* within the DE. This area has been determined based on the area of VT1 and VT4 which were identified as the preferred habitat of this species (Figure 10).

C. undulatum primarily prefers vegetation type VT1, and to a lesser extent, VT4. Of the 7.45 ha of suitable habitat for *C. undulatum* identified within the DE (Figure 10), VT1 comprises 4.26 ha and VT4 comprises 3.20 ha (Woodman 2021). The majority of this habitat (71%) is in Good to Excellent condition, as presented in Table 9.

Table 9 Wavy-leaved Smokebush habitat

Vegetation type	Condition	Area within the DE (ha)
VT1	Excellent	0.97
	Very Good	1.34
	Good	1.20
	Degraded	0.73
VT4	Excellent	1.27
	Very Good	0.14
	Good	0.36
	Degraded	1.42
Total		7.45

VT1 represents FCT 20a: '*Banksia attenuata* woodland over species rich dense shrublands', which forms part of the EPBC listed BWSCP TEC (see Section 4.3.1).

A total of 1114 individuals were recorded from 778 locations during the targeted survey for this species, with 62 individuals from 58 locations recorded within the DE (Figure 10). These records represent three distinct populations, with two occurring within Hartfield Park to the East and West of Tonkin Highway, and one on the western road verge 200 m south of Victoria Road. It is considered unlikely that any further locations of this taxon occur in the DE (Woodman 2021). This taxon had previously been recorded in the Survey Area by AECOM (2015) and DBCA (2019c).

Figure 10 presents the habitat and individuals recorded in the Woodman (2021) survey and DBCA records within the DE and a 5 km distance. Figure 10 indicates that *C. undulatum* recorded within the DE are relatively clumped in dense populations, with much of the area mapped as habitat (VT1 and VT2) not containing recorded individuals and unlikely to contain unrecorded individuals (Woodman 2021).

Local context

Based on data extracted from DBCA databases, 89 records of 7568 individuals from 20 populations are recorded within 5 km of the DE (1997 – 2018) (see Figure 10). These populations have been recorded within remnant bushland, road reserves, Hartfield Park, Perth International Airport, and private property (DBCA 2019c).

The Proposed Action will remove 62 individuals, which comprises approximately 0.8% of the estimated population within 5 km of the DE, and approximately 0.6% of the total estimated population of the taxon.

Proposed avoidance and mitigation measures

As part of the additional information requested for the Preliminary Documentation, DAWE requested specific information on the proposed avoidance and mitigation of impacts to *C. undulatum* and how they will be consistent with the species' Recovery Plan.

It is not possible to design the Proposed Action to avoid all individuals and habitat of *C. undulatum*.

Avoidance and mitigation measures will be implemented to reduce the impact of the Proposed Action to *C. undulatum*, including measures to reduce the impact of habitat clearing (refer to Section 6). Avoidance measures will include pre-construction survey and demarcation of all individuals and populations to be retained, and mitigation measures to prevent potential edge impacts to populations and habitat from stormwater runoff, erosion, sediment, contaminant spills, dieback and weeds.

These measures will include Declared Rare Flora (DRF) markers, fencing of subpopulations and weed control adjacent to the DE, consistent with the Recovery Plan for the species (refer to Section 7).

An Offset Strategy will be devised to mitigate the significant residual impacts to *C. undulatum* (refer to Section 8). This will increase the number of *C. undulatum* in the conservation estate, consistent with the Recovery Plan for the species.

Adequacy of surveys undertaken

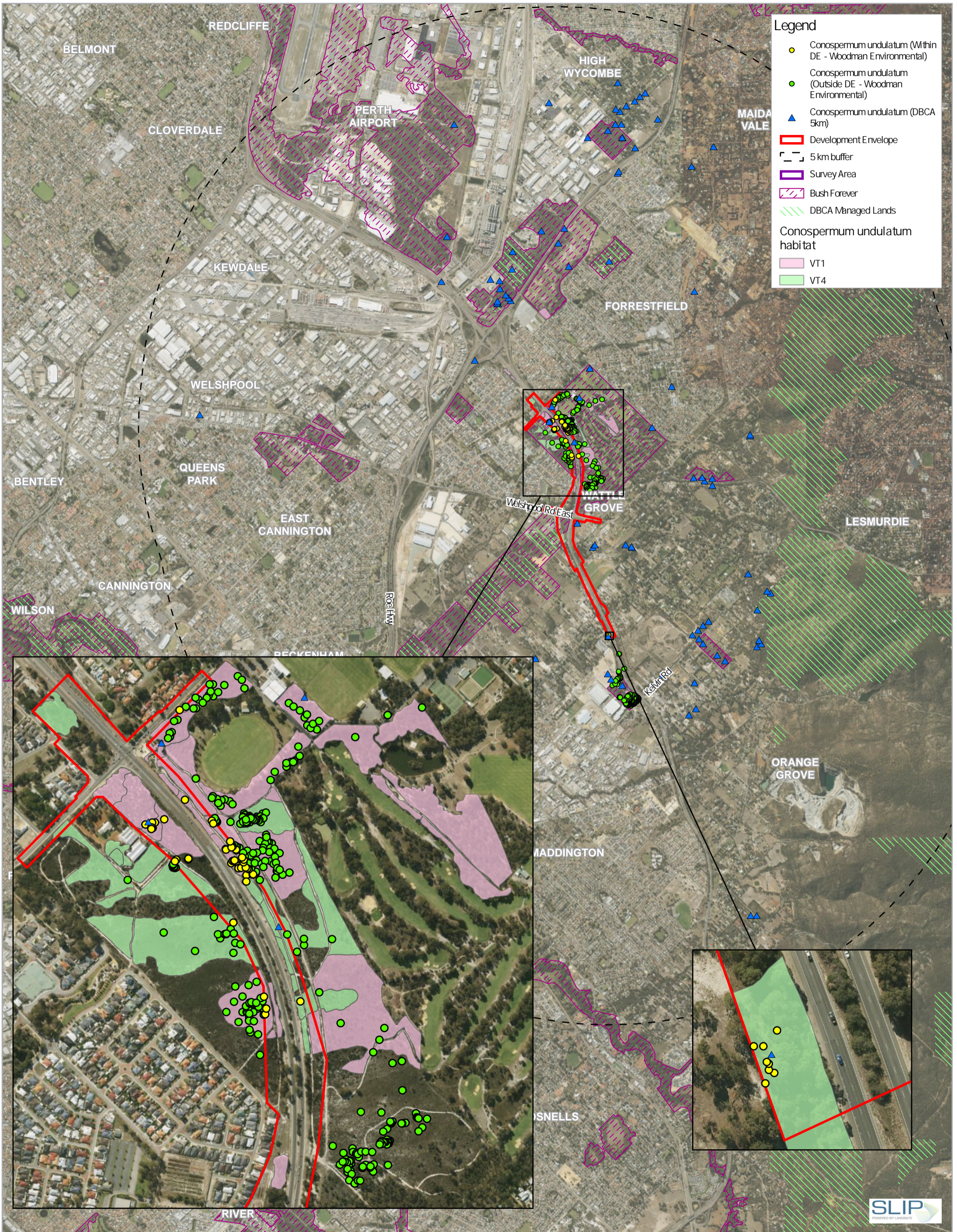
The potential presence of *C. undulatum* within and adjacent to the DE was identified through desktop reviews and previous surveys in the area (AECOM 2015). Contextual information for the Survey Area was available prior to the survey, including government databases (DBCA and DAWE), previous unpublished reports and data from the vicinity of the Survey Area (AECOM 2015; GHD 2015, Perth Airport 2018; Strategen 2019; 360 Environmental 2018) and numerous general sources pertaining to the climate, geomorphology, flora and vegetation of the SCP.

A targeted flora survey was undertaken for this species over 24 person days from August 2019 to March 2020 (Woodman 2021), which coincides with the species' flowering period. The survey included Winter, Spring and Summer survey periods. The majority of the survey was also conducted within what is considered to be the appropriate season for survey in the SCP bioregion (Spring). During the targeted survey for significant flora taxa, areas were searched on foot.

Methods, analysis and literature to assess values

As part of the additional information requested for the Preliminary Documentation, DAWE requested specific information on the methods, data analysis and scientific literature used to identify and assess the environmental values of *C. undulatum*. DAWE requested that survey data relating *C. undulatum* be as recent as possible and collected no more than 2 years before the date the draft Preliminary Documentation submitted to DAWE.

The significance of *C. undulatum* habitat was assessed based on data collected from within and surrounding the DE during field surveys, consideration of the approved Conservation Advice (DEC 2009a) and analysis of desktop assessments (NatureMap and Protected Matters Search results) undertaken in the biological survey (Woodman 2021) and peer reviewed published scientific literature (Delnevo et al. 2019a, Close et al. 2006). Woodman (2021) conducted a survey in the spring of 2019, no more than 12 months from the date of this Preliminary Documentation.



Wavy-leaved Smokebush
(Conospermum undulatum) -
Habitat and Local Context

FIGURE 10

4.5.2 Slender Andersonia

Description

Andersonia gracilis (Slender Andersonia) is a slender shrub, growing to 50 cm tall with few, spreading branches. The species produces pink to pale mauve flowers clustered in ovoid or oblong grounds of four to fourteen terminal heads, from September to November (DEC 2006).

The persistence of *A. gracilis* is contingent on the availability of soil-stored seed which germinates following fire, as adult plants are killed by fire. The species is also known to be highly susceptible to dieback disease (*Phytophthora cinnamomi*) (DEC 2006).

The species prefers seasonally damp, black sandy clay flats near or on the margins of swamps, often on duplex soils supporting low open heath vegetation with species such as *Calothamnus hirsutus*, *Verticordia densiflora* and *Kunzea recurva* over sedges.

There are 27 known populations, four of which occur in DBCA-managed tenure including an unnamed Conservation Park (R 49363), Kenwick Wetlands (R 49200 & R 50529) and Wongonderrah Nature Reserve (R 26248) (DBCA 2007–). The total population estimate is thought to be approximately 25,000 mature individuals (DPC 2015).

Andersonia gracilis is endemic to Western Australia and occurs over a wide geographic range from Perth (Kenwick wetlands) to Cataby in the north.

Assessment of habitat and presence of species

The survey (Woodman 2021) identified approximately 1.58 ha of suitable habitat for *A. gracilis* within the DE, corresponding to the extent of VT5 (Figure 11).

Andersonia gracilis prefers vegetation type VT5, which broadly consists of tall open shrubland of *Callitris pyramidalis* and *Adenanthos cygnorum* over mid sparse shrubland mixed species dominated by *Hakea* and *Melaleuca* species on brown and grey sand and sandy clay loam on lower slopes and flats. All of this habitat within the DE is in Good to Excellent condition, as presented in Table 10:

Table 10 Slender Andersonia habitat

Vegetation type	Condition	Area within the DE (ha)
VT5	Excellent	0.69
	Very Good	0.53
	Good	0.36
Total		1.58

The survey recorded 34 individuals at 15 locations, with a total of 11 individuals from ten locations within the DE (Figure 11). It is considered unlikely that any further locations of this taxon occur in the Survey Area (Woodman 2021). These records represent one discrete population, occurring within Hartfield Park to the west of Tonkin Highway. This species has not been previously recorded in the Hartfield Park area therefore this population is considered to be a new population.

Figure 11 presents the habitat and individuals recorded in the Woodman (2021) survey and DBCA records within the DE and a 5 km distance. Figure 11 indicates that *A. gracilis* recorded within the DE are clumped in a single population, with much of the area mapped as habitat (VT5) not containing further recorded individuals and unlikely to contain unrecorded individuals (Woodman 2021).

Local context

Based on data extracted from DBCA databases, only one record has previously been recorded within 5 km of the DE (1997 – 2018) (Figure 11). This record falls within Population 2, which has recorded up to 22 individuals and is listed as an important population within the Slender Andersonia Recovery Plan (DEC, 2006). This record also falls within the boundaries of Bush Forever Site ID 387 (Greater Brixton Street Wetlands).

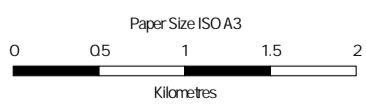
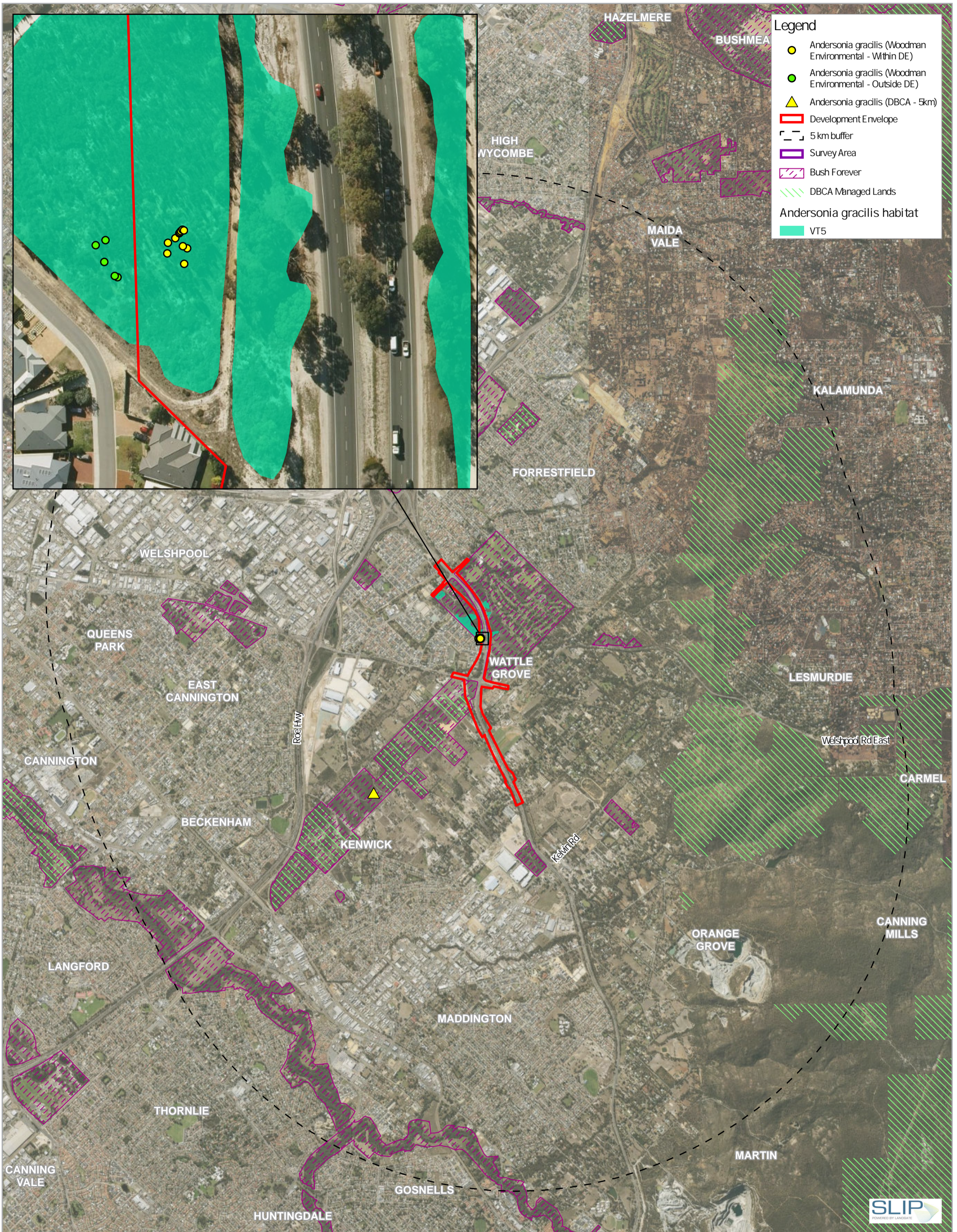
The Proposed Action will remove 11 individuals, which comprises approximately 20% of the estimated population of up to 56 individuals (34 recorded by Woodman [2020] plus 22 recorded previously) within 5 km of the DE, and approximately 0.04% of the total estimated population of 25,000 individuals.

Adequacy of surveys undertaken

Contextual information for the Survey Area was available prior to the survey, including government databases (DBCA and DAWE), previous unpublished reports and data from the vicinity of the Survey Area (AECOM 2015; GHD 2015, Perth Airport 2018; Strategen 2019; 360 Environmental 2018) and numerous general sources pertaining to the climate, geomorphology, flora and vegetation of the SCP.

A detailed and targeted flora and vegetation survey was undertaken by Woodman (2021) from August 2019 to March 2020. The survey included Winter, Spring and Summer survey periods.

Targeted flora surveys for *A. gracilis* were undertaken during the species' flowering period (September - November) (Woodman 2021). During the targeted survey for significant flora taxa, areas were searched on foot. The majority of the survey was also conducted within what is considered to be the appropriate season for survey in the SCP bioregion (Spring).



Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50



Main Roads
Tonkin Grade Separated Interchanges

Slender Andersonia
(Andersonia gracilis)
- Habitat and Local Context

Project No. 12523571
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Date 28/10/2020



FIGURE 11

4.5.3 Summer Honeypot

Description

Summer Honeypot (*Banksia mimica*), previously known as *Dryandra mimica*, is listed as Endangered under the EPBC Act. *Banksia mimica* is a prostrate, lignotuberous shrub with underground stems and leaves up to 41 cm long. The species produces yellow flowers with a tuft of long white hairs at the apex. Flowering occurs from December to February (Western Australian Herbarium 1998-).

Main threats to the species includes clearing for urban development, dieback caused by *Phytophthora cinnamomi*, and frequent fire, which can cause weed invasion and degradation of habitat.

Banksia mimica grows on flat to gentle slopes in grey and white sand in open woodlands. Associated vegetation includes *Andersonia* sp., *Stirlingia latifolia*, *Xanthorrhoea preissii*, *Leucopogon* sp., *Melaleuca thymoides* and *Petrophile* sp. (DPC 2015).

In the Darling Range and Mogumber, *Banksia mimica* occurs in mixed low heath with a *Banksia attenuata*/*B. menziesii* open low woodland over-storey. It is associated with species such as *Adenanthos cygnorum*, *Eucalyptus todtiana*, *Nuytsia floribunda*, *Jacksonia floribunda*, *Xanthorrhoea preissii*, *Banksia chamaephyton*, *Hakea conchifolia* and *Stirlingia latifolia* (Kelly et al. 1999).

The distribution of this species is not known to overlap with any EPBC Act-listed threatened ecological communities.

This taxon is known from 25 populations, 11 of which occur in DBCA-managed tenure including Blackwood State Forest, Boonanarring Nature Reserve, Fynes Nature Reserve, Jarrahwood State Forrest, Whicher National Park, Crown Freehold – Department Interest blocks - 1497/392, 2745/531, 2654/215 and un-named Nature Reserve (R 46899). The total population size is estimated to be over 7300 mature individuals (DEWHA 2008a).

B. mimica is endemic to Western Australia and is found over a range of approximately 320 km from south of Busselton to near Mogumber to the north (DBCA 2007–).

Assessment of habitat and presence of species

The survey (Woodman 2021) identified approximately 3.20 ha of suitable habitat for *B. mimica* was within the DE, corresponding to the extent of VT4 (Figure 12).

B. mimica prefers vegetation types VT4 and VT2 mapped in the biological survey. The DE does not intersect VT2. VT4 broadly consists of low open woodland of mixed species dominated by *Corymbia calophylla*, *Eucalyptus todtiana* and *Eucalyptus patens*, with grey sand and sandy loam on lower slopes and flats. VT2 broadly consists of mid sparse shrubland dominated by *Lambertia multiflora* var. *darlingensis* or *Hakea undulata* or *Hakea trifurcata* with landforms consisting of grey sand on lower slopes and flats (Woodman 2021). These habitats align with the preferred habitat outlined in the Approved Conservation Advice (DEWHA 2008a).

Approximately 56% (1.78 ha) of the VT4 within the DE was in Good to Excellent condition, as presented in Table 11.

Table 11 Summer Honeypot habitat

Vegetation type	Condition	Area within the DE (ha)
VT4	Excellent	1.27
	Very Good	0.14
	Good	0.36
	Degraded	1.42
Total		3.20

The survey recorded 30 individuals at 19 locations, with a total of three individuals from two locations within the DE (Figure 12). It is considered unlikely that any further locations of this taxon occur in the Survey Area (Woodman 2021). These records represent two discrete populations, occurring within Hartfield Park East and West of Tonkin Highway. Both populations have previously been recorded in the Survey Area and represent DBCA populations 15a and 15b (DBCA 2019b).

All populations of *B. mimica* are considered important populations (DPC 2015). The population within Hartfield Park (Population 15) contains 50% of the individuals of *B. mimica* that occur within the Perth Peel Region (DPC 2015).

Figure 12 presents the habitat and individuals recorded in the Woodman (2021) survey and DBCA records within the DE and a 5 km distance. Figure 12 indicates that *B. mimica* recorded within the DE is in one population, with much of the area mapped as habitat (VT4) not containing recorded individuals and unlikely to contain unrecorded individuals (Woodman 2021).

Local context

Based on data extracted from DBCA databases, five records of the taxon have previously been identified within 5 km of the DE (1990 – 2010) (Figure 11). These records comprise two populations, one of which (Population 15) lies in Hartfield Park and comprises 45 mature individuals, including some of those identified in the Survey Area, and the other of which (Population 3) lies to the south-east and comprises 20 recorded individuals (DPC 2015). These two populations are the only known populations of the taxon in the Perth Metropolitan Region (DPC 2015).

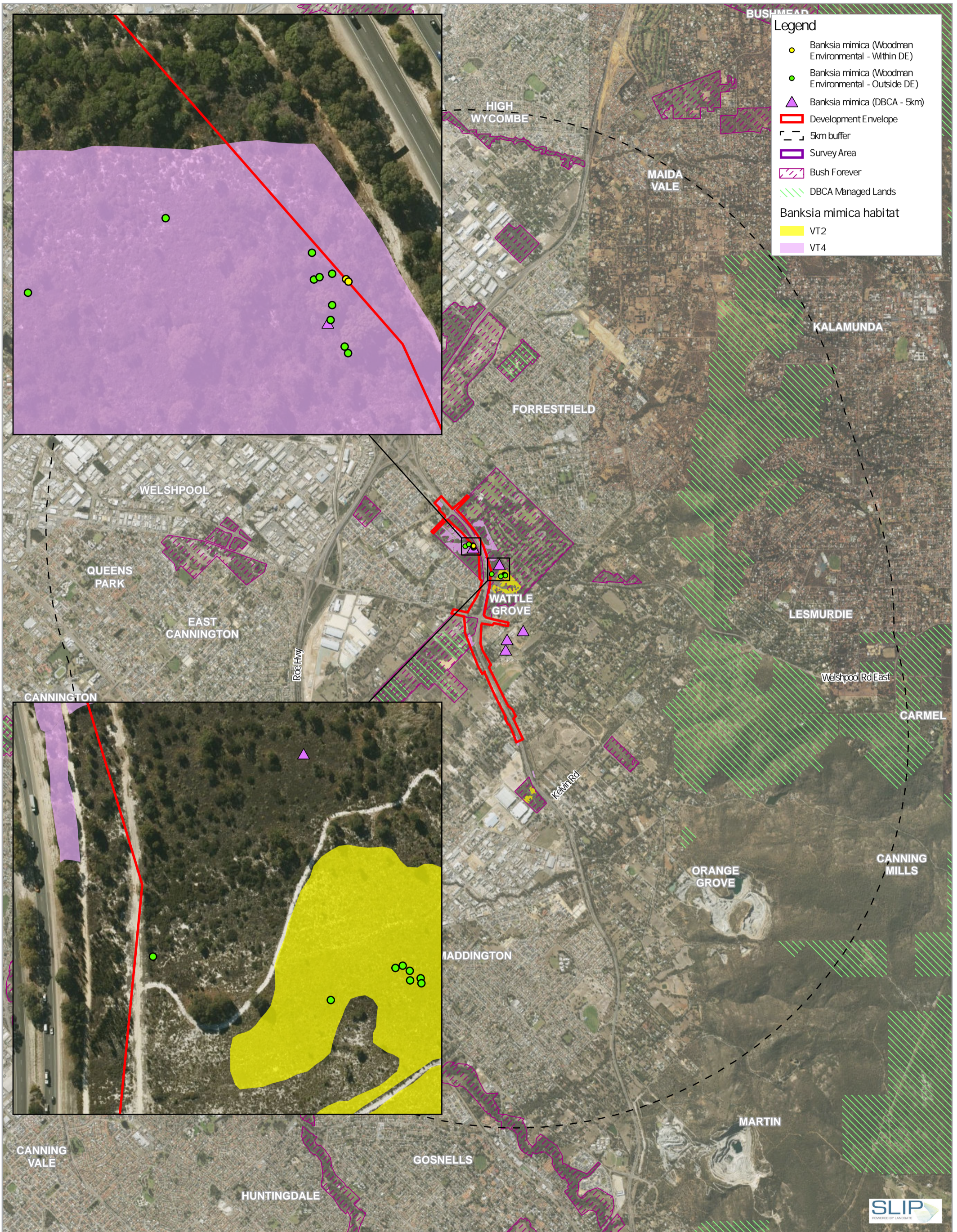
The Proposed Action will remove three individuals, which comprises approximately 5% of the known population of approximately 65 individuals within 5 km of the DE, and approximately 0.07% of the total estimated population of the taxon.

Adequacy of surveys undertaken

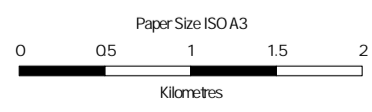
A detailed and targeted flora and vegetation survey was undertaken by Woodman (2021) from August 2019 to March 2020. The survey included winter, spring and summer survey periods and was consistent with EPA guidelines (2016a).

Targeted flora surveys for *B. mimica* were undertaken during the species' flowering period (December - February). During the targeted survey for significant flora taxa, areas were searched on foot.

The majority of the survey was also conducted within what is considered to be the appropriate season for survey in the SCP bioregion (Spring).



- Legend**
- Banksia mimica (Woodman Environmental - Within DE)
 - Banksia mimica (Woodman Environmental - Outside DE)
 - ▲ Banksia mimica (DBCA - 5km)
 - Development Envelope
 - 5km buffer
 - Survey Area
 - Bush Forever
 - DBCA Managed Lands
- Banksia mimica habitat**
- VT2
 - VT4



Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 50



Main Roads
 Tonkin Grade Separated Interchanges

Summer Honeypot
 (Banksia mimica)
 - Habitat and Local Context

Project No. 12523571
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FIGURE 12

4.5.4 King Spider-orchid

Description

King Spider-orchid (*Caladenia huegelii*) is listed as Endangered under the EPBC Act.

C. huegelii is a tuberous, perennial, herb, growing 0.25-0.6 m high. The flower is characterised by a greenish-cream labellum, with a maroon tip that curve backward. The flowering period is from September to October and the species grows in grey or brown sand and clay loam (Western Australian Herbarium, 1998–). The species typically occurs as a solitary plant rather than growing in clumps.

C. huegelii prefers areas of mixed woodland of Jarrah, Banksia with scattered Sheoak and Marri, usually in deep grey-white sand within 20 km of the coast (DEC, 2009b).

The species is known from 50 extant populations with a total of 1,340 mature plants (DPC 2015). There are 41 records (approximately 635 plants) of this species in the WA Herbarium database (Western Australian Herbarium, 1998–). More current abundance and distribution data for this species is not available. The largest population occurs in Jandakot, south of Perth.

C. huegelii has been recorded from the Jarrah Forest and SCP IBRA regions in Jarrah-Banksia woodland, within 20 km of the coast from north of Perth to the Busselton area (DEC 2009b). It occurs in scattered localities within 20 km of the coast, from the Upper Swan and Gngangara areas north of Perth to the Margaret River area in the south. Extensive urban and agricultural clearing has reduced its areas of occupancy and it is now restricted to remnant bushland.

Assessment of habitat and presence of species

C. huegelii was not identified during the biological survey (Woodman 2021). This species was considered unlikely to occur due to a lack of suitable habitat within the Survey Area (Woodman 2021). The majority of the survey was conducted within what is considered to be the appropriate season for survey in the SCP bioregion (Spring). Naturemap (DBCA 2007-) indicates one record of *C. huegelii* within 5km of the DE. This record is located approximately 3.8 km west of the DE.

The species was not observed in previous surveys (AECOM 2015). Although this species was deemed unlikely to occur within the DE and the immediate surrounding area, a targeted survey was undertaken for the DE in the spring of 2020 (GHD 2021, Appendix E). Despite the targeted search, no individuals of *C. huegelii* were recorded within the DE (GHD 2021, Appendix E).

Due to the lack of habitat, lack of records and the unlikely presence, the Proposed Action is highly unlikely to significantly impact (directly or indirectly) *C. huegelii*.

4.5.5 Purdie's Donkey-orchid

Description

Purdie's Donkey-orchid (*Diuris purdiei*) is listed as Endangered under the EPBC Act.

D. purdiei is a slender, terrestrial orchid growing up to 45 cm tall. The species produces unusual flattened flowers, which are prominently marked with brown blotches on their under surface. Flowering occurs from late September to mid-October, but only after a summer or early autumn fire (Brown et al. 1998). The plant dies back to cylindrical underground tubers over summer.

The species prefers sandy soils in low-lying areas subject to winter inundation. Plants grow in dense heath with scattered emergent paperbark (*Melaleuca pressiana*) and Christmas trees (*Nutsia floribunda*). Extensive clearing has reduced the habitat available to Purdie's donkey orchid, which is only known in scattered vegetation.

D. purdiei is known from 18 populations in Western Australia. Due to difficulty in detecting this species (as it only flowers following fire) current population estimates are unknown and population sizes are indicative only (DPC 2015).

The species occurs in Western Australia, from Perth south to near the Whicher Range, within the Perth Metropolitan, Peel and South West Regions. The distribution of this species is not known to overlap with any EPBC Act-listed threatened ecological communities.

Assessment of habitat and presence of species

A likelihood of occurrence assessment deemed this species as unlikely to occur due to a lack of suitable habitat within the Survey Area (Woodman 2021). There is one record of *D. purdiei* within 5km of the DE. This record is located approximately 1.6 km south west of the DE within the Greater Brixton Street Wetlands Bush Forever Site ID 387 and was observed in 2007.

The species was not identified during the biological survey (Woodman 2021). Although this species was deemed unlikely to occur within the DE and the immediate surrounding area, a targeted survey was undertaken for the DE in the spring of 2020 (GHD 2021, Appendix E). Despite the targeted search, no individuals of *D. purdiei* were recorded within the DE (GHD 2021).

Due to the lack of habitat, lack of records and the unlikely presence, the Proposed Action is highly unlikely to significantly impact (directly or indirectly) *Diuris purdiei*.

4.5.6 Glossy-leafed Hammer Orchid

Description

Glossy-leafed Hammer Orchid (*Drakaea elastica*) is listed as Endangered under the EPBC Act.

The Glossy-leafed Hammer orchid is a slender stemmed orchid endemic to Western Australia. The species grows to 30 cm high with a single, distinctly glossy, bright green, heart shaped leaf. It is found on the SCP from Cataby in the north to Busselton in the south. The flowering period is from October to November. The plant dies back to an underground tuber over summer.

Habitat preference includes white or grey sand in low-lying areas adjoining winter wet swamps (Western Australian Herbarium, 1998–). The species typically occurs in banksia woodland or Spearwood thicket vegetation and often with other orchid species such as *Drakaea glyptodon* (King-in-his-Carriage), *D. livida* (Warty Hammer Orchid) and *Paracaleana nigrita* (Flying Duck Orchid) (DEC 2009c).

A total of 33 populations of *D. elastica* are known in Western Australia and the estimated total population size is 4700 individuals. This species has been recorded from the SCP IBRA region, with populations identified between Cataby in the north to Busselton in the south (Brown et al., 2008, DEC 2009c).

Assessment of habitat and presence of species

This species is considered unlikely to occur due to a lack of suitable habitat within the Survey Area (Woodman 2021). Despite survey effort during the optimum flowering period, the species was not observed within the Survey Area (Woodman 2021). It is therefore considered unlikely that *D. elastica* occurs in the Survey Area.

Although this species was deemed unlikely to occur within the DE and the immediate surrounding area, a targeted survey was undertaken for the DE in the spring of 2020 (GHD 2021, Appendix E). Despite the targeted search, no individuals of *D. elastica* were recorded within the DE (GHD 2021, Appendix E).

Due to the lack of habitat, lack of records and the unlikely presence, the Proposed Action is highly unlikely to significantly impact (directly or indirectly) *D. elastica*.

5. Assessment of Impacts

5.1 Potential impacts

5.1.1 Direct impacts

The Proposed Action will result in the following direct impacts:

- Clearing of up to 3.99 ha of BWSCP TEC
- Loss of Black Cockatoo habitat including:
 - Clearing of up to 141 potential breeding trees for Black Cockatoos, none of which contain hollows suitable for Black Cockatoo nesting
 - Clearing of up to 18.7 ha moderate to low value foraging habitat for Carnaby's Cockatoo
 - Clearing of up to 7.9 ha of high to moderate value foraging habitat and 11.3 ha of moderate to low value foraging habitat for Baudin's Cockatoo and FRTBC
- Loss of known conservation significant flora and habitat, including:
 - Loss of up to 62 individuals of *Conospermum undulatum* and 7.45 ha of suitable habitat
 - Loss of up to 11 individuals of *Andersonia gracilis*
 - Loss of three individuals of *Banksia mimica*

The Proposed Action will not result in impacts to known or potential nesting hollows or roosting sites for Carnaby's Cockatoo, FRTBC or Baudin's Cockatoo.

The above estimates are conservative, representing the full extent of MNES values within the 51.5 ha DE. The actual clearing footprint is expected to be less and will be refined through the detailed design and construction planning process.

5.1.2 Indirect impacts

The Proposed Action has potential to cause indirect impacts to BWSCP TEC, Black Cockatoo habitat and threatened flora individuals and habitat that lies adjacent to the DE.

DAWE, in their request for additional information, considered that the Proposed Action may result in indirect impacts including:

- Fragmentation of habitat or construction of barriers which impede fauna movement
- Introduction and/or spread of weeds
- Introduction and/or spread of *Phytophthora cinnamomi* Dieback
- Increased risk of vehicle strike.

The Proposed Action is not expected to cause significant indirect impacts to BWSCP TEC, Black Cockatoo and threatened flora individuals and habitat, with discussion provided for each indirect impact below.

Fragmentation of habitat or construction of barriers which impede fauna movement

The Proposed Action will not fragment fauna habitat or construct barriers that impede fauna movement. The Proposed Action comprises the upgrade of an existing road. Habitat to the West and East of the DE was fragmented in the past by the original construction of Tonkin Highway and previous land uses (e.g. clearing for agriculture). The Proposed Action will not cause habitat

fragmentation or further fragment existing habitat. The existing Tonkin Highway is a barrier to fauna movement. The Proposed Action will not further impede fauna movement beyond the existing impediment.

There are no ground dwelling threatened fauna species listed under the EPBC Act that are expected to occur in the DE or its vicinity. Accordingly, the Proposed Action is highly unlikely to cause significant impacts to MNES due to impeded fauna movements from fragmentation of habitat or construction of barriers.

The only EPBC Act listed fauna species that are expected (known) to occur in the DE and its vicinity are Black Cockatoos, which are highly mobile and widely-distributed. Black Cockatoos are not expected to be impeded by the widening of a road corridor or installation of barriers.

Introduction and/or spread of weeds

The construction and operation phases of the Proposed Action have the potential to result in the spread of introduced weeds through activities such as clearing, and the increased movement of vehicles, or earth-moving machinery.

Woodman (2021) recorded 68 introduced taxa in the biological survey, of which 32 were found within the DE. Four of the introduced taxa within the DE are Declared Pest weed species under the Western Australian *Biosecurity and Management Act 2007* and two are a Weed of National Significance (WoNS):

- *Asparagus asparagoides* (Bridal Creeper) – Declared Pest and WoNS
- *Echium plantagineum* (Paterson's Curse) – Declared Pest
- **Moraea flaccida* (One-leaf Cape tulip) – Declared Pest
- **Opuntia stricta* (Common Prickly Pear) – Declared Pest and WoNS

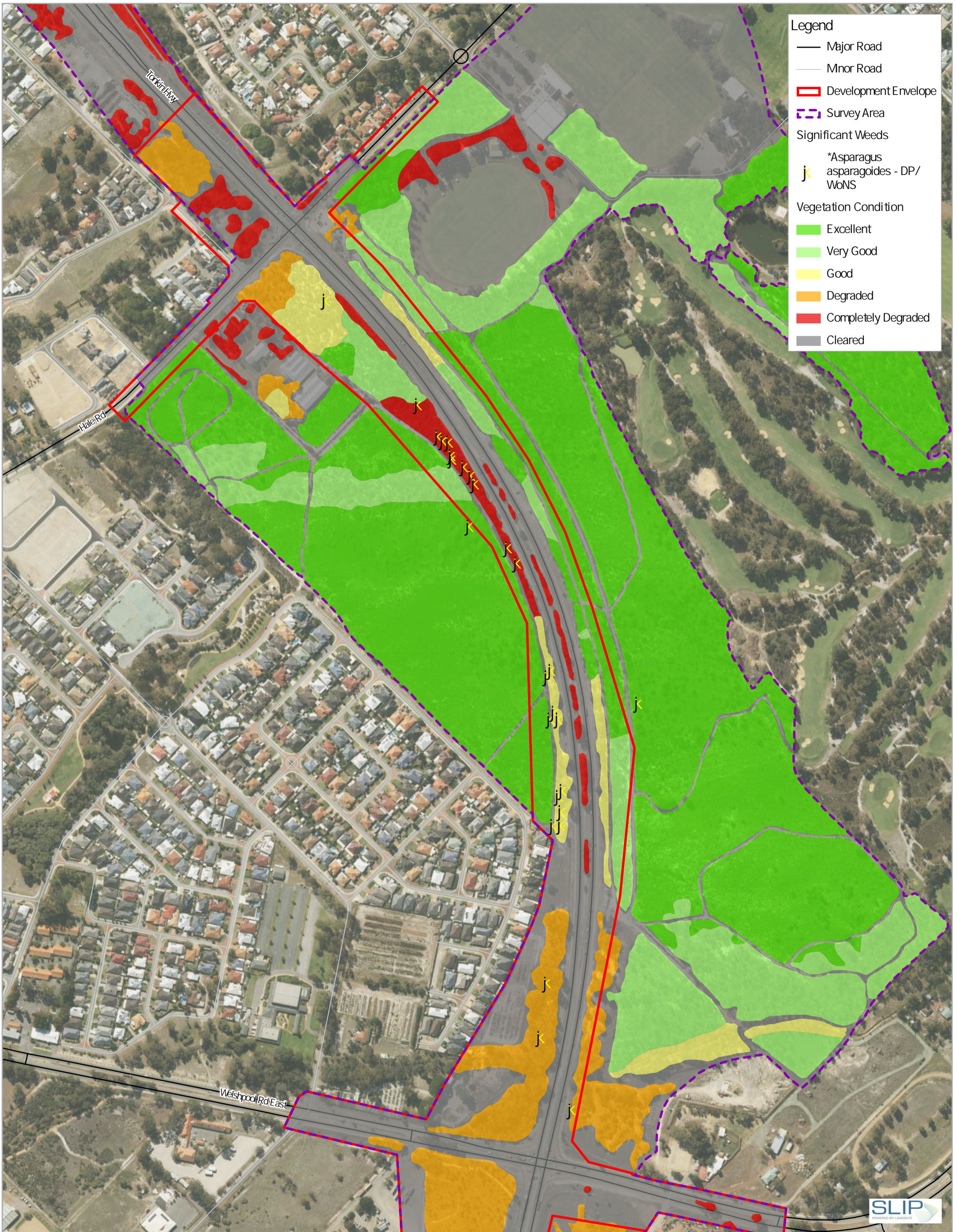
These species were found mostly in previously disturbed areas, and along vehicle tracks and drainage lines. Figure 13 presents the locations of Declared Pests and WoNS recorded within the Survey Area and DE.

The Proposed Action may result in the spread of Declared Pests and WoNS from the DE to adjacent, un-infested native vegetation through clearing and earthworks activities that spread weeds and seeds, and wind-blown spread of seeds from weeds establishing in the DE.

The Proposed Action will incorporate revegetation / landscaping with native species on local harvested topsoil, and weed control for a period of three years following completion of revegetation / landscaping, which will reduce the potential spread of weeds in the DE. Topsoil containing Declared Pests or WONS will not be reused in the landscaping and revegetation of the project.

Access controls, weed treatment, hygiene and monitoring will be implemented during and after construction to prevent the introduction and spread of weeds within the DE and to adjacent vegetation (Section 6). Established control methods for all Declared Pests recorded within the DE are outlined in the Action Management Plan (Appendix H) and will be implemented from the pre-construction through to post-construction phases of the Proposed Action.

The Proposed Action is not expected to spread weeds and seeds in stormwater runoff, as stormwater will be captured and infiltrated or detained within basins/swales in the road reserve. Weeds may become established in the infiltration basins/swales, which may then facilitate the spread via wind-blown seeds to adjacent un-infested native vegetation. Accordingly, ongoing weed management will occur in drainage areas adjacent to un-infested native vegetation as part of ongoing standard road maintenance.



Legend

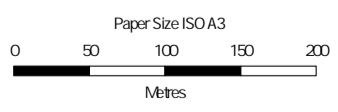
- Major Road
- Minor Road
- ▭ Development Envelope
- - - Survey Area

Significant Weeds

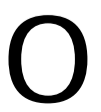
- *Asparagus asparagoides - DP/WoNS
- j

Vegetation Condition

- Excellent
- Very Good
- Good
- Degraded
- Completely Degraded
- Cleared



Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 50



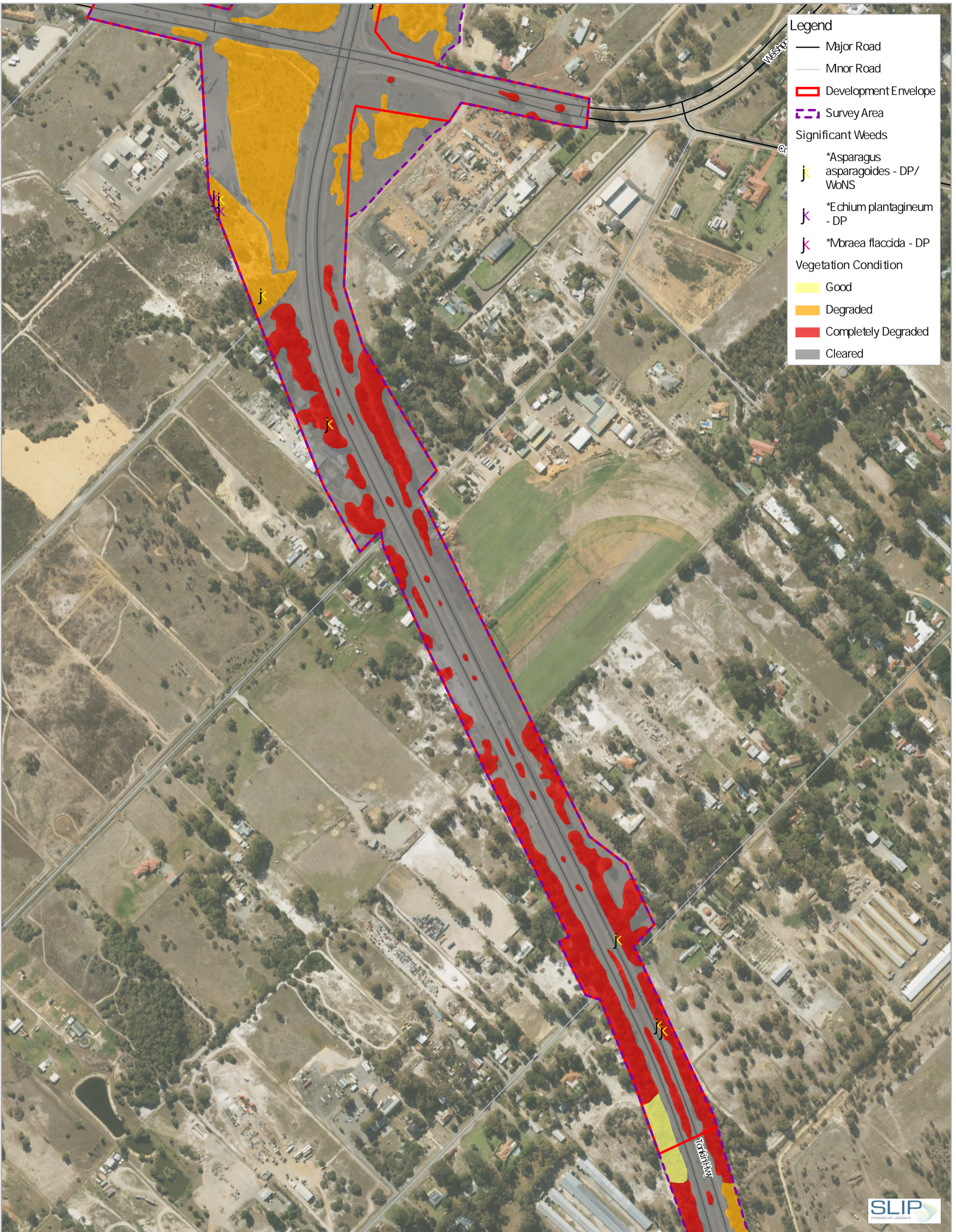
Main Roads
 Tonkin Grade Separated Interchanges

Significant Weeds

Project No. 12523571
 Revision No. 0
 Date 28/10/2020

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 Print date: 28 Oct 2020 - 15:25

Data source: Landgate_Subscription_Imagery\W\Now Landgate /SLIP, Roads - 2020 Woodman Vegetation mapping SignificantWeeds - 2020 Created by: bmginn



Legend

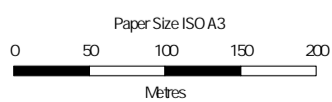
- Major Road
- Minor Road
- ▭ Development Envelope
- ▭ Survey Area

Significant Weeds

- j *Asparagus asparagoides - DP/WoNS
- k *Echium plantagineum - DP
- k *Mbraea flaccida - DP

Vegetation Condition

- ▭ Good
- ▭ Degraded
- ▭ Completely Degraded
- ▭ Cleared



Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 50



Main Roads
 Tonkin Grade Separated Interchanges

Significant Weeds

Project No. 12523571
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FIGURE 13



Through construction and operational management, the Proposed Action is not expected to result in the introduction or spread of weeds that could result in significant impacts to BWSCP TEC, Black Cockatoo habitat, or threatened flora species.

Introduction and/or spread of Phytophthora cinnamomi Dieback

Glevan Consulting (2020) conducted a *Phytophthora* Dieback Occurrence Assessment of the DE (Appendix F). The assessment identified areas of Dieback infestation within the DE between Hale Road and Welshpool Road intersections, as presented in Figure 14. The adjacent land to the West and East of the DE, within Hartfield Park, was identified as likely infested and associated with wetland areas. Areas of uninfested land were identified within the DE, south of the Hale Road intersection. The dieback mapping by Glevan (2020) expires in December 2020 and Main Roads is committed to undertaking up-to-date dieback mapping before commencing the Proposed Action.

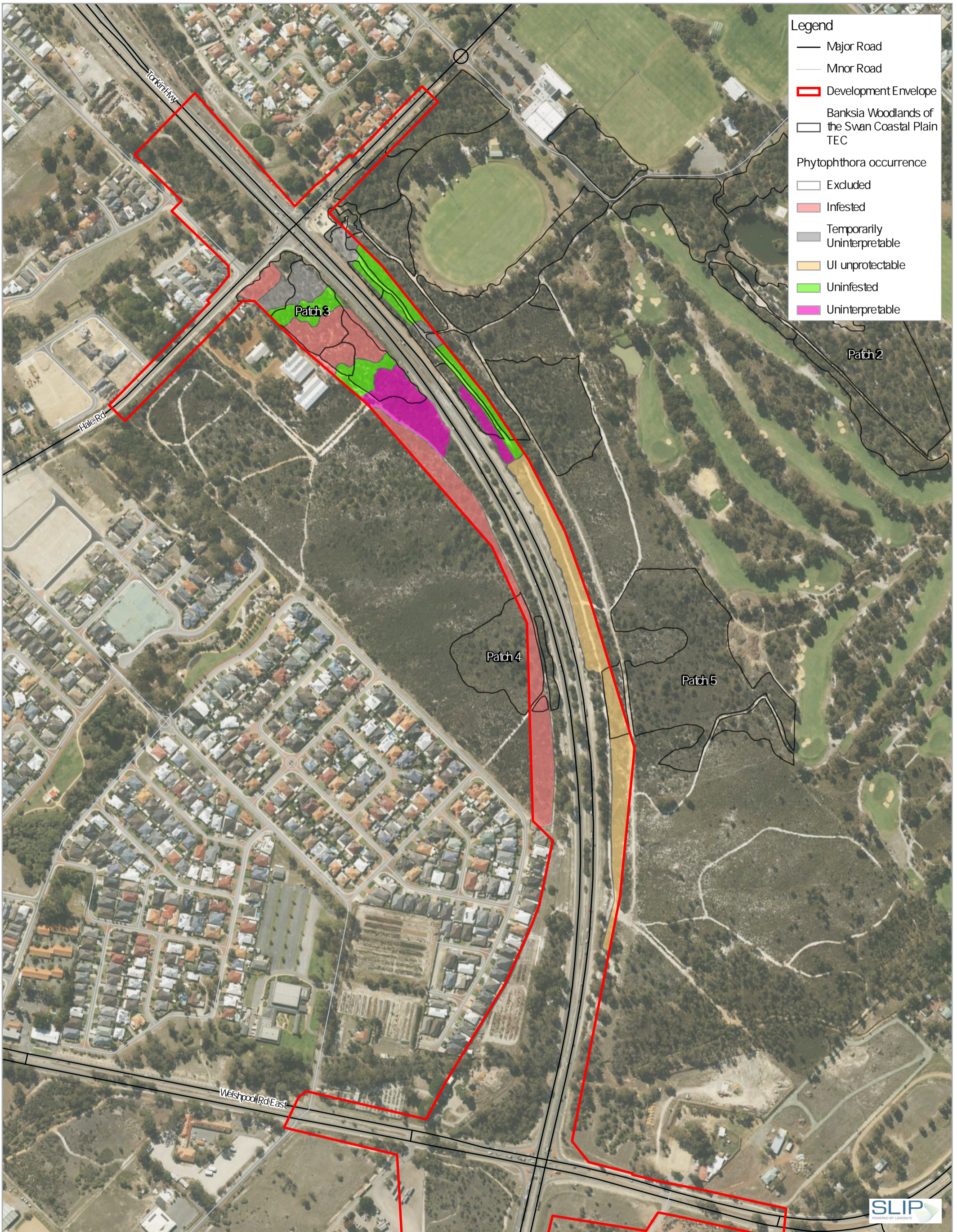
The uninfested land mapped on the East side of the DE is adjacent to mapped areas of Patch 2 of BWSCP TEC within Hartfield Park (Figure 14, and Figure 3, Section 4.3.1), which suggests that at least some portions of Patch 2 may be similarly uninfested. The uninfested land mapped on the West side of the DE lies adjacent to VT4 (Marri, Coastal Blackbutt and *E. patens* woodland over sparse shrubland) which comprises Black Cockatoo foraging habitat and includes some understorey species (e.g. *Xanthorrhoea preissii*) vulnerable to Dieback. VT4 is also habitat for *Andersonia gracilis*, which is vulnerable to Dieback.

The East boundary of the DE adjacent to the Hartfield Park Golf Course was mapped as unprotectable and is 'almost certainly infested' given the wet ground conditions (Glevan 2020). The large infested areas on the West boundary of the DE within Hartfield Park were considered to have been present for a considerable length of time (many decades) and reached an endemic state whereby there is currently no discernible disease activity (Glevan 2020). This suggests the infested land on the West side and likely the East side of the DE may have formed a single, large infested area prior to the construction of Tonkin Highway (Glevan 2020). The infested areas cover Patches 4 and 5 of the BWSCP TEC (see Figure 3 in Section 4.3.1), as well as habitat and identified populations of *Andersonia gracilis* (Figure 11, Section 4.5.2) and *Banksia mimica* (Figure 12, Section 4.5.3) both of which are vulnerable to Dieback.

The Proposed Action has potential to cause indirect impacts to BWSCP TEC through spread of Dieback to uninfested areas of Patch 2 within Hartfield. The Proposed Action is unlikely to cause indirect impacts to other patches of the TEC, as the patches are either already infested (Patches 4 and 5), will be totally removed (Patch 3) or lie away from the DE (Patches 1, 6 and 7). It is noted that the Dieback may also spread into Patch 2 from surrounding infested areas by other vectors, including public and illegal access through Hartfield Park reserve.

The Proposed Action has potential to cause indirect impacts to Black Cockatoo foraging habitat, due to impacts to vulnerable species within the BWSCP TEC and other areas of VT1 (e.g. *Banksia* spp., Jarrah, *Xanthorrhoea* spp.) and to a lesser extent VT4 (e.g. *Xanthorrhoea* spp.).

The Proposed Action has potential to cause impacts to *Banksia mimica* and *Andersonia gracilis*, through spread of Dieback to uninfested areas of habitat (VT4 and VT5) which may lie adjacent to uninfested areas on the West boundary of the DE. The Proposed Action is not expected to cause Dieback impacts to identified populations of *Banksia mimica* and *Andersonia gracilis* within Hartfield Park, as these populations are within existing Dieback infested areas.

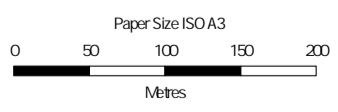


Legend

- Major Road
- Minor Road
- Development Envelope
- Banksia Woodlands of the Swan Coastal Plain TEC

Phytophthora occurrence

- Excluded
- Infested
- Temporarily Uninterpretable
- UI unprotectable
- Uninfested
- Uninterpretable



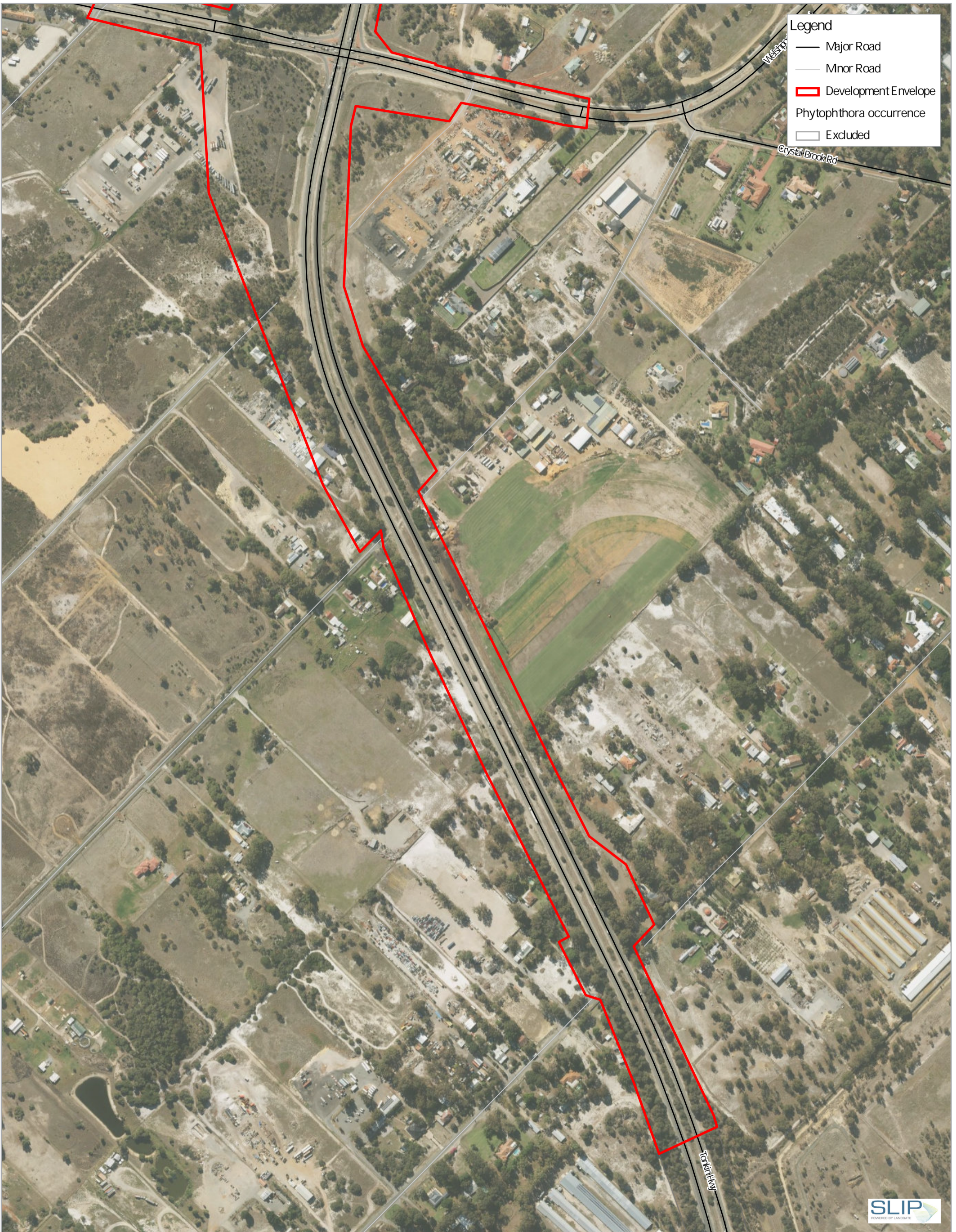
Map Projection: Transverse Mercator
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Main Roads
 Tonkin Grade Separated Interchanges

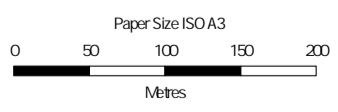
Phytophthora Dieback Occurrence

Project No. 12523571
 Revision No. 0
 Date 28/10/2020



Legend

- Major Road
- Minor Road
- ▭ Development Envelope
- ▭ Phytophthora occurrence
- ▭ Excluded



Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 50



Main Roads
 Tonkin Grade Separated Interchanges

Phytophthora Dieback Occurrence

Project No. 12523571
 Revision No. 0
 Date 28/10/2020



The Proposed Action will incorporate Dieback hygiene during construction to protect adjacent vegetation that may be uninfested and vulnerable, including Patch 2 of BWSCP TEC and areas of VT1, VT4 and VT5 that are mapped adjacent to uninfested areas of the DE. The Proposed Action will establish protectable areas along sections of the DE boundary and incorporate access controls, equipment and vehicle washing/segregation, soil movement controls, and monitoring during construction (see Action Management Plan in Appendix H). In particular, soil harvested from infested or unidentified areas will not be reused in protectable areas, and equipment and vehicles working in infested areas will not be able to access protectable areas unless cleaned and inspected. Soil harvested from infested areas will only be reused in infested areas in accordance with DBCA guidance, or disposed of at a licensed landfill.

The Proposed Action is not expected to spread Dieback through sediment in stormwater runoff, as stormwater will be captured and infiltrated within basins/swales in the road reserve and will not discharge into Hartfield Park outside the DE.

Through construction management, the Proposed Action is not expected to result in the introduction or spread of Dieback that could result in significant impacts to BWSCP TEC, Black Cockatoo habitat, or threatened flora species.

Increased risk of vehicle strike

The existing Tonkin Highway, Hale Road and Welshpool Road pose an existing risk of vehicle strike. There are no ground dwelling threatened fauna species listed under the EPBC Act that are expected to occur in the DE or its vicinity. Accordingly, the Proposed Action is highly unlikely to cause significant impacts to MNES due to vehicle strike on ground fauna crossing the road corridor.

The Proposed Action will enable an increase in traffic and vehicle movements in the local area, and may increase the likelihood of vehicle strike to Black Cockatoos. Carnaby's Cockatoo are most commonly killed by vehicle strikes whilst drinking from puddles on or besides roads, or flying between foraging trees on roadsides (Johnstone and Kirkby 2017). Johnstone *et al* (2017) note an increased incidence and risk of vehicle strike and mortality of FRTBC with their expansion onto the SCP, especially around Perth.

To minimise the likelihood of vehicle strikes to Black Cockatoos, Main Roads will not revegetate or landscape the DE with flora species that are foraging species for Black Cockatoos within 10 m of the edge of the road. Landscaping and revegetation greater than 10 m from the edge of the road will likely comprise Black Cockatoo foraging species.

5.2 Assessment of impacts

This section provides an assessment of the impacts to specific protected matters from the Proposed Action, assessed against the Significant Impact Guidelines 1.1 (DotE 2013). The assessment was limited to the MNES found within the DE, as follows:

- Banksia Woodlands of the Swan Coastal Plain TEC
- Three species of Black Cockatoos
- Wavy-leaved Smokebush
- Slender Andersonia
- Summer Honeypot.

The Proposal is not expected to cause significant impacts to other MNES, as presented in Section 4.

5.2.1 Banksia Woodlands of the SCP TEC

Overview of impact

The Proposed Action will result in the following impacts to BWSCP TEC:

- Clearing of up to 3.99 ha of BWSCP TEC over four patches
- Potential indirect impacts from the introduction or spread of weeds and *Phytophthora* Dieback, increased incidence of fire, and other edge impacts.

Assessment framework

The potential impacts of the Proposed Action on the BWSCP TEC have been assessed against the significant impact criteria for endangered ecological communities in the Significant Impact Guidelines 1.1 (DotE 2013). The Guidelines state that an action is likely to have a significant impact on an endangered ecological community if there is a real chance or possibility that it will:

- Reduce the extent of an ecological community
- Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines
- Adversely affect habitat critical to the survival of an ecological community
- Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns
- Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting
- Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:
 - Assisting invasive species, that are harmful to the listed ecological community, to become established
 - Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community
- Interfere with the recovery of an ecological community.

Reduce the extent of an ecological community

The Proposed Action will reduce the area of occurrence of the TEC by 3.99 ha. The TEC within the DE is relatively degraded compared to the TEC in the surrounding area. Within the DE, 42% of the TEC is in Good to Degraded condition, while in the Survey Area outside the DE, the vegetation is in much better condition with only 16% in Good to Degraded condition (see Table 3 and Table 4, Section 4.3.1). The relatively degraded condition of the TEC within the DE is expected given the DE lies over and is adjacent to existing disturbed areas along road corridors.

The Proposed Action will impact four patches of TEC, reducing the largest patch (Patch 2) by 1.19 ha or approximately 8.6%, removing all of Patch 3 (2.15 ha), and reducing Patch 4 by 0.43 ha or 26.6% and Patch 5 by 0.22 ha or 5.0%. Glevan (2020) noted that the land covered by Patches 3 and 4 is likely to be infested by *Phytophthora* Dieback.

The DE lies adjacent and parallel to existing cleared corridors and will not disrupt linkages between the TEC and adjacent green corridors in Hartfield Park and the Greater Brixton Street Wetlands.

The Proposed Action will reduce the area of occurrence of the TEC but will not reduce the TEC's regional distribution. The Proposed Action is situated well within the distribution of the TEC which extends from Dongara to Dunsborough. The Proposed Action impact to 3.99 ha represents approximately 0.6% of the approximately 667 ha of remnant vegetation identified within 5 km of the DE that is associated with the TEC. Approximately 60% of this remnant vegetation is protected in Bush Forever sites or DBCA managed lands.

Fragment or increase fragmentation of an ecological community

The Proposed Action will not fragment or increase fragmentation of the BWSCP TEC. As presented in Figure 3, the DE will not fragment any of the seven patches of BWSCP TEC identified in the Survey Area.

The Proposed Action avoids bisection of patches of native vegetation, including at Hartfield Park. Clearing will be limited to the edges of existing disturbed corridors along Tonkin Highway, Hale Road and Welshpool Road.

All associated infrastructure for the Proposed Action will be contained within the DE, including road pavements, footpaths, noise walls, stormwater drainage, fencing, and electrical power reticulation

Adversely affect habitat critical to the survival of an ecological community

The BWSCP TEC Conservation Advice defines all patches of TEC and a buffer of 20 – 50 m, as critical for the survival of the TEC (TSSC 2016).

The Proposed Action will directly impact up to 3.99 ha of BWSCP TEC patches. The TEC within the DE is relatively degraded compared to the TEC in the surrounding land. Within the DE, 42% of the TEC is in Good to Degraded condition, while in the Survey Area outside the DE, the vegetation is in much better condition with only 16% in Good to Degraded condition

Locally, there is approximately 667 ha of remnant vegetation within 5 km of the DE that may contain the TEC, of which approximately 60% is protected.

The Proposed Action will incorporate environmental management during construction (see Action Management Plan, Appendix H) to protect the integrity of BWSCP TEC within the vicinity of the DE.

Modify or destroy abiotic factors necessary for an ecological community's survival, including hydrology

The Proposed Action will not substantially modify or destroy abiotic factors necessary for the survival of the BWSCP TEC, including hydrology, nutrients or soil resources.

The Proposed Action will incorporate infiltration basins and/or swales to capture, treat and infiltrate surface water runoff. The Proposed Action will minimise runoff outside the DE that could impact adjacent TEC patches.

The Proposed Action may require dewatering for the construction of bridge piers, abutment footings and drainage structures. Dewatering, if required, will be limited as the depth to groundwater is approximately 4.1-4.3 m in the vicinity of the Hale Road intersection and 4.9-6.3 m in the vicinity of the Welshpool Road intersection (E. Makita, Arup, Pers. Comm.). In the event of dewatering, the horizontal extent of groundwater drawdown (cone of depression) will be limited due to clayey soil characteristics in the area. Dewatering, if required, will cause temporary and localised groundwater drawdown and is not expected to cause significant impacts to adjacent TEC patches. The clearing of vegetation within the DE is not expected to be of sufficient scale to cause substantial hydrological changes in the local area. The infiltration of surface water runoff within the DE will maintain the existing hydrological regime within the Pinjarra Plain, which is characterised by clayey soils and poor drainage.

The DE lies over land predominantly mapped as being at low to moderate risk of acid sulfate soils (ASS) at depths within 3 m from the surface, and at moderate to high risk of ASS at depths greater than 3 m from the surface. Dewatering could potentially result in oxidation of ASS at depth, however the extent of dewatering is expected to be limited, as described above. The Proposed Action will be subject to dewatering and ASS management in accordance with Department of Water and Environmental Regulation (DWER) guidelines and to DWER approval, which is expected to effectively mitigate potential ASS impacts to surrounding vegetation.

The Proposed Action will use native species on local topsoil for revegetation, restrict the use of fertilisers to the establishment phase and a case by case basis, and incorporate treatment of stormwater during infiltration. Accordingly, the Proposed Action is not expected to result in a substantial change in nutrient cycles that could impact TEC patches in the area.

The Proposed Action will incorporate harvesting and reuse of topsoil within the DE to ensure that local soil resources are maintained and support buffers of native vegetation within the road reserve, to enhance protection of adjacent TEC patches. The Action Management Plan (Appendix H) includes erosion and sediment controls to maintain the quality of soil within the DE and adjacent areas. Accordingly, the Proposed Action is not expected to substantially modify or destroy soil resources that could impact adjacent TEC patches.

Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species

The Proposed Action avoids fragmentation of TEC patches and intrusion into adjacent TEC areas including Hartfield Park. All associated infrastructure for the Proposed Action will be contained within the DE, including road pavements, footpaths, noise walls, stormwater drainage, fencing, and electrical power reticulation.

The treatment of weeds and planting of native vegetation within the road reserve will provide a buffer to adjacent TEC patches.

The Proposed Action will implement Dieback hygiene (see Section 5.1.2 and Action Management Plan, Appendix H) to prevent the introduction or spread of Dieback into uninfested areas of adjacent BWSCP TEC patches.

Accordingly, the Proposed Action is not expected to cause a decline or loss of functionally important species in TEC patches retained outside the DE.

Cause a substantial reduction in the quality or integrity of an ecological community

The Proposed Action is not expected to result in a substantial reduction in quality or integrity of TEC patches retained outside the DE, including those within Hartfield Park.

The Proposed Action incorporates construction management to protect the integrity of adjacent BWSCP TEC patches. The Proposed Action involves clearing of 3.99 ha of TEC that is in a relatively degraded condition compared to the surrounding TEC, and represents 0.6 % of remnant vegetation within 5 km that may contain the TEC.

The Proposed Action is not expected to result in the introduction or spread of weeds that results in significant impacts to BWSCP TEC. This is due to construction management including weed treatment and hygiene, and revegetation / landscaping with native species on local harvested topsoil with restricted use of fertiliser. Ongoing weed management will be undertaken in road drainage basins/swales to prevent spread of weeds into adjacent TEC patches.

Interfere with the recovery of an ecological community

There is no recovery plan in place for the TEC, however the conservation advice outlines priority research and conservation actions (TSSC 2016).

The Proposed Action has been planned and will be developed to align with relevant protection and recovery measures in the conservation advice, including:

- Identification and retention of high conservation value, unmodified areas of the TEC within Hartfield Park
- Preventing impacts to native vegetation, fauna, hydrology and soil structure from construction, through clearing controls, revegetation / landscaping with native species, fauna handling, stormwater drainage and topsoil management
- Establishing native vegetation using local native species within the road reserve to provide a buffer to adjacent TEC patches
- Avoiding disruption to any TEC linkages with vegetation and wildlife corridors
- Mapping of existing weed and *Phytophthora* infestations, and construction treatment, hygiene and monitoring to spread of Dieback and weeds within the TEC.

Given the above planning, design and construction measures, the Proposed Action is not expected to interfere with the recovery of the TEC.

Conclusion

Based on the above assessment against the Significant Impact Guidelines, the Proposed Action is expected to cause significant residual impacts to BWSCP TEC, due to the direct impact of clearing. Indirect impacts are not expected to be significant.

5.2.2 Black Cockatoos (Carnaby's Cockatoo, FRTBC, Baudin's Cockatoo)

Overview of impacts

The Proposed Action will result in the following impacts to Black Cockatoos:

- Clearing of up to 18.7 ha moderate to low value foraging habitat for Carnaby's Cockatoo
- Clearing of up to 7.9 ha of high to moderate value foraging habitat and 11.3 ha of moderate to low value foraging habitat for Baudin's Cockatoo and FRTBC
- Loss of up to 141 potential Black Cockatoo breeding trees (DBH>500 mm), none of which contain hollows suitable for Black Cockatoo nesting
- Potential indirect impacts from the introduction or spread of weeds and *Phytophthora* Dieback, increased incidence of fire, other edge impacts, and increased vehicle strike.

Assessment framework

The potential impacts of the Proposed Action on Black Cockatoos have been assessed against the significant impact criteria for Endangered species (Carnaby's Cockatoo and Baudin's Cockatoo) and Vulnerable species (FRTBC) in the Significant Impact Guidelines 1.1 (DotE 2013). The Guidelines state that an action is likely to have a significant impact on a threatened species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of a population of a species
- Reduce the area of occupancy of a population
- Fragment an existing population into two or more populations
- Adversely affect habitat critical to the survival of a species
- Disrupt the breeding cycle of a population
- Modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species is likely to decline

- Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
- Introduce disease that may cause the species to decline, or
- Interfere with the recovery of the species.

For Vulnerable species, the criteria relate to an 'important population' which are defined as (DotE 2013) a population that is necessary for a species' long-term survival and recovery, which may include populations identified as such in recovery plans, and/or that are:

- Key source populations either for breeding or dispersal
- Populations that are necessary for maintaining genetic diversity, and/or
- Populations that are near the limit of the species range.

DSWEPaC (2012) note that populations have not been defined for Black Cockatoos, due to the mobile and widely-distributed nature of these species, and the variation in flock compositions (e.g. between breeding and non-breeding seasons). Accordingly, DSEWPaC (2012) provided guidance on the risk of significant impacts on Black Cockatoos in terms of habitat rather than population. An assessment against the DSEWPaC (2012) guidance is provided in Section 5.2.3.

Lead to a long term decrease in the size of a population

The Proposed Action is not expected to lead to a long-term decrease in the size of Black Cockatoo populations as:

- The Proposed Action will not result in clearing of known breeding trees or hollows, nor any known roosting trees
- The Proposed Action occurs approximately 15 km from recorded breeding sites for Carnaby's Cockatoo, approximately 7.5 km from recorded breeding sites for FRTBC and approximately 27 km from recorded breeding sites for Baudins Cockatoo
- Clearing of up to 18.7 ha moderate to low value foraging habitat for Carnaby's Cockatoo, representing 0.73% of local habitat (within 5 km of DE) and 0.004% of regional habitat within the SCP
- Clearing of up to 7.9 ha of high to moderate value foraging habitat and 11.3 ha of moderate to low value foraging habitat for FRTBC, representing 0.74% of local habitat (within 5 km of DE) and 0.009% of regional habitat within the SCP
- Clearing of up to 7.9 ha of high to moderate value foraging habitat and 11.3 ha of moderate to low value foraging habitat for Baudin's Cockatoo, representing 0.74% of local habitat (within 5 km of DE) and 0.024% of regional habitat within the SCP
- Black Cockatoos are highly mobile species and are expected to forage outside the DE amongst foraging resources in the vicinity (2582 ha within 5 km), and are not dependent on a particular patch of foraging habitat within the DE
- The Proposed Action will not result in clearing of important roosting or breeding habitat nor does the DE lie adjacent to important roosting or breeding habitat
- The Proposed Action incorporates construction management to protect the integrity of Black Cockatoo habitat in Hartfield Park.

Reduce the area of occupancy of the species

The Proposed Action will reduce the area of occupancy for Black Cockatoos through:

- Clearing of up to 18.7 ha moderate to low value foraging habitat for Carnaby's Cockatoo, representing 0.73% of local habitat (within 5 km of DE) and 0.004% of regional habitat within the SCP
- Clearing of up to 7.9 ha of high to moderate value foraging habitat and 11.3 ha of moderate to low value foraging habitat for FRTBC, representing 0.74% of local habitat (within 5 km of DE) and 0.009% of regional habitat within the SCP
- Clearing of up to 7.9 ha of high to moderate value foraging habitat and 11.3 ha of moderate to low value foraging habitat for Baudin's Cockatoo, representing 0.74% of local habitat (within 5 km of DE) and 0.024% of regional habitat within the SCP
- Loss of up to 141 potential Black Cockatoo breeding trees (DBH>500 mm), none of which contain hollows suitable for Black Cockatoo nesting.

Fragment an existing population into two or more populations

The Proposed Action is not expected to fragment populations of Black Cockatoos, as:

- Clearing will occur over linear patches adjacent to existing cleared and disturbed areas along Tonkin Highway, Hale Road and Welshpool Road, and will not create a gap of 4 km or more between patches of habitat
- Black Cockatoos are highly mobile species and are expected to forage outside the DE amongst foraging resources in the vicinity (2582 ha within 5 km), and are not dependent on a particular patch of foraging habitat within the DE
- The Proposed Action will not result in clearing of important roosting or breeding habitat nor does the DE lie adjacent to important roosting or breeding habitat.

Adversely affect habitat critical to the survival of a species

The Proposed Action is not expected to directly or indirectly impact habitat critical to the survival of Carnaby's Cockatoo, as the DE does not comprise known or former breeding habitat or vegetation that provides habitat for watering. The closest recorded breeding site for Carnaby's Cockatoo is approximately 15 km to the south-east in Jarrah forest.

The Proposed Action is not expected to directly or indirectly impact habitat critical to the survival of FRTBC or Baudin's Cockatoo, as the DE lies outside the core species habitat of the Darling Scarp/Plateau and Baudin's Cockatoo breeding habitat in the South-West region.

Disrupt the breeding cycle of a population

The Proposed Action is not expected to disrupt the breeding cycle of a population of Black Cockatoos as no known breeding of Black Cockatoos occurs in the DE or the vicinity.

The Proposed Action will not result in clearing of any known breeding tree or hollow, nor any known important roosting tree. The DE is located between 7.5 km to 27 km from the nearest breeding records for Black Cockatoo species, all of which lie to the east in Jarrah forest of the Darling Scarp/Plateau. The DE is not considered current breeding habitat for Carnaby's Cockatoo or FRTBC but may provide breeding habitat at some point in the future if breeding patterns change. The DE is unlikely to be breeding habitat for Baudin's Cockatoo given the distance to core breeding habitat in the South-West region.

The DE lies within 5 km of 2582 ha of potential habitat for Black Cockatoos, of which approximately 55% is protected in Bush Forever or DBCA managed lands. This surrounding habitat is expected to provide similar potential for future breeding habitat as the habitat within the DE.

Modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Proposed Action is not expected to have the impact the availability or quality of habitat to the extent that Black Cockatoos are likely to decline, as:

- The Proposed Action will not result in clearing of important roosting or breeding habitat nor does the DE lie adjacent to important roosting or breeding habitat
- The Proposed Action will result in maximum clearing of foraging habitat that represents approximately 0.73% of local habitat (within 5 km of DE) and 0.004% of regional habitat for Carnaby's Cockatoo within the SCP
- The Proposed Action will result in maximum clearing of foraging habitat that represents approximately 0.74% of local habitat (within 5 km of DE) and 0.009% of regional habitat for FRTBC within the SCP
- The Proposed Action will result in maximum clearing of foraging habitat that represents approximately 0.74% of local habitat (within 5 km of DE) and 0.024% of regional habitat for Baudin's Cockatoo within the SCP
- The Proposed Action is surrounded by 2582 ha of potential foraging habitat, with approximately 55% of habitat within 5 km reserved in Bush Forever or DBCA managed lands
- The Proposed Action incorporates construction management to protect the integrity of Black Cockatoo habitat within Hartfield Park.

Result in invasive species that are harmful to the species becoming established in the species' habitat

As noted in Section 5.1.2, the DE has existing weed infestation associated with urban development. The Proposed Action is not expected to result in the introduction or spread of weeds that results in significant impacts to Black Cockatoo habitat. This is due to construction management including weed treatment and hygiene, and revegetation / landscaping with native species on local harvested topsoil. Ongoing weed management will be undertaken in road drainage basins/swales to prevent spread of weeds into adjacent habitat.

The Proposed Action is not expected to introduce any predator species (e.g. Fox, Cat) into the DE, as the Proposed Action will facilitate flow of traffic from surrounding suburbs through the DE and will not create a destination or facilitate access into surrounding areas of native vegetation.

Accordingly the Proposed Action is not expected to introduce or spread invasive species in Black Cockatoo habitat.

Introduce disease that may cause the species to decline

As noted in Section 5.1.2, the Proposed Action will include Dieback hygiene during construction to protect adjacent Black Cockatoo habitat. The Proposed Action will establish protectable areas along sections of the DE boundary and incorporate access controls, equipment and vehicle washing/segregation, soil movement controls, and monitoring during construction (see Action Management Plan in Appendix H).

The Proposed Action is not expected to spread Dieback through sediment in stormwater runoff, as stormwater will be captured and infiltrated within basins/swales in the road reserve and will not discharge into Black Cockatoo habitat outside the DE.

Accordingly the Proposed Action is not expected to introduce or spread invasive species that could cause Black Cockatoo habitat and thus the species to decline.

Interfere with the recovery of the species

The Proposed is not inconsistent with the recovery plans for Black Cockatoos, as presented in Section 7.

Conclusion

Based on the above assessment against the Significant Impact Guidelines, the Proposed Action is expected to cause significant residual impacts to Black Cockatoos, due to the direct impact of clearing habitat. Indirect impacts are not expected to be significant.

5.2.3 Black Cockatoos (Carnaby's Cockatoo, FRTBC, Baudin's Cockatoo) assessment against referral guidance

Overview of impacts

The Proposed Action will result in the following impacts to Black Cockatoos:

- Clearing of up to 18.7 ha moderate to low value foraging habitat for Carnaby's Cockatoo
- Clearing of up to 7.9 ha of high to moderate value foraging habitat and 11.3 ha of moderate to low value foraging habitat for Baudin's Cockatoo and FRTBC
- Loss of up to 141 potential Black Cockatoo breeding trees (DBH>500 mm), none of which contain hollows suitable for Black Cockatoo nesting
- Potential indirect impacts from the introduction or spread of weeds and *Phytophthora* Dieback, increased incidence of fire, other edge impacts, and increased vehicle strike.

Assessment framework

The Commonwealth Significant Impact Guidelines 1.1 adopts criteria for assessment of impact to threatened species relating to 'populations' and/or 'important populations' (DotE 2013). However, these terms have not been defined for Black Cockatoos, due to the mobile and widely-distributed nature of these species, and the variation in flock compositions (e.g. between breeding and non-breeding seasons). For Black Cockatoos, it is more appropriate to consider significance in terms of impacts on habitat rather than a resident population (DSEWPaC 2012). Accordingly, DSEWPaC (2012) provided guidance on the risk of significant impacts on Black Cockatoos as follows:

High risk of significant impacts:

- Clearing of any known nesting tree
- Clearing or degradation of any part of a vegetation community known to contain breeding habitat
- Clearing of more than 1 ha of quality foraging habitat
- Clearing or degradation (including pruning the top canopy) of a known night roosting site
- Creating a gap of greater than 4 km between patches of black cockatoo habitat (breeding, foraging or roosting).

Uncertainty, potential for significant impacts:

- Degradation (such as through altered hydrology or fire regimes) of more than 1 ha of foraging habitat. Significance will depend on the level and extent of degradation and the quality of the habitat.
- Clearing or disturbance in areas surrounding black cockatoo breeding, foraging or night roosting habitat that has the potential to degrade habitat through introduction of invasive species, edge effects, hydrological changes, increased human visitation or fire.

- Actions that do not directly affect the listed species but that have the potential for indirect impacts such as increasing competitors for nest hollows.
- Actions with the potential to introduce known plant diseases such as *Phytophthora* spp. to an area where the pathogen was not previously known.

Clearing of any known nesting tree

The Proposed Action will not result in clearing of a known nesting tree or a tree with hollows suitable for nesting. The DE does not contain any known nesting trees or hollows suitable for nesting (Section 4.4.1). The DE is located approximately 15 km from recorded breeding sites for Carnaby's Cockatoo, approximately 7.5 km from recorded breeding sites for FRTBC and approximately 27 km from recorded breeding sites for Baudins Cockatoo (Section 4.4.1).

Clearing or degradation of breeding habitat

The DE is not considered current breeding habitat for Carnaby's Cockatoo or FRTBC but may provide breeding habitat at some point in the future if breeding patterns change (Section 4.4.1). The DE is unlikely to be breeding habitat for Baudin's Cockatoo given the distance to core breeding habitat in the South-West region (Section 4.4.1).

Clearing of more than 1 ha of quality foraging habitat

The Proposed Action will result in clearing of up to 18.7 ha moderate to low value (score 2-4 out of 6) foraging habitat for Carnaby's Cockatoo, and up to 7.9 ha of high to moderate value (score 5 out of 6) foraging habitat and 11.3 ha of moderate to low value (score 2-4) foraging habitat for FRTBC and Baudin's Cockatoo (Section 4.4.1).

Clearing or degradation of a known night roosting site

The Proposed Action will not result in the clearing of any known night roosting trees. The DE does not contain a known night roosting tree (Section 4.4.1). GPS tracking data for Baudin's Cockatoo and FRTBC suggested the closest night roosting by Baudin's Cockatoo at approximately 0.5 km south of the DE, and no night roosting by FRTBC within 5 km of the DE. The Great Cocky Count (DBCA 2019a) indicates that the closest confirmed roosting site is in the Jarrah forest of the Darling Scarp to the east, and the closest potential roosting site lies in Hartfield Park to the east of the DE.

Creating a gap of greater than 4 km between black cockatoo habitat

The Proposed Action will not create a gap of greater than 4 km between patches of Black Cockatoo habitat. The Proposed Action comprises strips of clearing along existing road corridors, with patches of Black Cockatoo habitat remaining on either side of the DE.

Degradation (such as through altered hydrology or fire regimes) of more than 1 ha of foraging habitat

Dewatering, if required, will be limited as the depth to groundwater is approximately 4.1-4.3 m in the vicinity of the Hale Road intersection and 4.9-6.3 m in the vicinity of the Welshpool Road intersection. In the event of dewatering, the horizontal extent of groundwater drawdown (cone of depression) will be limited due to clayey soil characteristics in the area. Dewatering, if required, will cause temporary and localised groundwater drawdown during construction and is not expected to cause significant impacts to adjacent Black Cockatoo habitat.

The Proposed Action is not expected to alter the fire regime of the area. The Proposed Action involves an upgrade to an existing road and revegetation or landscaping with local, native species.

Potential to degrade habitat through introduction of invasive species, edge effects, hydrological changes, increased human visitation or fire

As noted in Section 5.1.2, the DE has existing weed infestation associated with urban development. The Proposed Action is not expected to result in the introduction or spread of weeds that results in significant impacts to Black Cockatoo habitat. This is due to construction management including weed treatment and hygiene, and revegetation / landscaping with native species on local harvested topsoil. Ongoing weed management will be undertaken in road drainage basins/swales to prevent spread of weeds into adjacent habitat.

The Proposed Action will facilitate flow of traffic from surrounding suburbs through the DE and will not create a destination or facilitate access into surrounding areas of native vegetation.

Dewatering, if required, will cause temporary and localised groundwater drawdown during construction and is not expected to cause significant impacts to adjacent Black Cockatoo habitat.

The Proposed Action is not expected to alter the fire regime of the area. The Proposed Action involves an upgrade to an existing road and revegetation or landscaping with local, native species.

Actions that do not directly affect the listed species but that have the potential for indirect impacts such as increasing competitors for nest hollows

The Proposed Action is not expected to cause increased competition for nest hollows. The Proposed Action is not expected to introduce competitor species such as European honeybees or other bird species (e.g. Galah) and breeding does not currently occur in the area.

Actions with the potential to introduce known plant diseases such as *Phytophthora* spp. to an area where the pathogen was not previously known.

As noted in Section 5.1.2, the Proposed Action will include Dieback hygiene during construction to protect adjacent Black Cockatoo habitat. The Proposed Action will establish protectable areas along sections of the DE boundary and incorporate access controls, equipment and vehicle washing/segregation, soil movement controls, and monitoring during construction (see Action Management Plan in Appendix H).

The Proposed Action is not expected to spread Dieback through sediment in stormwater runoff, as stormwater will be captured and infiltrated within basins/swales in the road reserve and will not discharge into Black Cockatoo habitat outside the DE.

Conclusion

Based on the above assessment against the referral guidelines, the Proposed Action is expected to cause significant residual impacts to Black Cockatoos, due to the direct impact of clearing quality foraging habitat. Indirect impacts are not expected to be significant.

5.2.4 Wavy- leaved Smokebush - *Conospermum undulatum*

Overview of impacts

The Proposed Action will result in the following impacts to *Conospermum undulatum*:

- Loss of 62 individuals from 58 locations
- Loss of up to 7.45 ha of suitable habitat
- Potential indirect impacts from the introduction or spread of weeds and *Phytophthora* Dieback, increased incidence of fire, and other edge impacts.

Assessment Framework

The potential impacts of the Proposed Action on *C. undulatum* have been assessed against the significant impact criteria for Vulnerable species in the Significant Impact Guidelines 1.1 (DotE 2013). The Guidelines state that an action is likely to have a significant impact on a threatened species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of an important population of a species
- Reduce the area of occupancy of an important population
- Fragment an existing important population into two or more populations
- Adversely affect habitat critical to the survival of a species
- Disrupt the breeding cycle of an important population
- Modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species is likely to decline
- Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
- Introduce disease that may cause the species to decline, or
- Interfere with the recovery of the species.

For Vulnerable species, the criteria relate to an 'important population' which are defined as (DotE 2013) a population that is necessary for a species' long-term survival and recovery, which may include populations identified as such in recovery plans, and/or that are:

- Key source populations either for breeding or dispersal
- Populations that are necessary for maintaining genetic diversity, and/or
- Populations that are near the limit of the species range.

The *C. undulatum* population recorded in Hartfield Park (Population 8) comprises an important population, comprising a large number of plants and lying within Bush Forever site 320 (DPC 2015).

Lead to a long-term decrease in the size of an important population

The Proposed Action will remove 53 individuals¹ from a total of 677 individuals recorded at Hartfield Park, which represents an approximate 8% loss. This will decrease the size of that important population (Population 8) in the short term.

Reduce the area of occupancy of an important population

The Proposed Action will reduce the area of occurrence of an important population (Population 8) of *C. undulatum*, but will not reduce the extent of the population which encompasses the Hartfield Park Bush Forever site 320.

The Proposed Action will clear up to 7.45 ha of habitat for *C. undulatum*, which is approximately 17.5% of the 42.6 ha of habitat (VT1 and VT4) mapped in the Survey Area. However, as described in Section 4.5.1, much of the mapped habitat is not populated by *C. undulatum*, which instead is found in dense, clumped populations.

Fragment an existing important population into two or more populations

The Proposed Action will not fragment an existing important population or the habitat of an existing important population into two or more populations. Clearing will occur over linear

¹ Note: a further nine individuals will be removed from another population south of Welshpool Road, which is not an important population. Total of 62 individuals within the DE.

patches adjacent to existing cleared and disturbed areas along Tonkin Highway, Hale Road and Welshpool Road.

Adversely affect habitat critical to the survival of a species

Habitat considered critical to *C. undulatum* includes areas of current occupancy of important populations, areas of similar habitat surrounding important populations, and the local catchment for the surface or groundwater that maintains the habitat of the species.

The Proposed Action will clear up to 7.45 ha of habitat for *C. undulatum*, which surrounds the important population located within the Hartfield Park Bush Forever site 320. Accordingly, the Proposed Action will impact habitat critical to the survival of *C. undulatum*. The impact represents approximately 17.5% of the 42.6 ha of critical habitat (VT1 and VT4) mapped in the Survey Area. However, as described in Section 4.5.1, much of the mapped habitat is not populated by *C. undulatum*, which instead is found in dense, clumped populations.

Disrupt the breeding cycle of an important population

The breeding cycle of *C. undulatum* is dependent on an adequate supply of pollinators, and fire, as the majority of the species reproduces through re-sprouting. The Proposed Action is not expected to disrupt the breeding cycle of an important population of *C. undulatum*, as it is not expected to impact the pollination success of the individuals remaining outside of the DE nor result in a reduction in the instances of fire occurring in the area.

Modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Proposed Action will modify and permanently remove 7.45 ha of *C. undulatum* habitat (VT1 and VT4), which represents approximately 1.1% of the 667 ha of remnant vegetation within 5 km of the DE that may contain *Banksia* woodlands (Figure 4, Section 4.3.1) and associated habitat for the taxon. Approximately 60% of this potential habitat within 5 km of the DE is protected in Bush Forever or DBCA managed lands. As described in Section 4.5.1 much of the habitat mapped in the DE is not populated by *C. undulatum*, which instead is found in dense, clumped populations.

The Proposed Action incorporates construction management to protect the integrity of critical habitat for the important population of *C. undulatum* within Hartfield Park.

Given the small scale of direct impacts and mitigation of indirect impacts the Proposed Action is not expected to impact habitat such that the species is likely to decline.

Result in invasive species that are harmful becoming established in the species' habitat

As noted in Section 5.1.2, the DE has existing weed infestation associated with urban development. The Proposed Action is not expected to result in the introduction or spread of weeds that results in significant impacts to *C. undulatum* habitat. This is due to construction management including weed treatment and hygiene, and revegetation / landscaping with native species on local harvested topsoil. Ongoing weed management will be undertaken in road drainage basins/swales to prevent spread of weeds into adjacent habitat.

The Proposed Action is not expected to introduce any invasive fauna species (e.g. Rabbit) into the DE, as the Proposed Action will facilitate flow of traffic from surrounding suburbs through the DE and will not create a destination or facilitate access into surrounding areas of native vegetation.

Accordingly the Proposed Action is not expected to introduce or spread invasive species that could cause *C. undulatum* to decline.

Introduce disease that may cause the species to decline

Although the Recovery Plan does not indicate Dieback as a threat to this species, there is potential for *C. undulatum* to be impacted should the condition of its habitat (VT1 Banksia woodland) be degraded due to Dieback.

As noted in Section 5.1.2, the Proposed Action will include Dieback hygiene during construction to protect adjacent uninfested areas that are protectable, including VT1 and VT4 which are habitat for *C. undulatum*. The Proposed Action will establish protectable areas along sections of the DE boundary and incorporate access controls, equipment and vehicle washing/segregation, soil movement controls, and monitoring during construction.

The Proposed Action is not expected to spread Dieback through sediment in stormwater runoff, as stormwater will be captured and infiltrated within basins/swales in the road reserve and will not discharge into *C. undulatum* habitat outside the DE.

Accordingly the Proposed Action is not expected to introduce a disease that could cause *C. undulatum* to decline.

Interfere with the recovery of the species.

The Proposed Action is not inconsistent with the species Recovery Plan (DEC 2009), as presented in Section 7.

Conclusion

Based on the above assessment against the Significant Impact Guidelines, the Proposed Action is expected to cause significant residual impacts to *C. undulatum*, due to the direct impact of clearing to an important population. Indirect impacts are not expected to be significant.

5.2.5 Slender Andersonia (*Andersonia gracilis*)

Overview of impacts

The Proposed Action will result in the following impacts to *Andersonia gracilis*:

- Loss of 11 individuals from 10 locations
- Potential indirect impacts from the introduction or spread of weeds and *Phytophthora* Dieback, increased incidence of fire, and other edge impacts.

Assessment framework for endangered species

The potential impacts of the Proposed Action on *Andersonia gracilis* have been assessed against the significant impact criteria for Endangered species in the Significant Impact Guidelines 1.1 (DotE 2013), as listed in Section 5.2.4 but with respect to any population (rather than important populations, as for Vulnerable species).

Lead to a long-term decrease in the size of a population

The Proposed Action will remove 11 individuals from a total of 34 individuals recorded in Hartfield Park (considered to be a new population), which represents an approximate 32% loss. This will decrease the size of the population in the short term.

Following implementation of the Proposed Action, there will be 23 individuals remaining at five locations within Hartfield Park, adjacent to the DE. These individuals occur within one single clumped population which is located approximately 10-20 m west of the DE (Figure 11).

The Proposed Action is not expected to spread dieback, weeds or herbicides through runoff or sediment into the remaining population, as stormwater will be captured and infiltrated within basins/swales in the road reserve and will not discharge into Hartfield Park. Construction will be subject to weed treatment, and to weed and dieback hygiene (see Action Management Plan,

Appendix H), to prevent introduction or spread into adjacent vegetation. Revegetation / landscaping will be undertaken with native species on local harvested topsoil, and ongoing weed management will be undertaken in road drainage basins/swales to prevent spread of weeds into adjacent vegetation. The Proposed Action is not expected to alter the fire regime of the area as it involves an upgrade to an existing road and revegetation / landscaping with local, native species. It is noted the 11 individuals of *A. gracilis* located in the DE have persisted within 40 m of the existing Tonkin Highway and in an area mapped as infested with dieback (Figure 14). Accordingly, the Proposed Action is not expected to cause edge impacts that result in a long-term decline to the remaining population outside the DE.

Reduce the area of occupancy of the species

The Proposed Action will reduce the area of occurrence of a population of *A. gracilis*, but will not reduce the distribution of the species which spans a 180 km range from Nambung in the north to Kenwick in the south, including 342 ha of known and supporting habitat (DPC 2015).

The Proposed Action will clear up to 1.58 ha of habitat for *A. gracilis*, which is approximately 19% of the 8.13 ha of habitat (VT5) mapped in the Survey Area. However, as described in Section 4.5.2 much of the habitat mapped in the DE is not populated by *A. gracilis*, which instead is found in a single, clumped population.

Fragment an existing population into two or more populations

The Proposed Action will not fragment an existing important population or the habitat of an existing population into two or more populations. Clearing of the habitat for *A. gracilis* will occur over linear patches adjacent to existing cleared and disturbed areas along Tonkin Highway.

Adversely affect habitat critical to the survival of a species

Habitat critical to the survival of *A. gracilis* includes the remnant vegetation in which important populations occur, areas of similar habitat and the local catchment for the surface and groundwater that maintains the habitat of the species.

The population identified in Hartfield Park during the survey for the Proposed Action is newly discovered and comprises one of two populations known within the Perth Metropolitan Region, the other being in the Greater Brixton Street Wetlands (DPC 2015). Given the size and the location within a Bush Forever site, the population may constitute an important population.

The Proposed Action will clear up to 1.58 ha of habitat for *A. gracilis* which may be associated with an important population. Accordingly, the Proposed Action may impact habitat critical to the survival of the species. The impact represents is approximately 19% of the 8.13 ha of habitat (VT5) mapped in the Survey Area. However, as described in Section 4.5.2 much of the habitat mapped in the DE is not populated by *A. gracilis*, which instead is found in a single, clumped population.

Disrupt the breeding cycle of a population

Population persistence and reproduction of *A. gracilis* is contingent on the availability of soil-stored seed which germinates following fire. The Proposed Action is not expected to alter the instances of fire in the area. The Proposed Action will therefore not disrupt the breeding cycle of any known populations.

Modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Proposed Action will modify and permanently remove 1.58 ha of *A. gracilis* habitat (VT5), which represents approximately 19% of the 8.13 ha of habitat within the Survey Area, and approximately 0.5% of the 342 ha of known and supporting habitat identified for the species

over its 180 km range (DPC 2015). As described in Section 4.5.2 much of the habitat mapped in the DE is not populated by *A. gracilis*, which instead is found in a single, clumped population.

The Proposed Action incorporates construction management to protect the integrity of surrounding native vegetation including habitat for *A. gracilis*.

Given the small scale of direct impacts and mitigation of indirect impacts the Proposed Action is not expected to impact habitat such that the species is likely to decline.

Result in invasive species that are harmful to the species becoming established in the species habitat

As noted in Section 5.1.2, the DE has existing weed infestation associated with urban development. The Proposed Action is not expected to result in the introduction or spread of weeds that results in significant impacts to *A. gracilis* habitat. This is due to construction management including weed treatment and hygiene, and revegetation / landscaping with native species on local harvested topsoil. Ongoing weed management will be undertaken in road drainage basins/swales to prevent spread of weeds into adjacent habitat.

The Proposed Action is not expected to introduce any invasive fauna species (e.g. Rabbit) that could be harmful to *A. gracilis*, as the Proposed Action will facilitate flow of traffic from surrounding suburbs through the DE and will not create a destination or facilitate access into surrounding areas of native vegetation.

Accordingly the Proposed Action is not expected to introduce or spread invasive species that could cause *A. gracilis* to decline.

Introduce disease that may cause the species to decline, or

Andersonia gracilis is highly susceptible to *Phytophthora cinnamomi*. The identified population of *A. gracilis* in Hartfield Park is located on land that is considered Dieback infected (Section 5.1.2).

As noted in Section 5.1.2, the Proposed Action will include Dieback hygiene during construction to protect adjacent uninfested areas that are protectable. The Proposed Action will establish protectable areas along sections of the DE boundary and incorporate access controls, equipment and vehicle washing/segregation, soil movement controls, and monitoring during construction.

The Proposed Action is not expected to spread Dieback through sediment in stormwater runoff, as stormwater will be captured and infiltrated within basins/swales in the road reserve and will not discharge into *A. gracilis* habitat outside the DE.

Accordingly the Proposed Action is not expected to introduce a disease that could cause *A. gracilis* to decline.

Interfere with the recovery of the species.

The Proposed Action is not inconsistent with the species Recovery Plan (DEC 2006), as presented in Section 7.

Conclusion

Based on the above assessment against the Significant Impact Guidelines, the Proposed Action is expected to cause significant residual impacts to *A. gracilis*, due to the direct impact of clearing to a potentially important population. Indirect impacts are not expected to be significant.

5.2.6 Summer Honeypot (*Banksia mimica*)

Overview of impacts

The Proposed Action will result the following impacts:

- Loss of three individuals of *B. mimica* from two locations
- Potential indirect impacts from the introduction or spread of weeds and *Phytophthora* Dieback, increased incidence of fire, and other edge impacts.

Assessment Framework

The potential impacts of the Proposed Action on *Banksia mimica* have been assessed against the significant impact criteria for Endangered species in the Significant Impact Guidelines 1.1 (DotE 2013), as listed in Section 5.2.4 but with respect to any population (rather than important populations, as for Vulnerable species).

The *B. mimica* population recorded in Hartfield Park (Population 15) comprises an important population, comprising 45 mature individuals within Bush Forever site 320 (DPC 2015).

Lead to a long-term decrease in the size of a population

The Proposed Action will remove three individuals from a total of 45 individuals recorded at Hartfield Park, which represents a 7% loss. This will decrease the size of Population 15.

Reduce the area of occupancy of a population

The Proposed Action will reduce the area of occurrence of an important population (Population 15) of *B. mimica*. The Proposed Action will clear up to 3.20 ha of habitat for *B. mimica*, which is approximately 16% of the 20.3 ha of habitat (VT2 and VT4) mapped in the Survey Area. As described in Section 4.5.3 much of the habitat mapped in the DE is not populated by *B. mimica*, which instead is found in one population.

Fragment an existing important population into two or more populations

The Proposed Action will not fragment an existing important population or the habitat of an existing population into two or more populations. Clearing of the habitat for *B. mimica* will occur over linear patches adjacent to existing cleared and disturbed areas along Tonkin Highway.

Adversely affect habitat critical to the survival of a species

The Conservation Advice for *B. mimica* does not identify critical habitat. The Significant Impact Guidelines 1.1 (DotE 2013) define critical habitat as areas that are necessary:

- For activities such as foraging, breeding, roosting, or dispersal
- For the long-term maintenance of the species (including the maintenance of species essential to the survival of the species, such as pollinators)
- To maintain genetic diversity and long term evolutionary development, or
- For the reintroduction of populations or recovery of the species.

Given that the population at Hartfield Park comprises an important population, it may potentially be important for future dispersal, genetic diversity or reintroduction or recovery of the species. Accordingly the habitat associated with the Hartfield Park population may potentially represent critical habitat for the species.

The Proposed Action will clear up to 3.20 ha of habitat for *B. mimica*, which may comprise critical habitat. The impact represents is approximately 16% of the 20.3 ha of habitat (VT2 and VT4) mapped in the Survey Area. However, the loss of three individuals represents 0.04% of

the total estimated population of 7300 mature plants. Also, much of the potential habitat mapped in the DE is not populated by *B. mimica*, which instead is found in one population.

Disrupt the breeding cycle of a population

B. mimica reproduces via underground rhizomes that re-sprout following fire. Population persistence and reproduction of *B. mimica* is contingent on the availability of soil-stored seed which germinates following fire. Due to the implementation management measures, the Proposed Action is not expected to alter the instances of fire in the area. The species produces small amounts of seed, resulting in 'clumping' of populations that are vegetative clones. The Proposed Action will not affect the breeding cycle of any known populations.

Modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Proposed Action will modify and permanently remove 3.2 ha of *B. mimica* habitat (VT2 and VT4), which represents approximately 16% of the 20.3 ha of habitat within the Survey Area. Much of the habitat mapped in the DE is not populated by *B. mimica*, which instead is found in one population.

The area of habitat across other populations within the species range is not recorded, however the removal of three individuals comprises 0.04% of the total species population which suggests that larger areas of habitat are located at Mogumber and the Whicher Range.

The Proposed Action incorporates construction management to protect the integrity of surrounding native vegetation including habitat for *B. mimica*.

Given the small scale of loss of individuals compared to the total population and the mitigation of indirect impacts, the Proposed Action is not expected to impact the availability or quality of habitat such that the species is likely to decline.

Result in invasive species that are harmful to a species becoming established in the species' habitat

As noted in Section 5.1.2, the DE has existing weed infestation associated with urban development. The Proposed Action is not expected to result in the introduction or spread of weeds that results in significant impacts to *B. mimica* habitat. This is due to construction management including weed treatment and hygiene, and revegetation / landscaping with native species on local harvested topsoil. Ongoing weed management will be undertaken in road drainage basins/swales to prevent spread of weeds into adjacent habitat.

The Proposed Action is not expected to introduce any invasive fauna species (e.g. Rabbit) that could be harmful to *B. mimica*, as the Proposed Action will facilitate the flow of traffic from surrounding suburbs through the DE and will not create a destination or facilitate access into surrounding areas of native vegetation.

Accordingly the Proposed Action is not expected to introduce or spread invasive species that could cause *B. mimica* to decline.

Introduce disease that may cause the species to decline

B. mimica is susceptible to *Phytophthora cinnamomi*. The identified population of *B. mimica* in Hartfield Park is located on land that was considered Dieback infected, however some habitat (VT4) in the north was assessed as uninfested (Section 5.1.2).

As noted in Section 5.1.2, the Proposed Action will include Dieback hygiene during construction to protect adjacent uninfested areas that are protectable. The Proposed Action will establish protectable areas along sections of the DE boundary and incorporate access controls, equipment and vehicle washing/segregation, soil movement controls, and monitoring during construction.

The Proposed Action is not expected to spread Dieback through sediment in stormwater runoff, as stormwater will be captured and infiltrated within basins/swales in the road reserve and will not discharge into *B. mimica* habitat outside the DE.

Accordingly the Proposed Action is not expected to introduce a disease that could cause *B. mimica* to decline.

Interfere with the recovery of the species.

There is no Recovery Plan for this species; however the Conservation Advice identifies a number of research priorities and conservation actions (TSSC 2016). The Proposed Action is inconsistent with the following recovery measure in the Conservation Advice.

- Ensure road widening and maintenance activities (or other infrastructure or development activities as appropriate) in areas where the species occurs do not adversely impact on known populations.

Conclusion

Based on the above assessment against the Significant Impact Guidelines, the Proposed Action is expected to cause significant residual impacts to *B. mimica*, due to the direct impact of clearing to an important population. Indirect impacts are not expected to be significant.

5.3 Risk assessment

Appendix G presents a risk assessment for the Proposed Action. The risk assessment addresses the following:

- Likelihood and consequence of impacts to MNES, based on the material presented in Sections 4, 5.1 and 5.2 of the Preliminary Documentation
- Whether nature and/or scale of impacts are unknown, unpredictable or irreversible
- Confidence of predictions of impacts.

The risk assessment indicates that the Proposed Action poses a low residual risk to MNES, with the exception of the following:

- Direct impacts to MNES from proposed clearing: High residual risk, to be counterbalanced by an Offset Strategy (Section 8, Appendix I).
- Indirect impacts to MNES from introduction or spread of weeds and Dieback: Medium residual risk, to be addressed by Action Management Plan (Appendix H).

6. Avoidance and mitigation measures

6.1 Impact avoidance

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

1. The DE incorporates a predominantly cleared corridor along Tonkin Highway, Hale Road and Welshpool Road, including an existing stormwater infiltration basin.
2. The widening of Tonkin Highway from 4 to 6 lanes will occur in the median in order to minimise the impacts on adjacent native vegetation and MNES.
3. The option of south bound ramps at the Hale Road intersection was discarded to reduce the size of the intersection and minimise impacts to the Hartfield Park Bush Forever site
4. The DE lies over BWSCP TEC in relatively degraded condition compared to the TEC in the wider Survey Area, including that of Hartfield Park.
5. The DE avoids bisection of patches of native vegetation, including Hartfield Park and Greater Brixton Street Wetlands. The DE is limited to land adjacent to existing cleared areas of Tonkin Highway, Hale Road, and Welshpool Road. As shown in Figure 3 the DE does not fragment any of the seven patches of BWSCP TEC identified in the Survey Area.
6. The DE avoids additional disruption of linkages between TEC patches and wider vegetation and fauna corridors at Hartfield Park or Greater Brixton Street Wetlands.
7. The Proposed Action will be implemented to avoid impacts to a potential breeding tree with a hollow suitable for Black Cockatoo nesting, which lies adjacent to the DE. The tree (ID 204) is a Coastal Blackbutt located south of Victoria Road in Kenwick, and the trunk lies outside the DE however the canopy and root zone extend within the DE. Design and construction will be undertaken to avoid impacts to the tree hollow, root zone and canopy.
8. All associated infrastructure for the Proposed Action will be contained within the DE, including road pavements, footpaths, noise walls, stormwater drainage, fencing, and electrical power reticulation.
9. All laydowns, stockpiles and access tracks will be constructed within existing cleared areas or within the permanent footprint of the works. No native vegetation will be cleared for temporary works outside the permanent footprint.
10. The design of the Proposed Action has sought to reduce and minimise the proposed clearing by steepening batter slopes and installation of safety barriers. Earthworks have been reduced (fill height/cut depth) in areas where native vegetation exists. Any embankments above 2.5 m have been steepened to 3:1 with an additional 1 m of barrier earthworks required for barrier protection. Without the proposed wire-rope barrier, the minimum slope would be 4:1, requiring a larger clearing footprint.
11. Kerbing has been considered and will be implemented in the design where appropriate, reducing the need for table drains, which would require a larger clearing footprint.
12. Surface runoff within the DE will drain into infiltration basins and/or swales constructed within the DE. The infiltration basins/swales will be designed to capture and infiltrate runoff from a 1 in 100 year Average Recurrence Interval (ARI) rainfall event, to prevent stormwater runoff into adjacent areas of native vegetation. The infiltration basins/swales will be planted with native vegetation to assist with nutrient stripping of stormwater during

infiltration. The impacts of clearing for the proposed drainage is considered to be conservative given many of the basins will be located in areas already cleared.

The measures detailed in the Action Management Plan (Appendix H) will further reduce impacts to remaining BWSCP TEC, Black Cockatoo habitat and Threatened flora habitat.

6.2 Justification for residual impacts

Following the avoidance and minimisation measures presented in Section 6.1, the Proposed Action will result in the direct impacts presented in Section 5.1.1. These direct impacts will be reduced, where practicable, during detailed design and construction planning, but cannot be further reduced at the current planning and design stage.

Further reduction and avoidance is limited by the requirement for the Proposed Action to meet road safety standards. Lane widths, road vertical and horizontal geometry, steepness of roadside batters and road pavement construction are dictated by a series of Australian Standards and Austroads guidelines. The footprint and residual impact presented represents the minimum impact area possible in order to allow the Proposed Action to proceed.

The direct impacts presented in Section 5.1.1 are required in order to provide the required functionality of the Proposed Action to fulfil the social and economic objectives presented in Section 9.4, and with consideration to stakeholder objectives and concerns (see Sections 9.1 and 9.2. Further avoidance or reduction of impact is not considered practicable or achievable given the current planning and design for the Proposed Action.

6.3 Management actions

The Action Management Plan (Appendix H) presents management objectives, performance criteria, actions and monitoring for the following aspects:

- Clearing and access controls
- Dieback and weed management
- Fauna management
- Sediment and erosion controls
- Soil management
- Revegetation and landscaping.

6.4 Revegetation

Revegetation within the DE will be undertaken in accordance with *MRWA Vegetation Placement within the Road Reserve* Doc. No. 6707/022 (MRWA, 2003). This guide defines the recommended setbacks and clearance requirements that apply to all revegetation or landscaping associated with new road construction.

Revegetation will utilise locally native species that will be planted in the first winter after construction is completed. Opportunities to use species of foraging habitat for Black Cockatoos, including but not limited to, *Banksia* spp., *Hakea* spp., *Grevillea* spp. and *Eucalyptus* spp. will be investigated as part of the landscaping and revegetation works, while avoiding the potential to increase vehicle strike through appropriate placement. Black Cockatoo foraging species will not be placed within 10 m of the road edge.

Placement of vegetation near road infrastructure is restricted to maintain road safety. These requirements minimise ongoing maintenance and maintain a standard amenity level for road users. Revegetation will incorporate these restrictions when undertaking planting, in particular,

the need for roadside maintenance and clear zones. Rehabilitation would not include areas required for ongoing operations such as drainage basins, road embankments and median strips.

6.5 Effectiveness of avoidance and mitigation measures

Main Roads has a strong track record of both developing and implementing best practice in environmental management and implementation of management measures. The avoidance and mitigation measures presented in this Preliminary Documentation, including the Action Management Plan, have been successfully implemented on past projects subject to EPBC conditions and management measures including:

- Gateway WA – Perth Airport and Freight Access Project (EPBC 2010/5384).
- Perth-Darwin National Highway (EPBC 2013/7042)
- Mitchell Freeway Extension - Burns Beach to Hester Avenue (EPBC 2013/7091)
- Great Northern Highway Upgrade Stage 2 (EPBC 2016/7761)
- Bowelling Curves Realignment (EPBC 2016/7757)
- Northam Pithara Road Widening (EPBC 2015/7454).

Main Roads is a State agency with an assured record of responsible environmental management and environmental management systems. Main Roads is not subject to any past or present proceedings under Commonwealth or State law for protection of the environment or conservation and sustainable use of natural resources. Main Roads track record indicates a history of effective implementation and monitoring of management measures to ensure effectiveness and implementation of corrective actions when effectiveness does not meet completion criteria.

7. Application of Recovery Plans and Threat Abatement Plans

The Proposed Action is generally not inconsistent with relevant Recovery Plans, Threat Abatement Plans and Conservation Advice relating to the MNES identified in the DE, as presented in Table 12.

The Proposed Action is inconsistent with the objective of the Recovery Plan for Slender Andersonia, as it will cause a small reduction to an insitu population in the wild. However the Proposed Action is not inconsistent with the actions listed in the Recovery Plan.

Table 12 Assessment against Recovery and Threat Abatement Plans

Recovery Plan / Abatement Plan	Priority Actions	Assessment against Plan
<p>Banksia Woodlands of the Swan Coastal Plain TEC Threatened Species Scientific Committee 2016, Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community, Department of the Environment and Energy</p>	<p>The Conservation Advice recommends the following priority protection and restoration actions:</p> <ol style="list-style-type: none"> 1. Prevent vegetation clearance and direct habitat damage, through: <ul style="list-style-type: none"> • Identify and map priority areas for protection/restoration • Prevent further clearance, fragmentation particularly for high conservation value, unmodified and old growth areas • Consider important landscape connections for reservation or other conservation tenure • Reduce cumulative impacts through liaison and planning with Local and State Government • Avoiding and mitigating impacts before offsetting, and match offsets to the same sub-community • Protect soil seed bank • Retain fauna habitat features and protect fauna during construction. 2. Prevent weeds, feral animals, dieback and other diseases, though: <ul style="list-style-type: none"> • Minimise soil disturbance • Avoid introduction and spread of weeds • Prevent introduction of feral and domestic animals • Monitor <i>P. cinnamomi</i> and manage early for local eradication 	<p>The Proposed Action is not inconsistent with the recommendations of the Conservation Advice, through the following:</p> <ul style="list-style-type: none"> • Survey and mapping of TEC extent and condition • Minimised clearance of TEC, avoiding fragmentation of any TEC patches, and avoiding better condition TEC within Hartfield Park • Avoided and mitigated impacts to TEC (see Section 6), and provision of offsets from the same sub-community • Local harvesting and reuse of topsoil for revegetation within the road reserve • Revegetation to use local, native species to provide buffer to TEC • Weed and Dieback surveys, treatment and hygiene to avoid the introduction and spread of weeds and Dieback • Access controls and fencing to prevent unauthorised access that could introduce or spread weeds, Dieback or fire • Ongoing monitoring and treatment of weeds in road reserves • The Proposed Action is not expected to alter the fire regime, hydrological regimes or introduce grazing pests or feral/domestic animals within BWSCP TEC patches.

Recovery Plan / Abatement Plan	Priority Actions	Assessment against Plan
	<ul style="list-style-type: none"> • Appropriate weed and disease hygiene • Monitoring and treatment of weeds for new roads, for several years after construction • Avoid impacts on non-target species from control actions. <ol style="list-style-type: none"> 3. Manage groundwater abstraction. 4. Manage fire, through identifying appropriate fire regimes, weed control and implementing fire management. 5. Preventing grazing damage, through fencing and managing populations. 6. Revegetation, including: <ul style="list-style-type: none"> • Use local seeds for canopy/understorey and species resilient to climate change • Site specific restoration with appropriate FCT • Restore wildlife corridors and linkages • Habitat for conservation significant species, including Carnaby's Cockatoo • Adaptive management regimes • Weed management. 7. Communication and support, including a communication strategy, education programs, local participation, promotion of awareness with agencies and industries, and measures for new residential areas. 	<p>Accordingly, the Proposed Action is not inconsistent with the priority protection and restoration actions of the Approved Conservation Advice for BWSCP TEC (2016).</p>

Recovery Plan / Abatement Plan	Priority Actions	Assessment against Plan
<p>Carnaby's Cockatoo</p> <p>Department of Parks and Wildlife 2013, Carnaby's Cockatoo (<i>Calyptorhynchus latirostris</i>) Recovery Plan, Department of Parks and Wildlife, Perth, Western Australia.</p>	<p>The objective of this Recovery Plan is to stop further decline in the distribution and abundance of Carnaby's Cockatoo by protecting the birds throughout their life stages and enhancing habitat critical for survival throughout their breeding and non-breeding range, ensuring that the reproductive capacity of the species remains stable or increases.</p> <p>The recovery actions within the plan include:</p> <ul style="list-style-type: none"> • Protect and manage breeding habitat and associated feeding habitat • Protect and manage of non-breeding habitat • Undertake regular monitoring • Conduct research to inform management • Manage other impacts • Engage with the broader community • Undertake information and communication activities. <p>The Recovery Plan specifies activities that will adversely affect Carnaby's Cockatoo should be avoided, and then minimised or mitigated if avoidance cannot be achieved.</p>	<p>The Proposed Action is not inconsistent with the recommendations of the Recovery Plan, through the following:</p> <ul style="list-style-type: none"> • The Proposed Action will not involve clearing of any known or potential breeding trees/hollows. The DE is 15 km from the closest breeding record for Carnaby's Cockatoo • The Proposed Action will not involve clearing of any known roosting trees • The Proposed Action has been subject to a targeted survey to identify Carnaby's Cockatoo habitat; and consideration of Carnaby's Cockatoo, habitat mapping by DBCA • The Proposed Action has been planned and designed to minimise clearing of potential breeding and foraging habitat for Carnaby's Cockatoo • The Proposed Action incorporates design and management measures to protect potential breeding and foraging habitat in adjacent native vegetation • Planning and design of the Proposed Action has involved consultation with relevant stakeholders including the broader community. <p>Accordingly, the Proposed Action is not inconsistent with the Carnaby's Cockatoo Recovery Plan (2013).</p>
<p>Baudin's Cockatoo and FRTBC</p>	<p>The objective of this Recovery Plan is to stop further decline in the breeding populations of Baudin's Cockatoo and FRTBC and to ensure</p>	<p>The Proposed Action is not inconsistent with the recommendations of the Recovery Plan, through the following:</p>

Recovery Plan / Abatement Plan	Priority Actions	Assessment against Plan
<p><i>Forest Black Cockatoo (Baudin's Cockatoo</i> <i>Calyptorhynchus baudinii and Forest Red-tailed Black Cockatoo</i> <i>Calyptorhynchus banksii naso)</i> <i>Recovery Plan</i> (Western Australian Department of Environment and Conservation, 2008)</p>	<p>their persistence throughout their current range in the south-west of Western Australia.</p> <p>Priority actions within the plan include (listed in highest to lowest priority):</p> <ul style="list-style-type: none"> • Seek the funding required to implement future recovery actions • Determine and promote non-lethal means of mitigating fruit damage by Baudin's Cockatoo in orchards • Eliminate illegal shooting • Develop and implement strategies to allow for the use of noise emitting devices in orchards • Determine and implement ways to remove feral Honeybees from nesting hollows • Identify factors affecting the number of breeding attempts and breeding success and manage nest hollows to increase recruitment • Determine and implement ways to minimise the effects of mining and urban development on habitat loss • Determine and implement ways to manage forests for the conservation of Forest Black Cockatoos • Identify and manage important sites and protect from threatening processes • Map feeding and breeding habitat critical to survival and important populations, and prepare management guidelines for these habitats 	<ul style="list-style-type: none"> • The Proposed Action is not related to mining, orchards or forest management, nor is the Proposed Action expected to increase the prevalence of feral honeybees or risk of illegal shooting • As a component of urban development, the Proposed Action has been subject to survey to identify Black Cockatoo habitat (including consideration of Black Cockatoo habitat mapping by DBCA and breeding records from WA museum) • The Proposed Action will not involve clearing of any known or potential breeding trees/hollows. The DE is 7.5 km from the closest breeding record for FRTBC and 27 km from the closest breeding record for Baudin's Cockatoo • The Proposed Action will not involve clearing of any known roosting trees • The DE has been planned and designed to minimise clearing of FRBTC and Baudin's Cockatoo foraging habitat. <p>Accordingly, the Proposed Action is not inconsistent with the Forest Black Cockatoo Recovery Plan (Chapman 2008).</p>

Recovery Plan / Abatement Plan	Priority Actions	Assessment against Plan
	<ul style="list-style-type: none"> • Monitor population numbers and distribution • Determine the patterns and significance of movement. <p>With respect to urban development, the following recovery actions are specified:</p> <ul style="list-style-type: none"> • Fauna survey to identify presence of Commonwealth listed threatened fauna species and referral of any proposed impacts to DEE • Wherever possible, retention of habitats known to be used for feeding, breeding and roosting by Forest Black Cockatoos • Obtain advice from State Government and Western Australian Museum on protection of remaining habitat. 	
<p>Wavy-leaved Smokebush Department of Environment and Conservation (2009a). Wavy-leaved Smokebush (<i>Conospermum undulatum</i>) Recovery Plan. Commonwealth Department of the Environment, Water, Heritage</p>	<p>The objective of this Recovery plan is to maintain or improve the conservation status of <i>Conospermum undulatum</i> during the term of this plan by abating identified threats. The Recovery Plan states the following recovery actions for <i>C. undulatum</i>:</p> <ul style="list-style-type: none"> • Coordinate recovery actions • Monitor populations • Liaise with relevant land managers regarding management of bushland containing <i>Conospermum undulatum</i>. • Install DRF markers at Populations 14,17 and 23 and sub populations 1c-e, 4g, 4k, 4o, 8b, 10a+d, 11b, 16b-l, 18i,18j, 18n and 22a and b. • Fence subpopulations 	<p>The Proposed Action is consistent with the objective of the Plan as it will result in an improvement to the conservation status of <i>C. undulatum</i> through an Offset Strategy. The Offset Strategy will increase the area of <i>C. undulatum</i> in the conservation estate resulting in a net ecological benefit.</p> <p>The Proposed Action is not inconsistent with the recovery actions outlined in the Recovery Plan.</p> <ul style="list-style-type: none"> • The Proposed Action will not interfere with the monitoring of populations, liaison with land managers, the collection of seed, assessment of development applications, research trials, fire management strategies, or raising awareness of the species

Recovery Plan / Abatement Plan	Priority Actions	Assessment against Plan
and the Arts, Canberra	<ul style="list-style-type: none"> • Collect seed and other material to preserve genetic diversity • Undertake weed control • Develop and implement a rabbit control strategy • Reassess population numbering and size based on tenure • Assess development applications for lands containing <i>Conospermum undulatum</i> • Increase area of <i>Conospermum undulatum</i> in the conservation estate - • Conduct further surveys • Develop and implement a fire management strategy • Promote awareness • Develop and implement fire and soil disturbance trials • Obtain biological and ecological information • Map habitat critical to the survival of <i>Conospermum undulatum</i> • Review the plan and need for further recovery actions. 	<ul style="list-style-type: none"> • DRF markers are not required to be installed as the Proposed Action will not interfere with any of the listed populations • A targeted survey was conducted within the DE and adjacent habitats • Main Roads will undertake weed control measures in the DE during and post construction of the Proposed Action.
Slender Andersonia Department of Environment and Conservation (2006) Slender Andersonia (<i>Andersonia gracilis</i>) Interim	<p>The objective of this Interim Recovery Plan is to abate identified threats and maintain or enhance viable <i>in situ</i> populations to ensure the long-term preservation of the species in the wild.</p> <p>The Interim Recovery Plan states the following recovery actions <i>A. gracilis</i>:</p> <ul style="list-style-type: none"> • Coordinate recovery actions • Verify known populations 	<p>The Proposed Action is inconsistent with the objective of the Recovery Plan as it will cause a minor reduction to <i>in situ</i> populations in the wild.</p> <p>However it is not inconsistent with the recovery actions, through the following:</p> <ul style="list-style-type: none"> • The Proposed Action will not interfere with the monitoring of populations, the verification of known populations,

Recovery Plan / Abatement Plan	Priority Actions	Assessment against Plan
<p>Recovery Plan 2006-2011. Department of Environment and Conservation, Western Australia</p>	<ul style="list-style-type: none"> • Map habitat critical to the survival of the species • Install Declared rare Flora markers • Liaise with relevant land managers • Map and manage dieback disease • Monitor populations • Conduct further surveys • Collect and preserve seed and cutting material • Research fire ecology and develop a fire management strategy • Implement a fire management strategy • Implement weed control • Install fencing if required • Promote awareness • Seek security of tenure for important populations • Obtain biological and ecological information • Review the need for further recovery actions. 	<p>mapping of critical habitat, liaison with relevant land managers,</p> <ul style="list-style-type: none"> • The individuals of <i>A. gracilis</i> within Population 2 will be marked with DRF markers • Weed and Dieback surveys, treatment and hygiene to avoid the introduction and spread of weeds and Dieback • Access controls and fencing to prevent unauthorised access that could introduce or spread weeds, Dieback or fire • Main Roads will undertake ongoing monitoring and treatment of weeds in their road reserves, consistent with the Interim Recovery Plan.
<p>Summer Honeypot Department of the Environment, Water, Heritage and the Arts (2008a). <i>Approved Conservation</i></p>	<p>The Conservation Advice states that the main identified threats to the Summer Honeypot is land clearing for agriculture and urban development. The main potential threats include dieback caused by <i>Phytophthora cinnamomi</i>, and frequent fire which may encourage weed invasion and habitat degradation.</p> <p>The Conservation Advice recommends the following regional and local priority recovery and threat abatement actions:</p>	<p>The Proposed Action is inconsistent with the recommendations of the Conservation Advice, as the road development activities will adversely impact on known populations of <i>B. mimica</i> through the removal of three individuals and 3.2 ha of habitat.</p> <p>However, efforts will be made to reduce the impacts on the recovery of the species, through the following measures:</p>

Recovery Plan / Abatement Plan	Priority Actions	Assessment against Plan
<p><i>Advice for Dryandra mimica (Summer Honeypot).</i> Canberra: Department of the Environment, Water, Heritage and the Arts.</p>	<ul style="list-style-type: none"> • Monitor and minimise habitat loss, disturbance and modification, to identify key threats, and species recovery, including: • Ensure road widening and maintenance activities (or other infrastructure or development activities (or other infrastructure or development activities as appropriate) in areas where the species occurs do not adversely impact on known populations. • Develop and implement a suitable fire management strategy • Develop and implement suitable hygiene protocols to protect against outbreaks of dieback caused by <i>Phytophthora cinnamomi</i> • Raise awareness. 	<ul style="list-style-type: none"> • Weed and Dieback surveys, treatment and hygiene to avoid the introduction and spread of weeds and Dieback • Access controls and fencing to prevent unauthorised access that could introduce or spread weeds, Dieback or fire • Ongoing monitoring and treatment of weeds in road reserves.
<p>Dieback <i>Threat Abatement Plan for Disease in Natural Ecosystems Caused by Phytophthora cinnamomi</i> (Department of the Environment 2014).</p>	<p>The goal of this Threat Abatement Plan is to minimise the impacts of dieback on MNES under the EPBC Act and priority biodiversity assets identified by the actions of this plan.</p> <p>The plan has three objectives:</p> <ul style="list-style-type: none"> • Identify and prioritise for protection biodiversity assets that are, or may be, impacted by dieback. • Protect priority biodiversity assets through reducing the spread and mitigating the impacts of dieback. • Communication and training. 	<p>The Proposed Action is not inconsistent with the goal or objectives of the Threat Abatement Plan.</p> <p>The Threat Abatement Plan identifies road construction as a high risk activity requiring dieback education, restricting access to infected locations, and enforcing hygiene procedures to minimise the spread of dieback in the landscape.</p> <p>A Dieback Occurrence Assessment was undertaken for the Proposed Action, which identified infested, uninfested and unprotectable areas along the DE.</p> <p>The Assessment has enable the identification of potential impacts to adjacent areas of vulnerable flora and vegetation including BWSCP TEC, Black Cockatoo habitat and threatened flora.</p>

Recovery Plan / Abatement Plan	Priority Actions	Assessment against Plan
		<p>The Proposed Action will incorporate Dieback hygiene during construction to protect adjacent vegetation that may be uninfested and vulnerable.</p> <p>The Proposed Action will establish protectable areas along sections of the DE boundary and incorporate access controls, equipment and vehicle washing/segregation, soil movement controls, and monitoring during construction (see Action Management Plan in Appendix H).</p> <p>In particular, soil harvested from infested or unidentified areas will not be reused in protectable areas, and equipment and vehicles working in infested areas will not be able to access protectable areas unless cleaned and inspected. Soil harvested from infested areas will only be reused in infested areas or else will be disposed of at a licensed landfill.</p> <p>The Proposed Action is not expected to spread Dieback through sediment in stormwater runoff, as stormwater will be captured and infiltrated within basins/swales in the road reserve and will not discharge into Hartfield Park outside the DE.</p>
<p>Introduced species (Cats) Threat Abatement Plan for Predation by Feral Cats (Department of the Environment, 2015).</p>	<p>Threat abatement plan has the following objectives:</p> <ul style="list-style-type: none"> • Effectively control feral cats in different landscapes • Improve effectiveness of existing control options for feral cats • Develop or maintain alternative strategies for threatened species recovery • Increase public support for feral cat management and promote responsible cat ownership 	<p>The Threat Abatement Plan is not directly relevant to the Proposed Action, however the Proposed Action is not inconsistent with the Plan.</p> <p>The Proposed Action will not increase the prevalence of feral cats in the area, as it will encourage through traffic and not provide a destination or increase public access to surrounding vegetation. The Proposed Action will not increase food sources that may attract cats.</p>

Recovery Plan / Abatement Plan	Priority Actions	Assessment against Plan
		<p>The DE is not considered to be existing breeding habitat for Black Cockatoos, therefore predation of chicks from nesting hollows is unlikely to occur.</p>
<p>Introduced species (Rabbits) Threat Abatement Plan for competition and land degradation by rabbits (Department of the Environment and Energy 2016)</p>	<p>Threat abatement plan has the following objectives:</p> <ul style="list-style-type: none"> • Strategically manage rabbits at the landscape scale and suppress rabbit populations to densities below threshold levels in identified priority areas • Improve knowledge and understanding of the impact of rabbits and their interactions with other species and ecological processes • Improve the effectiveness of rabbit control programs. 	<p>The Threat Abatement Plan is not directly relevant to the Proposed Action, however the Proposed Action is not inconsistent with the Plan.</p> <p>The Proposed Action will not increase the prevalence of rabbits in the area, as it will encourage through traffic and not provide a destination or increase public access to surrounding vegetation.</p>
<p>Introduced species (Fox) Threat Abatement Plan for Predation by the European Red Fox (Department of the Environment, Water, Heritage and the Arts 2008b).</p>	<p>Threat abatement plan has the following objectives:</p> <ul style="list-style-type: none"> • Prevent foxes occupying new areas in Australia and eradicate foxes from high-conservation-value 'islands' • Promote the maintenance and recovery of native species and ecological communities that are affected by fox predation • Improve knowledge and understanding of fox impacts and interactions with other species and other ecological processes Improve the effectiveness, target specificity, integration and humaneness of control options for foxes 	<p>The Threat Abatement Plan is not directly relevant to the Proposed Action, however the Proposed Action is not inconsistent with the Plan.</p> <p>The Proposed Action will not increase the prevalence of the Red Fox in the area, as it will encourage through traffic and not provide a destination or increase public access to surrounding vegetation. The Proposed Action will not increase food sources that may attract the Red Fox.</p> <p>The DE is not considered to be existing breeding habitat for Black Cockatoos, therefore predation of chicks from nesting hollows is unlikely to occur.</p>

8. Offsets

8.1 Proposed offset strategy

Main Roads are investigating a number of options to develop a package of offsets to counterbalance the significant residual impacts of the Proposed Action to BWSCP TEC, Carnaby's Cockatoo, FRTBC, Baudin's Cockatoo, Wavy-Leaved Smokebush, Slender Andersonia and Summer Honeypot. The options under investigation comprise acquisition of land and funding of land management.

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

Main Roads is liaising with DBCA regarding acquisition of suitable land in order to meet offset requirements and intends to have all required offsets in place within 24 months of commencement of construction. Main Roads has provided a separate confidential package of information on the five offsets under consideration to DAWE. Information on these offset properties is confidential due to ongoing negotiations with landowners and DBCA.

Identification and acquisition of land to counterbalance significant residual environmental impacts associated with Main Roads infrastructure projects is now being managed through a Memorandum of Understanding (MoU) between Main Roads and DBCA. The MoU commits Main Roads funding to assist DBCA in identifying and acquiring suitable land offsets to be added to the conservation estate. Once suitable offset land is acquired, Main Roads will reimburse DBCA the land acquisition costs. Acquisition of suitable offset land aims to satisfy Commonwealth and State environmental compliance requirements.

Table 13 provides a summary of the potential for the offset package to counterbalance the potential significant residual impacts to BWSCP TEC, Carnaby's Cockatoo, FRTBC, Baudin's Cockatoo, Wavy-Leaved Smokebush, Slender Andersonia and Summer Honeypot. Appendix I provides a draft Offset Strategy with supporting information offsets where available, and a completed offsets assessment guide and justification for each direct offset.

Table 13 Summary of offset package compensation for potential significant residual impacts

Residual impacts to MNES	Offset 1 Gingin offset	Offset 2 Lake Clifton offset	Offset 3 Slender Andersonia offset	Offset 4 Mogumber offset	Offset 5 Maddington offset
MNES values confirmed	Inferred, to be surveyed	Inferred, to be surveyed	Inferred, to be surveyed	Inferred, to be surveyed	Inferred, to be surveyed
BWSCP TEC 3.99 ha x quality 6 = 2.39 ha total	21 ha = 104% of impact offset	May contain TEC, not accounted for in this offset	Site unlikely to be suitable	May contain TEC, not accounted for in this offset	May contain TEC, not accounted for in this offset
Carnaby's Cockatoo 18.74 ha x quality 6 = 11.24 ha total	96 ha = 100% of impact offset	May contain habitat, not accounted for in this offset	Site unlikely to be suitable	May contain habitat, not accounted for in this offset	May contain habitat, not accounted for in this offset
FRTBC 19.14 ha x quality 6 = 11.48 ha total	90 ha = 100% of impact offset	May contain habitat, not accounted for in this offset	Site unlikely to be suitable	May contain habitat, not accounted for in this offset	May contain habitat, not accounted for in this offset
Baudin's Cockatoo 19.14 ha x quality 6 = 11.48 ha total	May contain habitat, not accounted for in this offset	98 ha = 100% of impact offset	Site unlikely to be suitable	Site unlikely to be suitable	May contain habitat, not accounted for in this offset
Slender Andersonia 11 individuals	Site unlikely to be suitable	Site unlikely to be suitable	75 individuals = 101% of impact offset	Site unlikely to be suitable	Site unlikely to be suitable
Summer Honeypot Three individuals	May contain populations, not accounted for in this offset	Site unlikely to be suitable	Site unlikely to be suitable	21 individuals = 104% of impact offset	Site unlikely to be suitable
Wavy-Leaved Smokebush 62 individuals 7.45 ha critical habitat x quality 6 = 4.47 ha total	Site unlikely to be suitable	Site unlikely to be suitable	Site unlikely to be suitable	Site unlikely to be suitable	125 individuals = 101% of impact offset 16 ha = 100% of impact offset

Extent to which offset package compensates potential significant residual impacts

As presented in Table 13, the offset package is expected to provide adequate compensation for potential significant residual impacts to BWSCP TEC, Carnaby's Cockatoo, FRTBC, Baudin's Cockatoo, Wavy-Leaved Smokebush, Slender Andersonia and Summer Honeypot.

Offsets 1 to 5 will involve transfer of freehold properties to DBCA, to provide at 100% direct offset for significant residual impacts to BWSCP TEC, Carnaby's Cockatoo, FRTBC, Baudin's Cockatoo, Wavy-Leaved Smokebush, Slender Andersonia and Summer Honeypot.

Main Roads are consulting with DBCA to confirm the availability and commercial terms to acquire Offsets 1 to 5. Should the properties be suitable for acquisition, Main Roads will arrange for surveys to confirm the ecological values present, including extent and quality of values associated with MNES.

The draft Offset Strategy will be refined based on the findings of surveys underway, consultation with DBCA and pursuit of additional offsets for BWSCP TEC. The refined Offset Strategy will inform preparation of an Offset Proposal, to achieve a minimum 100% direct offset for all seven MNES.

Suitability of potential offset sites for BWSCP TEC, Black Cockatoos, and threatened flora

Offset 1 is suitable for BWSCP TEC, Carnaby's Cockatoo and FRTBC, lying within the distribution of the Black Cockatoos, on vegetation complexes associated with the TEC, and representative vegetation identified through site inspection.

Offset 2 will be suitable for Baudin's Cockatoo, Offset 3 will be suitable for Slender Andersonia, and Offset 4 will be suitable for Summer Honeypot. Offsets 2, 3 and 4 may potentially be suitable for BWSCP TEC, Carnaby's Cockatoo and FRTBC, depending on their location. At present the ecological values of the offset sites remain to be confirmed. Accordingly, offset of the TEC, Carnaby's Cockatoo and FRTBC is not accounted for in the preliminary offset calculations for Offsets 2, 3 and 4.

Offset 5 is suitable for Wavy-Leaved Smokebush. Depending on the ecological values of Offsets 1 and 2, Offset 5 may potentially be used to counterbalance residual impacts to BWSCP TEC, Carnaby's Cockatoo and FRTBC. The specific ecological values of Offset 5 and thus the quantum of TEC or Black Cockatoo habitat included remains to be confirmed. Accordingly, offset of the TEC and Black Cockatoo impacts is not accounted for in the preliminary offset calculations for Offset 5.

Conservation gain, timing and certainty

Offsets 1 to 5 will involve transfer of land to DBCA, with conservation gain through protection against loss and land management to maintain MNES values. The time to achieve conservation gain will be effective immediately upon land transfer and the level of certainty is high (90%).

Land tenure, acquisition and management

Options 1 to 5 will involve transfer of land to DBCA. Main Roads does not have the authority to create conservation reserves. Main Roads will provide funds to DBCA for the acquisition of offset land and DBCA is responsible for arranging the land acquisition process. DBCA and the Conservation and Parks Commission are then responsible for the management of the land and creation of the conservation reserve.

Options 1 to 5 will involve either direct transfer of land owned by Main Roads or acquisition of land from a third party, with DBCA arranging the acquisition and Main Roads providing funding directly. Once Main Roads has provided the funds to DBCA for acquisition and management of

the land, DBCA will be responsible for the ongoing management and conservation of the offset land.

8.2 EPBC Act Environmental Offsets Policy

The proposed offset strategy is consistent with the principles of the EPBC Act Environmental Offsets Policy (DSEWPaC 2012) as presented in Table 14.

Table 14 Consistency with EPBC Act Environmental Offsets Policy

Policy overarching principles	Comment
Suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of the protected matter	<p>The offsets will provide a conservation outcome that maintains or improves the viability of the BWSCP TEC, Carnaby's Cockatoo, FRTBC, Baudin's Cockatoo, Wavy-Leaved Smokebush, Slender Andersonia and Summer Honeypot. The offset strategy provides at least 100% offset for all seven protected matters.</p> <p>The conservation outcome will be achieved through retention of the protected matters through transfer of land containing BWSCP TEC; Black Cockatoo habitat; and populations of Wavy-Leaved Smokebush, Slender Andersonia and Summer Honeypot to DBCA.</p>
Suitable offsets must be built around direct offsets but may include other compensatory measures	The offset strategy is built around direct offsets, involving a package of suitable offset properties to provide at least 100% direct offsets for BWSCP TEC, Carnaby's Cockatoo, FRTBC, Baudin's Cockatoo, Wavy-Leaved Smokebush, Slender Andersonia and Summer Honeypot.
Suitable offsets must be in proportion to the level of statutory protection that applies to the protected matter	The quantum of offsets proposed are in proportion to the level of statutory protection applied to the BWSCP TEC (Endangered), Carnaby's Cockatoo (Endangered), FRTBC (Vulnerable), Baudin's Cockatoo (Endangered), Wavy-Leaved Smokebush (Vulnerable), Slender Andersonia (Endangered), and Summer Honeypot (Endangered) as presented in the preliminary offset calculations.
Suitable offsets must be of a size and scale proportionate to the residual impacts on the protected matter	<p>The offsets will be of a size and scale proportional to the residual impacts on BWSCP TEC, Carnaby's Cockatoo, FRTBC, Baudin's Cockatoo, Wavy-Leaved Smokebush, Slender Andersonia and Summer Honeypot. The offset strategy provides at least 100% offset for all seven protected matters.</p> <p>The provision of direct offsets is based on completed offset assessment guide calculations, incorporating justification for all inputs based on available data.</p>
Suitable offsets must effectively account for and manage the risks of the offset not succeeding	<p>The estimation of direct offsets is based on completed offset assessment guide calculations, incorporating a conservative assessment of risk of the offset not succeeding.</p> <p>Main Roads has a history of offset management, including provision of land to DBCA for ongoing management and conservation. The transfer of land to DBCA is expected to have a high chance (90%) of successfully delivering the required conservation outcomes.</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	The proposed offsets are additional to any other requirements.
Suitable offsets must be efficient, effective, timely,	The proposed offsets identified in the offset strategy will be acquired and implemented in consultation and agreement

Policy overarching principles	Comment
transparent, scientifically robust and reasonable	<p>with DBCA as the State agency with lead responsibility for conservation.</p> <p>The offsets will involve an efficient and timely transfer of land to DBCA. Main Roads, working with DBCA, is experienced in and has the resources to fund acquisition and transfer of properties to DBCA for ongoing management and conservation.</p> <p>Main Roads is liaising with DBCA regarding acquisition of suitable land in order to meet offset requirements and intends to have all required offsets in place within 24 months of commencement of construction.</p> <p>The offsets will be scientifically robust, based on surveys of the Proposal DE and offset properties.</p> <p>The Offset Proposal will be a transparent document developed in consultation with DBCA and relevant local stakeholders.</p>
Suitable offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced	<p>All offset sites will be managed by DBCA through conservation tenure.</p> <p>The Offset Proposal will be based on a Memorandum of Understanding between Main Roads and DBCA, including requirements for land management and monitoring.</p>

9. Economic and social matters

9.1 Public consultation activities and outcomes

Main Roads has developed a comprehensive Communication and Stakeholder Engagement (CSE) Strategy for the Proposed Action, in line with the Infrastructure Sustainability Council of Australia (ISCA) Rating Scheme. This CSE identifies stakeholders to be consulted for the Proposed Action, including:

- DAWE
- DBCA
- Department of Water and Environmental Regulation (DWER)
- Department of Planning, Lands and Heritage (DPLH)
- City of Kalamunda
- City of Gosnells
- Public Transport Authority
- Department of Education
- Local residents
- Local businesses (including chambers of commerce)
- Community groups including Friends of Brixton St Wetlands, Wildflower Society of Western Australia, Beeliar Professors, Friends of Woodlupine Living Stream, Kalamunda Environmental Advisory Committee, Nature Reserves Preservation Group, Friends of Woodlupine Brook, Hartfield Park Recreation Centre, Veteran Car Club of WA, cycling groups
- Freight and logistics industry
- All road users
- South West Aboriginal Land & Sea Council and the Whadjuk Working Party.

A number of methods will be used to communicate with stakeholders including:

- Face-to-face meetings (including drop in sessions)
- Facilitated group meetings
- Main Roads' website
- Electronic and social media; telephone discussions.

Stakeholder consultation will be undertaken in accordance with the CSE. Ongoing engagement will take place as the project progresses through design and construction. The CSE is an evolving document designed to underpin communication and engagement of the Proposal through the development and delivery of the Proposal, and incorporate stakeholder interests via ongoing review or feedback and activities. The Stakeholder Communication Strategy provides:

- A comprehensive project narrative and messaging around key issues to ensure consistency of communication
- Identification of key issues, risks and challenges requiring careful management, along with proposed mitigation methods

- A summary of Main Roads' approach to communication and engagement and the tools and methods utilised to maximise community involvement.

The overarching objectives of the stakeholder engagement program are:

- Generate awareness of and support (where possible) for the project
- Understand stakeholder and community aspirations, opportunities, issues and concerns associated with the project
- Obtain community buy-in to the design and construction methodology, ensuring where possible that the project addresses community concerns, and if not, explain why not
- Minimise social and environmental impact of works
- Build strong, ongoing relationships with the local community, generating trust and confidence in Main Roads and our vision for the road network.

Stakeholder feedback has been and will continue to be considered and used to inform the planning, design, and delivery of the Proposed Action throughout the development timeline (2019 – 2023).

The CSE Strategy was developed following the announcement of project funding in May 2019 and will be implemented throughout the Proposed Action from planning through to development and delivery. In addition to the CSE strategy, which has identified potential issues and engagement requirements, Main Roads has commenced the consultation process. Key activities held throughout 2019 included:

- Project page uploaded to the Main Roads website
- Briefings with the two local government authorities – the City of Gosnells and the City of Kalamunda to discuss the project and seek feedback
- Meetings with communications managers at the Cities of Gosnells and Kalamunda to discuss the project and seek advice and collaboration for community engagement
- Engagement with community groups
- Letters to nearby residents regarding property access and noise monitoring requirements.

In 2020 Main Roads has expanded its engagement to the wider community as the Proposed Action is further developed. This engagement includes, but is not limited to:

- A full Council briefing with the City of Kalamunda
- Meetings with, and letters to, potentially impacted landowners prior to wider consultation (including Hardey Road closure)
- Newsletters emailed to residents, businesses and key stakeholders
- Targeted meetings with interested residents and businesses
- Meetings with: Friends of Woodlupine Living Stream, Nature Reserves Preservation Group, Friends of Woodlupine Brook
- Commitment to meet with Kalamunda Environmental Advisory Committee
- Commitment to advise community and stakeholders about outcomes for local roads with reference to traffic modelling, develop visual communications to show size/ scale of interchange structures, travel time improvements and environmental impacts.

A Community Reference Group or groups may be established in the locality of the Proposed Action. Issues-based engagement targeting specific key stakeholders will also continue to ensure issues and opportunities are thoroughly explored.

The Tonkin Grade Separations Project is taking a comprehensive approach to communications and stakeholder engagement in order to deliver a project that balances the needs of multiple stakeholders within a framework of sustainability as defined by the ISCA rating scheme.

9.2 Consultation with indigenous stakeholders

Main Roads undertook consultation with representatives of the Whadjuk Noongar Representatives on 23 August 2019, as part of an Aboriginal Ethnographic and Archaeological Site Identification Survey under the *Aboriginal Heritage Act 1972* (AH Act). The ethnographic survey was conducted on the 22 August 2019. The archaeological survey was conducted on the 22 August and 11 September 2019. The site visit was attended by Archae-Aus and eight nominated Whadjuk Noongar representatives. Attendees were advised that the survey was the first planned investigation and no other works by Main Roads in relation to the Proposed Action had commenced/been permitted prior, which was well received.

The report completed by Archae-Aus (2019) advised that Main Roads apply for Section 18 Ministerial consent under the *Aboriginal Heritage Act 1972* in order to use the land on which Aboriginal site DPLH ID 3773 / Welshpool Reserve (Maamba Reserve) and OHP DPLH ID 36929 / Yule Brook, Mandoorn are located.

The attendees expressed an interest in the following areas of the Proposed Action:

- Hard and Soft Landscaping – Incorporation of Whadjuk designs/themes (e.g. designs on overpass structures, noise walls etc.)
- Wayfinding/Signage – Addition of acknowledgment wayfinding/signage (e.g. a plaque adjacent to PSP) for Maamba Reserve
- Potential Whadjuk Naming of Overpasses.

These priorities will be reflected in the ongoing engagement program for planning, development and delivery.

No objections were raised to the proposed upgrades to Tonkin Highway by the Whadjuk Noongar representatives during the ethnographic survey (Archae-Aus 2019). No new sites were found either during the archaeological or the ethnographic surveys.

9.3 Monitoring ongoing changes to economic and social characteristics

Monitoring of ongoing changes to economic and social benefits is undertaken on a broad basis across the Perth metropolitan area and includes the following:

- Traffic monitoring and modelling, which is incorporated into reviews of predicted travel time and traffic congestion levels upon opening to traffic. After 12 months of operation, Main Roads will review the travel times and congestion levels to confirm whether or not targets have been met. A detailed traffic analysis report has been commissioned.
- Vehicle crash data, which is collected and analysed for trends and future investment allocation. The Proposed Action is predicted to achieve certain crash reduction benefits after completion. After 12 month period, a full crash audit is undertaken to determine the extent of the crash savings.
- Vehicle Operating Costs are a key component of the determination of a projects benefit profile. After 12 months of the Proposed Action being open, modelling will be undertaken to determine the network wide benefits of the Proposed Action.

All reports will be sent to Department of Transport and to Infrastructure Australia.

9.4 Projected economic costs and benefits and basis for estimation

9.4.1 Projected costs and benefits

Main Roads has completed a Business Case submission to Infrastructure Australia. The cost benefit analysis (CBA) analysed costs and benefits over a 30 year operating period, with a 7% real discount rate.

The present value of benefits have been estimated at \$353.1 million, with an estimated total of \$420.5 million in benefits occurring due to reduced travel time and greater reliability. The present value of costs have been estimated at \$310.8 million, for a benefit cost ratio of 1.14. Sensitivity analysis (4% to 10% discount rate, plus/minus 20% in cost and benefits), indicated a benefit-cost ratio (BCR) above one, suggesting the Net Present Value (NPV) result is robust.

The Australian Government has committed \$183 million towards the Proposed Action.

9.4.2 Basis for estimation

The CBA included the following categories:

- Costs
 - Capital costs
 - Operation and maintenance
- Benefits
 - Travel time savings
 - Travel time reliability saving
 - Vehicles operating cost savings
 - Reduced environmental externalities
 - Reduced incidences of crashes.

Construction costs were estimated from engineering design and current construction rates provided by the construction industry in Perth. Maintenance and renewal costs were estimated from Main Roads' operational data for the Tonkin Highway upgrade.

Benefits were estimated through outputs from Main Roads' Regional Operations Model v24 (ROM24), which is a multi-modal strategic transport model. ROM24 incorporates trip generation, trip distribution, modal split and traffic assignment. This enables calculation of benefits as a function of vehicle trips, travel time, travel distance, speed, and vehicle type and trip purpose. For example, externalities were calculated on the basis of changes in vehicle kilometres travelled (VKT) by vehicle types and the value of associated air pollution impacts and greenhouse gas emissions.

9.4.3 Non-monetised benefits

In addition to the monetised costs and benefits analyses through the CBA, the Proposed Action is expected to benefit the local economy by:

- Supporting sustainable, higher density development in the south east subregion through improving connectivity and encouraging business development and associated employment opportunities in areas of high population growth
- Promoting private investment in key economic centres in the south east by accelerating land use outcomes through a reduction in congestion and improved access to jobs,

services and social opportunities for people living and working in the north west subregion and corridor

- Promoting greater levels of subregional employment self-sufficiency through improved connectivity between growing residential areas and local employment hubs.

9.5 Benefits to the local and wider community

The Business Case to Infrastructure Australia (Main Roads 2019) identified the Proposed Action objectives as the following:

“Reduce congestion and delay at ... intersections and surrounding road network, so as to increase both the safety and efficiency of the movement of freight and people in the strategically significant Kewdale / Forrestfield / Welshpool area.

Tonkin Highway is a critical component of the Metropolitan Road Freight Network as it facilitates movements to and from commercial / industrial zones in Canning Vale, Kewdale, Ashfield, Malaga and Balcatta, and resource sector locations in the north of the State as well as to the Perth and Jandakot Airports. These areas combine to generate some of the highest levels of employment in the Perth metropolitan area. Tonkin Highway therefore serves a critical purpose in facilitating the movement of freight and commuter traffic.

The Proposed Action will provide benefits to the local and wider community through the following:

- Employment and expenditure for road construction, maintenance and renewal
- Reduced travel time, vehicle operating costs
- Reduce the high level of safety risks which exist on Tonkin Highway (reduction in crashes)
- Reduce capacity pressures on the wider metro transport network Improved safety outcomes
- Improved freight access to the Maddington-Kenwick and Welshpool strategic industrial area.

10. Ecological sustainability

Section 3A of the EPBC Act defined the principles of ecologically sustainable development. Table 15 outlines how the Proposed Action meets each of the five principles of ecologically sustainable development.

Table 15 EPBC Act Principles of Ecologically Sustainable Development

No.	Principle	Consideration of Principle in the Proposed Action
a)	Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations	<p>The Proposed Action planning has considered social and environmental matters raised through stakeholder consultation, as presented in Sections 3.7, 9.1 and 9.2</p> <p>The Proposed Action provides long term economic, social and equity benefits for the metropolitan region north of Perth, as presented in Sections 9.4 and 9.5. This includes improved road safety, reduced travel time, economic growth and employment generation.</p> <p>The Proposed Action is consistent with the Regional Road Reserve within the Metropolitan Region Scheme.</p> <p>The Proposed Action has been planned and designed to reduce impacts to native vegetation, the Hartfield Park Bush Forever site and registered Aboriginal site while meeting community and stakeholder objectives, as presented in Section 3.7 and 6.1.</p>
Precautionary Principles		
b)	If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation	<p>The Proposed Action has been subject to comprehensive studies to assess the environmental values and potential impacts of the Proposed Action, including:</p> <ul style="list-style-type: none"> Woodman (2021) <i>Biological Survey and Targeted Black Cockatoo Habitat Assessment</i>. Unpublished report prepared for Main Roads Western Australia. GHD (2020) <i>Tonkin Highway Corridor Vegetation Survey</i>. Unpublished report prepared for Main Roads, Western Australia. GHD (2021) <i>Tonkin Highway Corridor (Roe Highway to Kelvin Road), Targeted Flora and Black Cockatoo Hollow Assessment</i>. Unpublished report prepared for Main Roads Western Australia. Glevan (2020) <i>Phytophthora Dieback Occurrence Assessment</i>. Unpublished report prepared for Main Roads Western Australia. AECOM (2015) <i>Tonkin Highway / Hale Road, Tonkin Highway/ Welshpool Road and Tonkin Highway / Kelvin Road Biological Assessment</i>. Unpublished report prepared for Main Roads Western Australia. <p>Information gathered during these studies was used to inform the environmental impact assessment and has reduced the</p>

No.	Principle	Consideration of Principle in the Proposed Action
		<p>uncertainty surrounding the prediction of impacts for the assessment.</p> <p>Main Roads has planned and designed the Proposed Action to avoid, where possible, serious or irreversible damage to the environment. The design characteristics take engineering, environmental and social investigations and stakeholder consultation into account. This will continue to be considered as the detail design is produced.</p> <p>Direct and indirect impacts to BWSCP TEC, Black Cockatoo and threatened flora habitat have been identified and minimised, with effective mitigation and management measures proposed to ensure they are environmentally acceptable.</p>
c)	<p>The principle of intergenerational equity - That the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.</p>	<p>The Proposed Action will ensure the health, diversity and productivity of the environment by avoiding as much remnant vegetation as possible.</p> <p>The Proposed Action incorporates design and management to protect the environmental values to adjacent Bush Forever sites 320 and 387.</p> <p>The Proposed Action lies within and adjacent to existing disturbed areas along Tonkin Highway, Hale Road and Welshpool Road. Clearing occurs within areas of relatively degraded vegetation. Clearing of adjacent Bush Forever sites 320 and 387 will be minimised.</p> <p>Offsets will also be implemented as appropriate.</p>
d)	<p>The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making</p>	<p>The Proposed Action lies within and adjacent to existing disturbed areas along Tonkin Highway, Hale Road and Welshpool Road. Clearing occurs within areas of relatively degraded vegetation.</p> <p>The Proposed Action incorporates design considerations and management measures to maintain and enhance the biological diversity and ecological integrity of adjacent Bush Forever sites, as presented in Sections 3.7 and 6.1.</p>
e)	<p>Improved valuation, pricing and incentive mechanisms should be promoted</p>	<p>Main Roads acknowledges the need for improved valuation, pricing and incentive mechanisms and endeavours to pursue these principles when appropriate.</p> <p>The Proposed Action design has given consideration to avoiding the clearing of remnant vegetation within the urban environment. Impacts on direct and indirect impacts to BWSCP TEC, Black Cockatoo and threatened flora habitat have assessed and mitigation and management measures proposed.</p> <p>Main Roads accepts that the cost of the Proposed Action must include environmental impact mitigation, management and maintenance activities. These requirements will be incorporated into the overall Proposed Action costs.</p>

11. Environmental records

Main Roads is a State agency with an assured record of responsible environmental management and a certified environmental management system. Main Roads is not subject to any past or present proceedings under Commonwealth or State law for protection of the environment or conservation and sustainable use of natural resources. All work undertaken by Main Roads is completed in accordance with Main Roads' Environmental Policy and Environmental Management System (EMS) which is certified with the requirements of ISO 14001:2015 environmental management systems comprising 'Activities, products and services associated with delivering Road Management (planning, building, and maintaining) on Western Australia's State Road Network' (Certificate #MRWQ51-CCE04). Main Roads' environmental policy can be found at

<https://www.mainroads.wa.gov.au/OurRoads/Environment/Pages/environmentalmanagement.aspx#policy>

Main Roads' EMS is independently certified and covers the processes and activities that have the potential to impact the environment, including mitigation and management measures proposed as part of the action. The EMS ensures compliance with Main Roads' environment and heritage compliance obligations, providing the framework for driving environmental requirements through leadership, planning, support, operation, performance evaluation and improvement actions. The action, therefore, will be undertaken, monitored and measured in accordance with the Main Roads EMS. Main Roads EMS covers processes and activities that have the potential to impact on the environment and ensures compliance with environment and heritage compliance obligations. The EMS responsibilities includes appropriate resource allocation to ensure compliance costs are appropriately budgeted and assessed as part of the overall business case for the project. This ensures that the costs of proposed management measures and offsets is considered in the budget approvals and ensures compliance is appropriately funded and resourced.

12. Approvals and conditions

A summary of the approvals or conditions that apply or are likely to apply to the Proposed Action (in addition to an approval under the EPBC Act) are outlined below. No approvals have been received to date for the Proposed Action.

12.1.1 Environmental Protection Act 1986, Part IV Environmental Impact Assessment

The Proposed Action will be referred to the Environmental Protection Authority, under Part IV of the *Environmental Protection Act 1986* (EP Act) which is the primary legislation governing environmental protection and impact assessment in Western Australia. Division 1 of Part IV of the EP Act provides for the referral and assessment of significant and strategic Proposed Actions.

In the event that the EPA do not assess the Proposed Action, then Main Roads will apply for a Native Vegetation Clearing Permit under Part V of the EP Act. The application will be made to DWER.

12.1.2 Other approvals and regulation

Following primary environmental approval of the Proposed Action under Part IV of the EP Act, additional regulatory approvals will be required to develop and operate the Proposed Action. These are summarised in Table 16.

Table 16 Summary of other regulatory approvals required

Proposed activities	Type of approval	Regulatory agency	Legislation regulating the activity
Interference with the bed and banks of a water course or wetland (clearing of vegetation and construction works)	Application for a permit to authorise the interference or obstruction of the bed and banks of a watercourse or wetland	DWER	<i>Rights in Water and Irrigation Act 1914</i> (RIWI Act)
Abstraction and discharge of water during construction	Licence to take	DWER	RIWI Act
Authorisation to take (flora and fauna) and modify TEC	Licence to take and modify	DBCA	<i>Biodiversity Conservation Act 2016</i>
Disturbance of a registered Aboriginal heritage site	Section 18 consent	DPLH	<i>Aboriginal Heritage Act 1972</i> (AH Act).

12.1.3 Planning Approvals

The alignment of the Proposed Action will not be fully located within land currently reserved under the Metropolitan Region Scheme (MRS) for Primary Regional Roads or Other Regional Roads. Areas outside the MRS will be subject to a development approval through the Western Australian Planning Commission (WAPC). No development approval is required for road construction works on land reserved by the MRS for the purpose of Primary Regional Roads or Other Regional Roads.

Following completion of the Proposed Action all areas outside the existing Primary Regional Roads reservation will be incorporated into Primary Regional Roads, or zoned appropriately, through an omnibus amendment to the MRS pursuant to section 28 (1) of the *Land Administration Act 1997*.

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Appendices

Appendix A

Preliminary Documentation Additional Information Request List

Appendix B

Concept Design Layout

Appendix C

Biological Survey and Targeted Black Cockatoo Assessment

Appendix D

Hale Road Vegetation Assessment

Appendix E

Targeted Flora Survey and Black Cockatoo Hollow Assessment

Appendix F

Phytophthora Dieback Occurrence Assessment

Appendix G

Risk Assessment

Appendix H

Action Management Plan

Appendix I

Draft Offset Strategy

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