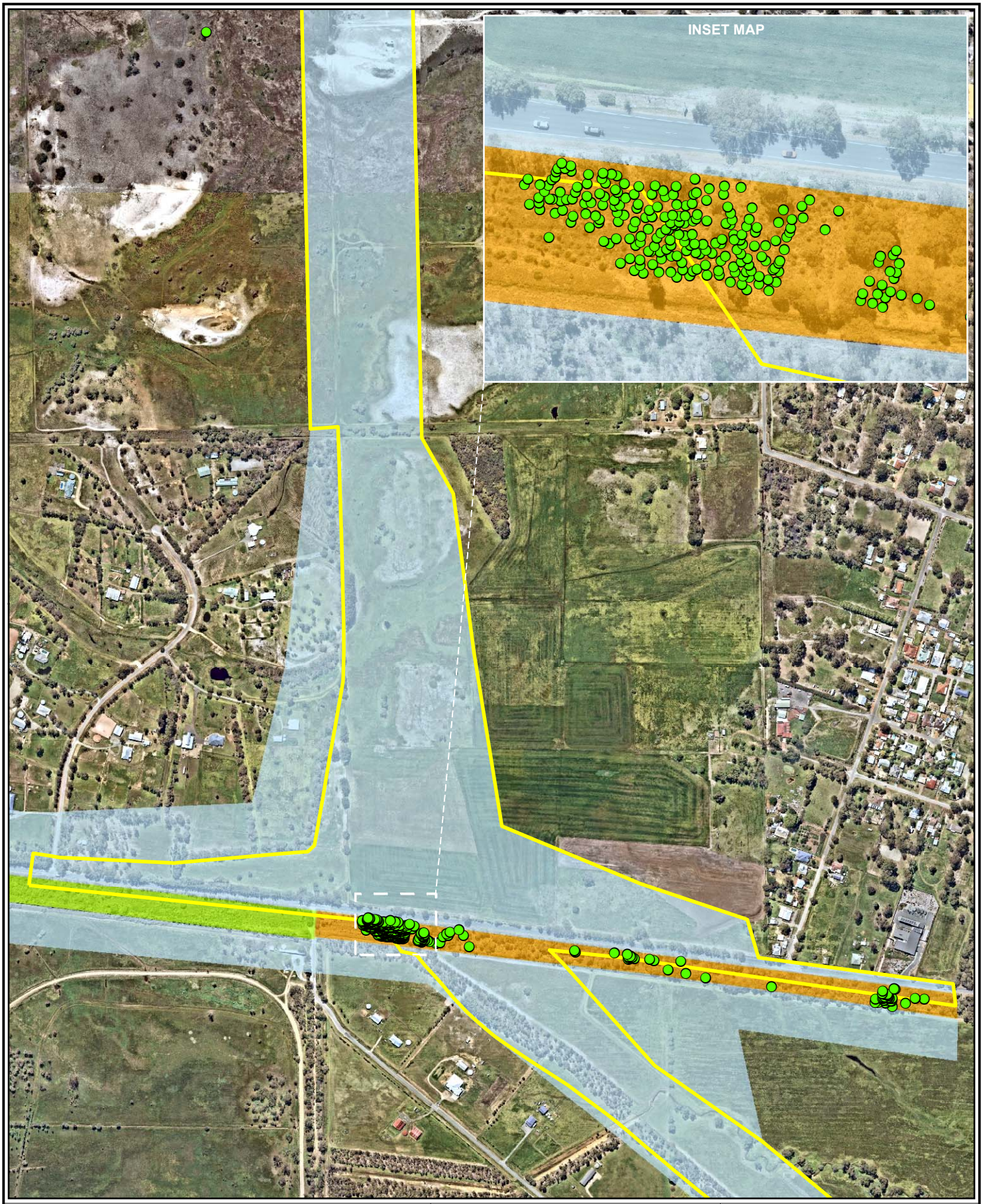


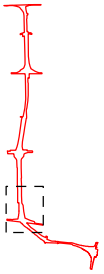
Legend

- Proposed Action
- *Tetraria australiensis* (V) locations

Phytophthora Dieback status

- Excluded
- Infested
- Uninterpretable unprotectable

LOCALITY MAP



Scale 1:9,000 at A4

0 100 200
Meters

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58910

Client: Main Roads Western Australia

Version: A | Date: 16-Feb-2021

Drawn By: hsullivan | Checked By: DN

Tonkin Highway Extension WA

***TETRARIA AUSTRALIENSIS* LOCATIONS AND *PHYTOPHTHORA* DIEBACK STATUS WITHIN THE AREA OF THE PROPOSED ACTION**

FIGURE 18

strategen JBS&G

File Name: W:\Projects\1)Open\Main Roads\58910 Tonkin Extension PD\GIS\Maps\R01_Rev_A\58910_18_T_australiensis.mxd
Image Reference: www.nearmap.com© - Imagery Date: 18 September 2020.

4.7 Black Cockatoos

4.7.1 Carnaby's Cockatoo Calyptorhynchus latirostris

Carnaby's cockatoo is classified as Endangered under the EPBC and BC Act (DBCA 2018c, DAWE 2020).

4.7.1.1 Abundance, Distribution and Ecology

The total population of Carnaby's Cockatoo was estimated at between 11,000 and 60,000 birds in the 1980's (Saunders *et al.* 1985). In 2010, the population was refined to an estimated 40,000 individuals (DPaW 2013). As of September 2019, the total population of Carnaby's Cockatoo is estimated to be 40,000 individuals, of which at minimum 13,984 individuals occur in the Greater Perth-Peel Region (Peck et al. 2019 and EPA 2019).

Carnaby's Cockatoo is endemic to the south west of Western Australia, with a widespread distribution range from Kalbarri in the north-west through to Nuytsland Nature Reserve in the south-east (DotEE 2017). Breeding takes place between late July and December and most breeding occurs in the inland parts of its distribution range, in areas receiving between 300 and 700mm of annual average rainfall (DotEE 2017).

The majority of the population migrates seasonally, coinciding with breeding, with birds moving to the higher rainfall coastal areas during non-breeding season. On the Swan Coastal Plain, breeding is restricted to isolated pockets around Yanchep, Rockingham, Bunbury and Busselton. Carnaby's Cockatoo breed predominantly in woodland or forest where species such as Salmon Gum (*Eucalyptus salmonophloia*), Wandoo (*Eucalyptus wandoo*), Tuart (*Eucalyptus gomphocephala*), Jarrah (*Eucalyptus marginata*), Flooded Gum (*Eucalyptus rudis*), Karri (*Eucalyptus diversicolor*) and Marri (*Corymbia calophylla*) are present, although may also breed in areas of former woodland or forest in isolated trees.

Foraging habitat includes proteaceous woodlands and shrublands typically comprising *Banksia* spp., *Hakea* spp., and *Grevillea* spp., however the traditional diet of mostly native seeds and nectar has changed to include increased amounts of seeds from introduced plant species such as broad-acre crops and plantation pines (DPaW 2013).

Breeding habitat

Mapping by the Department of Biodiversity, Conservation and Attractions (DBCA) indicates that the Proposed Action area is not situated within a confirmed breeding area or buffer of a confirmed breeding area (DBCA 2011). The nearest known breeding site for Carnaby's Cockatoo occurs approximately 10 km to the east of the Proposed Action area in the Wungong Catchment (Kirkby 2019).

The Kirkby (2019) survey identified a total of seven potential Black Cockatoo breeding trees with hollows that were potentially suitable for Black Cockatoo breeding within the Proposed Action area, comprising of 1 Jarrah, 5 Marri and 1 Marri stag (Table 4.4Figure 19). These trees were subject to further detailed inspection (Kirkby 2020) to assess their suitability for Black Cockatoo breeding. Only two Marri trees were considered to contain hollows suitable for Black Cockatoo breeding.

Based on mapping of native vegetation extent and vegetation complexes containing species known to be used for foraging by Carnaby's Cockatoo the estimated extent of potential breeding habitat within 12km of the Proposed Action area is approximately 31,000 ha (Strategen JBS&G 2020) (Figure 20).

Table 4.4: Black Cockatoo Potential Breeding Trees

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

[1]One hollow has since collapsed
[2]Two trees contain suitable hollows

Foraging habitat

Based on the Black Cockatoo habitat assessment (Strategen-JBS&G 2020), the majority of the Proposed Action area (199.33 ha) was determined to be of 'Nil' foraging value (Table 4.5), which comprises completely cleared areas and areas of highly disturbed vegetation.

In total, the Proposed Action area contains 34.2 ha of Carnaby's Cockatoo foraging habitat, comprising of 9.3 ha of 'Moderate' quality, 11.6 ha of 'Low to Moderate' quality, 8.7 ha of 'Low' quality and 4.5 ha of 'Negligible to Low' quality foraging habitat (Table 4.5; Figure 19). Foraging habitat with 'low' and 'negligible to low' quality is not considered further as it is not considered to provide quality habitat for Carnaby's Cockatoo. Therefore, there is 20.93 ha of 'moderate to low' value foraging habitat for Carnaby's Cockatoo within the Proposed Action area

Based on mapping of native vegetation extent and vegetation complexes containing species known to be used for foraging by Carnaby's Cockatoo the estimated extent of potential foraging habitat within 12km of the Proposed Action area is approximately 31,000 ha (Strategen JBS&G 2020) (Figure 20).

Table 4.5: Carnaby's Cockatoo Foraging Habitat Extent and Quality

Habitat quality and score	Extent within Proposed Action area (ha)	Proportion of Proposed Action area (%)
High foraging value (6)	0	0
Moderate to High foraging value (5)	0	0
Moderate foraging value (4)	9.32	4.0
Low to Moderate foraging value (3)	11.61	5.0
Low foraging value (2)	8.69	3.7
Negligible to low foraging value (1)	4.55	2.0
No foraging value (0)	199.33	85.4
Total	**233.50**	**100**

Roosting habitat

Regional mapping undertaken by the Department of Biodiversity, Conservation and Attractions (DBCA), BirdLife Australia and WA Museum indicates that the Proposed Action area is situated within the buffer of one confirmed white-tailed Black Cockatoo roosting area (DBCA 2011), although the centre-point does not fall within the Proposed Action area. No evidence or observations of night roosting was recorded within the Proposed Action area (Kirkby 2019).

Publicly available data from the most recent annual Great Cocky Count (Peck *et al.* 2019) indicates that there is 1 confirmed white-tail cockatoo (Carnaby's Cockatoo and/or Baudin's Cockatoo) roost (a known joint roost site) within 1km of the Proposed Action area and 31 confirmed roosts within a 12km radius (Figure 20). A number of these roosts are joint roosts, shared with Forest Red-tailed Black Cockatoo.

Current and historical patterns of use

Kirkby (2019) did not record any evidence of foraging by Carnaby's Cockatoo within the Proposed Action area, which was expected due to the limited presence of preferred *Banksia* species, as well as the degraded nature of the remaining vegetation. Heavy chewing around the entrance of one hollow contained within Tree 6 was observed by Kirkby (2020), indicating that the hollow may have been used by Black Cockatoos in the past, however it was not determined which species.

An examination of historical aerial imagery from Landgate Map Viewer illustrates that much of the vegetation within the Proposed Action area and the immediate surrounds was cleared prior to the earliest available imagery from 1953. Based on pre-European vegetation mapping, vegetation which has been cleared within the Proposed Action area is consistent with the vegetation remaining in the Proposed Action area and it is considered likely that the entire area would have been utilised by Carnaby's Cockatoo for foraging and breeding prior to clearing.

4.7.1.2 Impact of Proposed Action

The Proposed Action area contains 20.93 ha of 'moderate to low' quality foraging habitat for Carnaby's Cockatoo as well as 346 potential breeding trees with a DBH greater than 500 mm, including two that contain potentially suitable hollows for Black Cockatoo nesting.

Legend

- Proposed Action

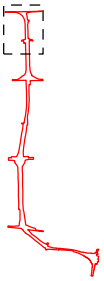
Foraging value - CBC

- Moderate (4)
- Low to moderate (3)
- Negligable to low (1)

Black Cockatoo significant habitat trees

- Flooded Gum
- Jarrah stag
- Marri
- Marri stag
- Unsuitable breeding hollows

LOCALITY MAP



Scale 1:9,500 at A4

0 100 200
Meters

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58910

Client: Main Roads Western Australia

Version: A | Date: 27-Jan-2021

Drawn By: hsullivan | Checked By: DN

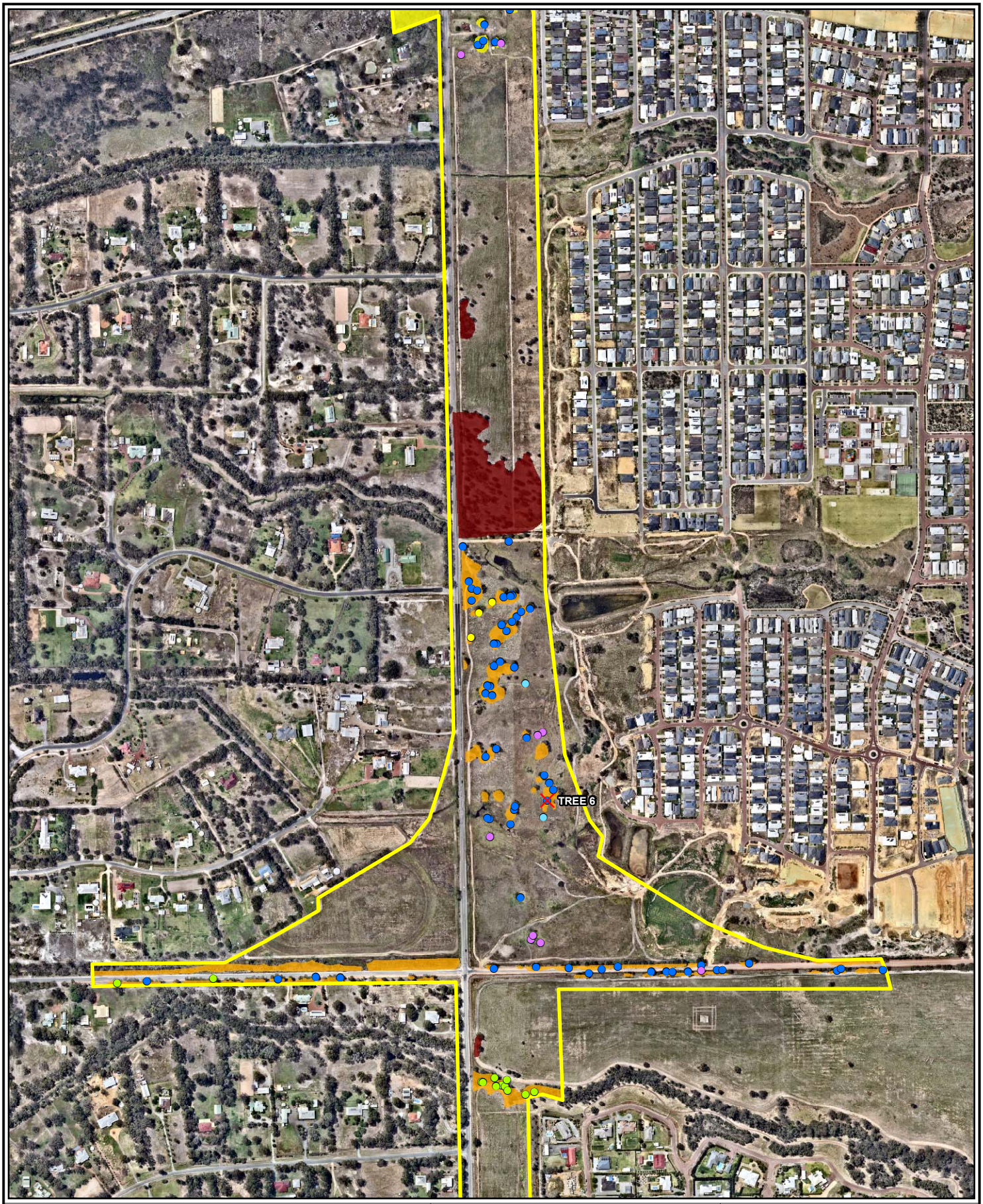
Tonkin Highway Extension WA

CARNABY'S BLACK COCKATOO HABITAT WITHIN THE AREA OF THE PROPOSED ACTION

FIGURE 19 **PAGE 1**

strategen JBS&G

File Name: W:\Projects\1)Open\Main Roads\58910 Tonkin Extension PD\GIS\Maps\R01_Rev_A\58910_19_BCHabitatCarnabys.mxd
Image Reference: www.nearmap.com© - Imagery Date: 12 May 2020.



Legend

- Proposed Action

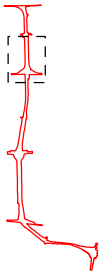
Foraging value - CBC

- Moderate (4)
- Low to moderate (3)
- Negligable to low (1)

Black Cockatoo significant habitat trees

- Flooded Gum
- Jarrah
- Jarrah stag
- Marri
- Marri stag
- Possible breeding hollows

LOCALITY MAP



Scale 1:9,000 at A4

0 100 200
Meters

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58910

Client: Main Roads Western Australia

Version: A | Date: 27-Jan-2021

Drawn By: hsullivan | Checked By: DN

Tonkin Highway Extension WA

CARNABY'S BLACK COCKATOO HABITAT WITHIN THE AREA OF THE PROPOSED ACTION

FIGURE 19 **PAGE 2**

strategen JBS&G

File Name: W:\Projects\1)Open\Main Roads\58910 Tonkin Extension PD\GIS\Maps\R01_Rev_A\58910_19_BCHabitatCarnabys.mxd
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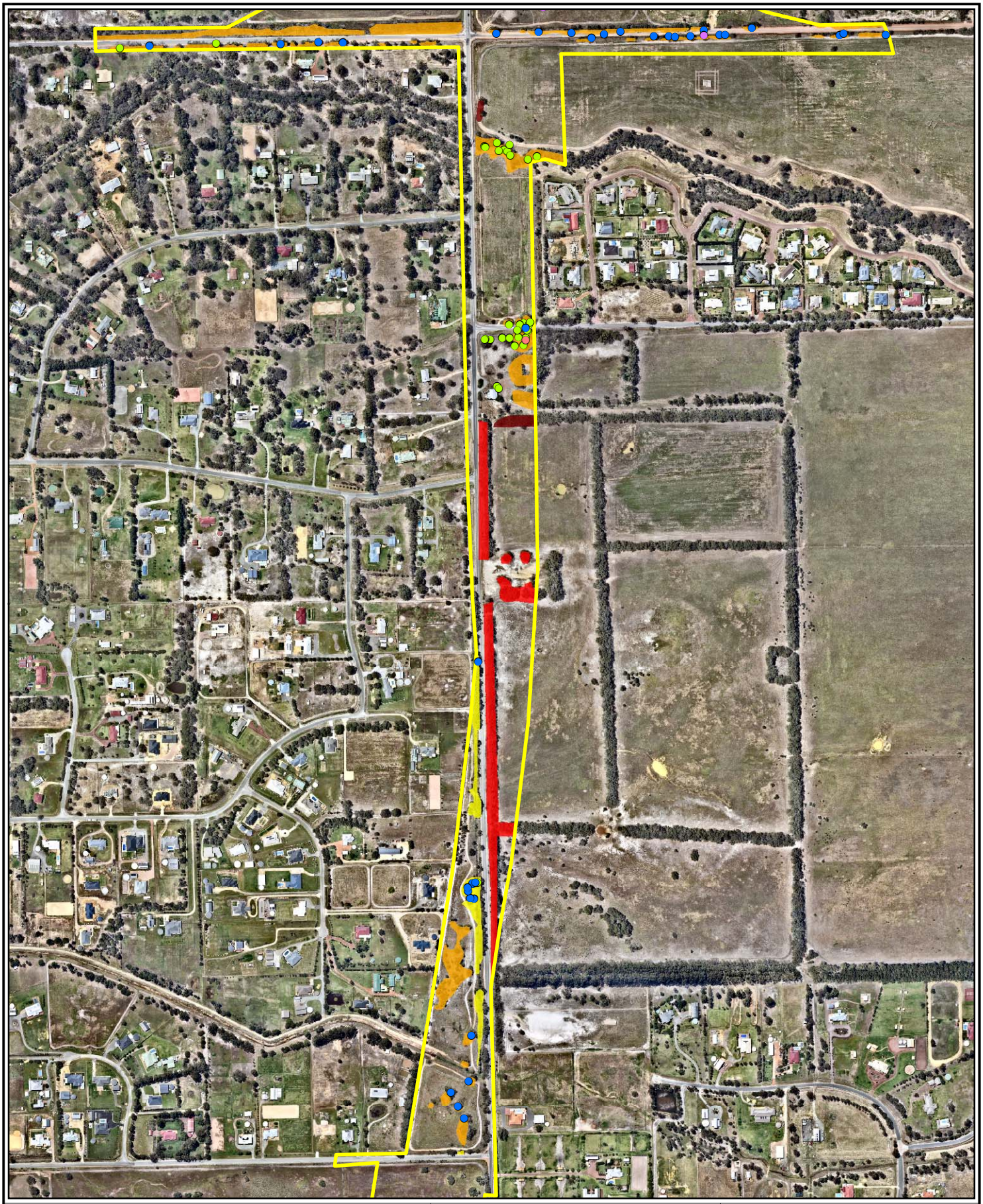


Legend

- Proposed Action

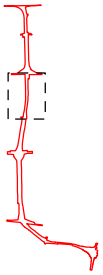
Foraging value - CBC

- Moderate (4)
- Low to moderate (3)
- Low (2)
- Negligable to low (1)

Black Cockatoo significant habitat trees

- Flooded Gum
- Flooded Gum stag
- Marri
- Marri stag

LOCALITY MAP



Scale 1:9,000 at A4

0 100 200
Meters

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58910

Client: Main Roads Western Australia

Version: A | Date: 27-Jan-2021

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Tonkin Highway Extension WA

CARNABY'S BLACK COCKATOO HABITAT WITHIN THE AREA OF THE PROPOSED ACTION

FIGURE 19 **PAGE 3**

strategen JBS&G

File Name: W:\Projects\1)Open\Main Roads\58910 Tonkin Extension PD\GIS\Maps\R01_Rev_A\58910_19_BCHabitatCarnabys.mxd
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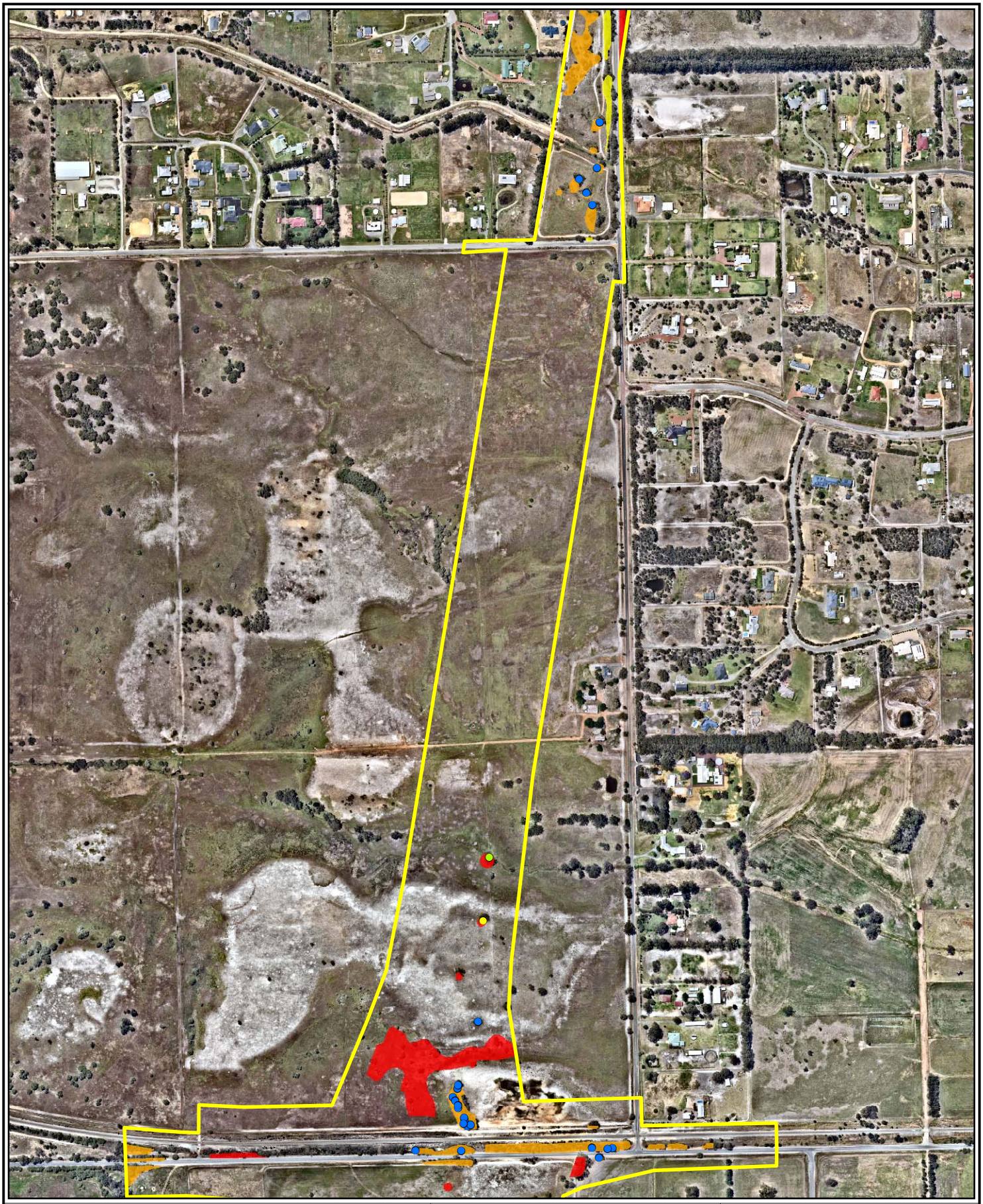


Legend

- Proposed Action

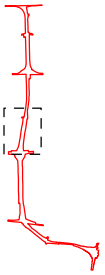
Foraging value - CBC

- Moderate (4)
- Low to moderate (3)
- Low (2)

Black Cockatoo significant habitat trees

- Flooded Gum
- Jarrah
- Marri

LOCALITY MAP



Scale 1:9,000 at A4

0 100 200
Meters

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58910

Client: Main Roads Western Australia

Version: A | Date: 27-Jan-2021

Drawn By: hsullivan | Checked By: DN

Tonkin Highway Extension WA

CARNABY'S BLACK COCKATOO HABITAT WITHIN THE AREA OF THE PROPOSED ACTION

FIGURE 19 **PAGE 4**

strategen JBS&G

File Name: W:\Projects\1)Open\Main Roads\58910 Tonkin Extension PD\GIS\Maps\R01_Rev_A\58910_19_BCHabitatCarnabys.mxd
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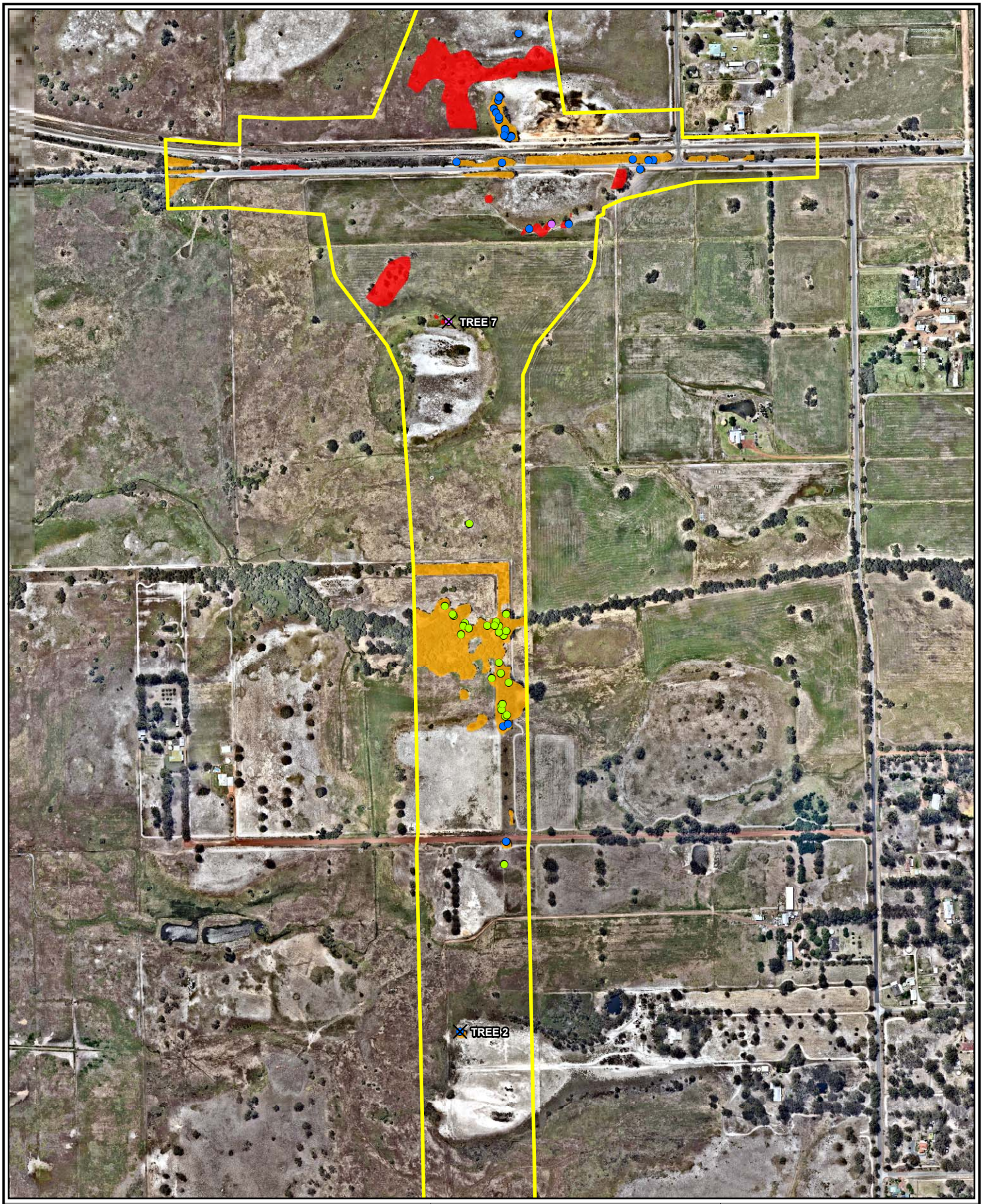


Legend

- Proposed Action

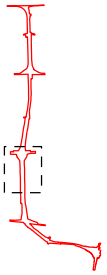
Foraging value - CBC

- Low to moderate (3)
- Low (2)

Black Cockatoo significant habitat trees

- Flooded Gum
- Marri
- Marri stag
- Unsuitable breeding hollows

LOCALITY MAP



Scale 1:9,000 at A4

0 100 200
Meters

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58910

Client: Main Roads Western Australia

Version: A | Date: 27-Jan-2021

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Tonkin Highway Extension WA

CARNABY'S BLACK COCKATOO HABITAT WITHIN THE AREA OF THE PROPOSED ACTION

FIGURE 19 **PAGE 5**

strategen JBS&G

File Name: W:\Projects\1)Open\Main Roads\58910 Tonkin Extension PD\GIS\Maps\R01_Rev_A\58910_19_BCHabitatCarnabys.mxd
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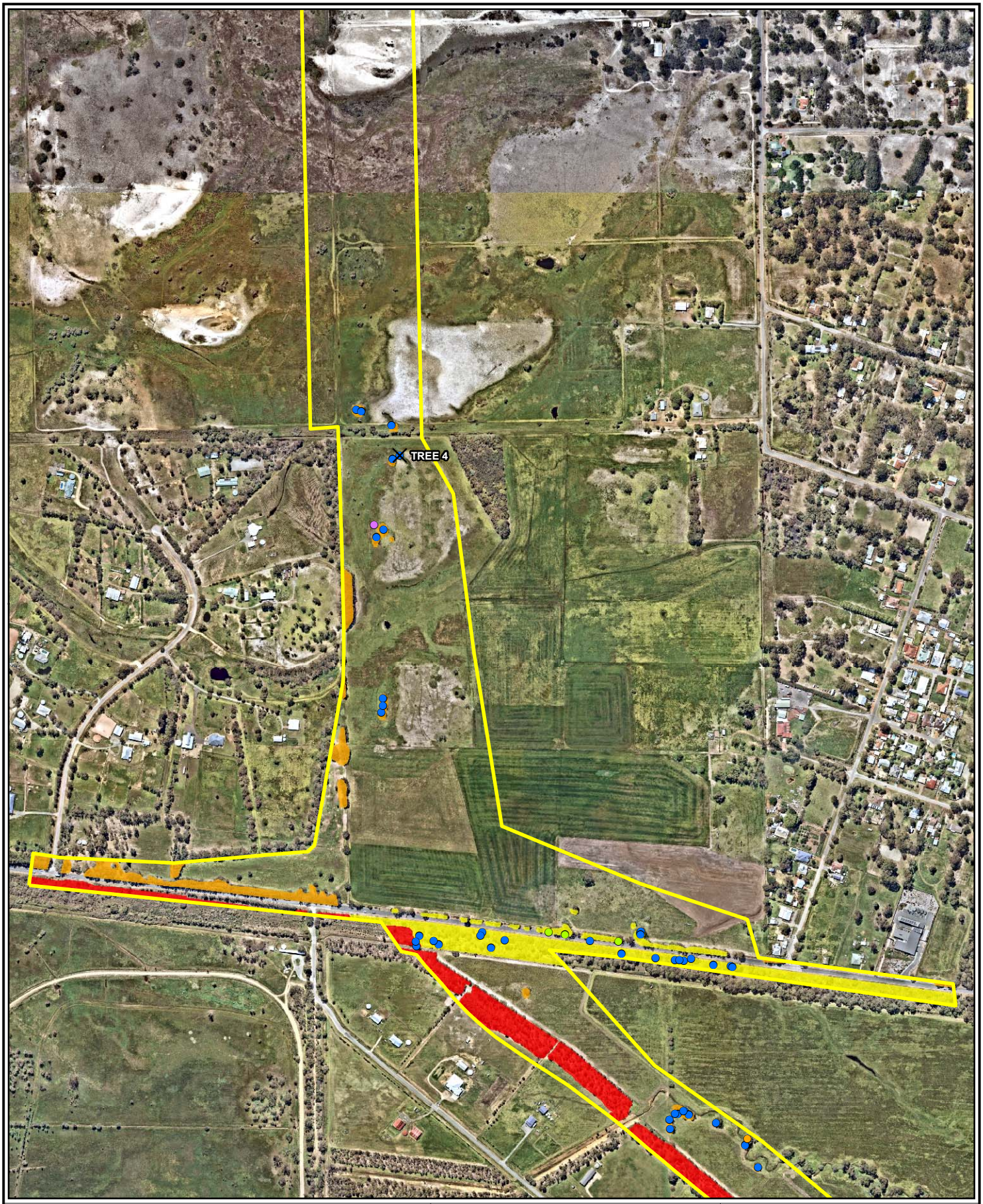


Legend

- Proposed Action

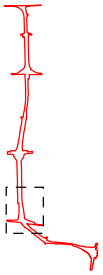
Foraging value - CBC

- Moderate (4)
- Low to moderate (3)
- Low (2)

Black Cockatoo significant habitat trees

- Flooded Gum
- Marri
- Marri stag
- Wandoo
- Unsuitable breeding hollows

LOCALITY MAP



Scale 1:9,000 at A4

0 100 200
Meters

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58910

Client: Main Roads Western Australia

Version: A | Date: 27-Jan-2021

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Tonkin Highway Extension WA

CARNABY'S BLACK COCKATOO HABITAT WITHIN THE AREA OF THE PROPOSED ACTION

FIGURE 19 **PAGE 6**

strategen JBS&G

File Name: W:\Projects\1)Open\Main Roads\58910 Tonkin Extension PD\GIS\Maps\R01_Rev_A\58910_19_BCHabitatCarnabys.mxd
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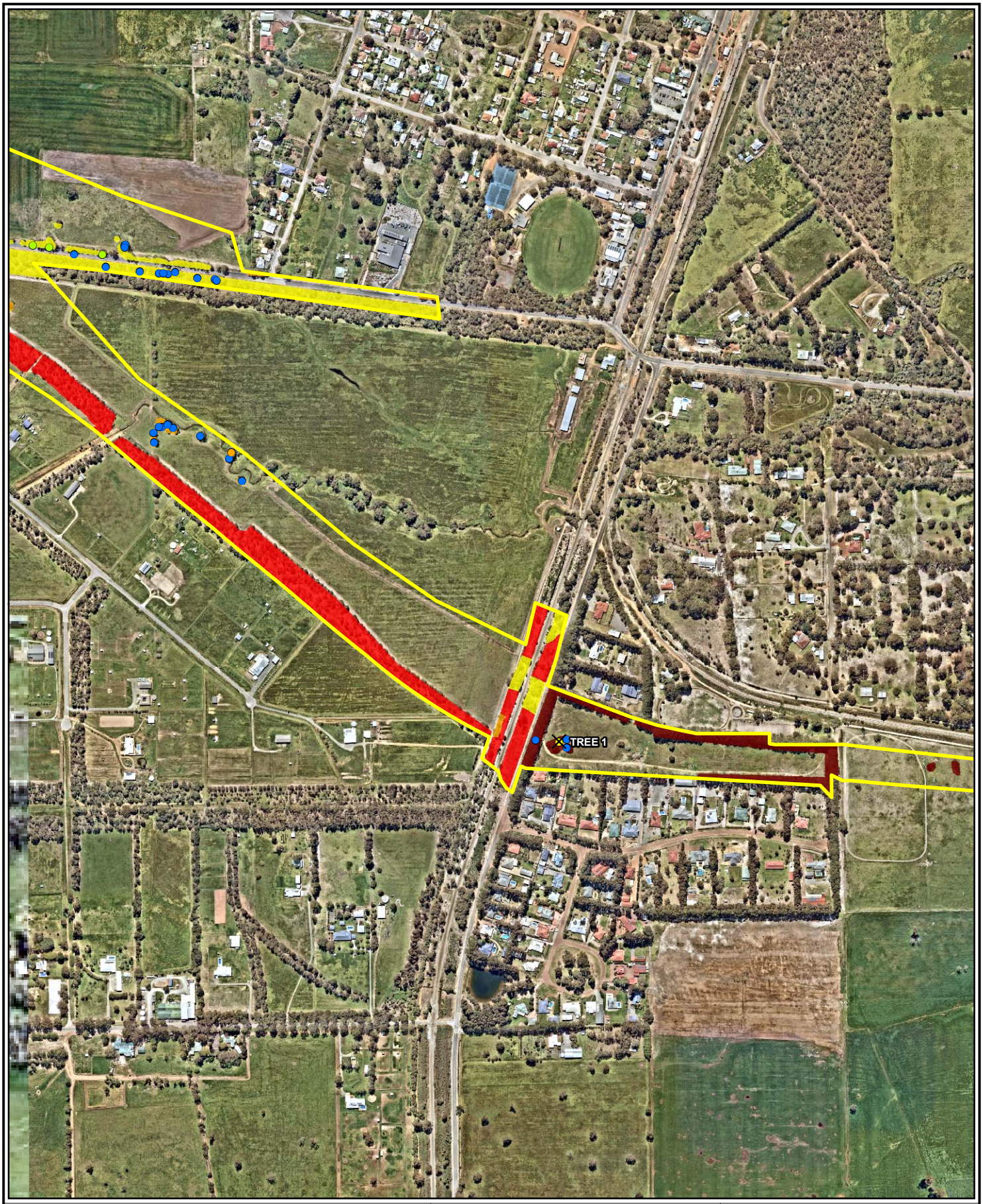


Legend

- Proposed Action

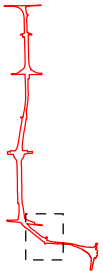
Foraging value - CBC

- Moderate (4)
- Low to moderate (3)
- Low (2)
- Negligable to low (1)

Black Cockatoo significant habitat trees

- Flooded Gum
- Jarrah
- Marri
- Wandoo
- Unsuitable breeding hollows

LOCALITY MAP



Scale 1:9,000 at A4

0 100 200

Meters

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58910

Client: Main Roads Western Australia

Version: A

Date: 27-Jan-2021

Drawn By: hsullivan

Checked By: DN

Tonkin Highway Extension WA

CARNABY'S BLACK COCKATOO HABITAT WITHIN THE AREA OF THE PROPOSED ACTION

FIGURE 19 **PAGE 7**

strategen JBS&G

File Name: W:\Projects\1)Open\Main Roads\58910 Tonkin Extension PD\GIS\Maps\R01_Rev_A\58910_19_BCHabitatCarnabys.mxd
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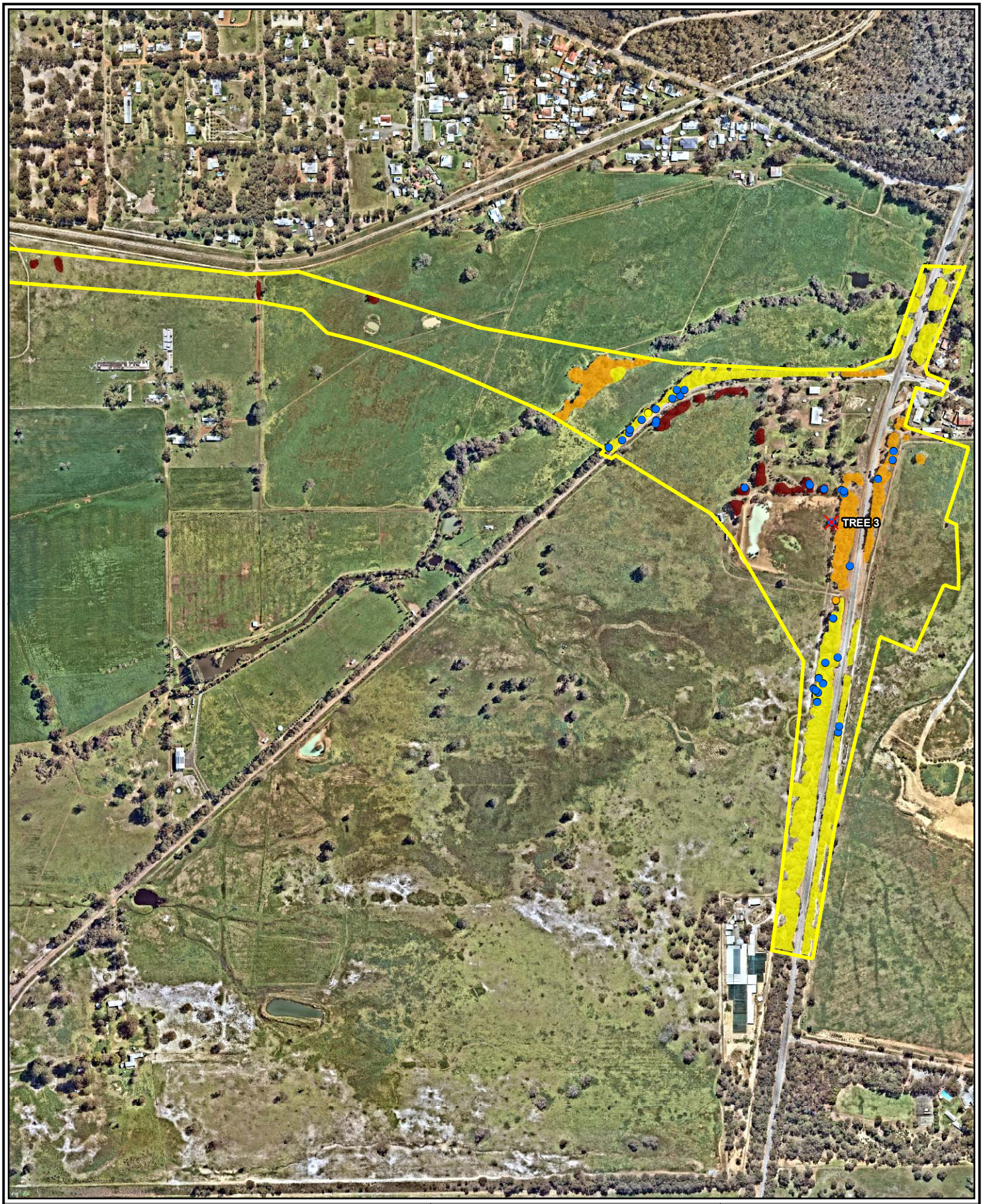


Legend

- Proposed Action

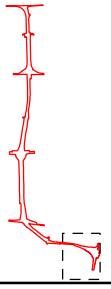
Foraging value - CBC

- Moderate (4)
- Low to moderate (3)
- Negligable to low (1)

Black Cockatoo significant habitat trees

- Jarrah
- Marri
- Wandoo
- Possible breeding hollows

LOCALITY MAP



Scale 1:9,000 at A4

0 100 200
Meters

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58910

Client: Main Roads Western Australia

Version: A | Date: 27-Jan-2021

Drawn By: hsullivan | Checked By: DN

Tonkin Highway Extension WA

CARNABY'S BLACK COCKATOO HABITAT WITHIN THE AREA OF THE PROPOSED ACTION

FIGURE 19 **PAGE 8**

strategen JBS&G

File Name: W:\Projects\1)Open\Main Roads\58910 Tonkin Extension PD\GIS\Maps\R01_Rev_A\58910_19_BCHabitatCarnabys.mxd
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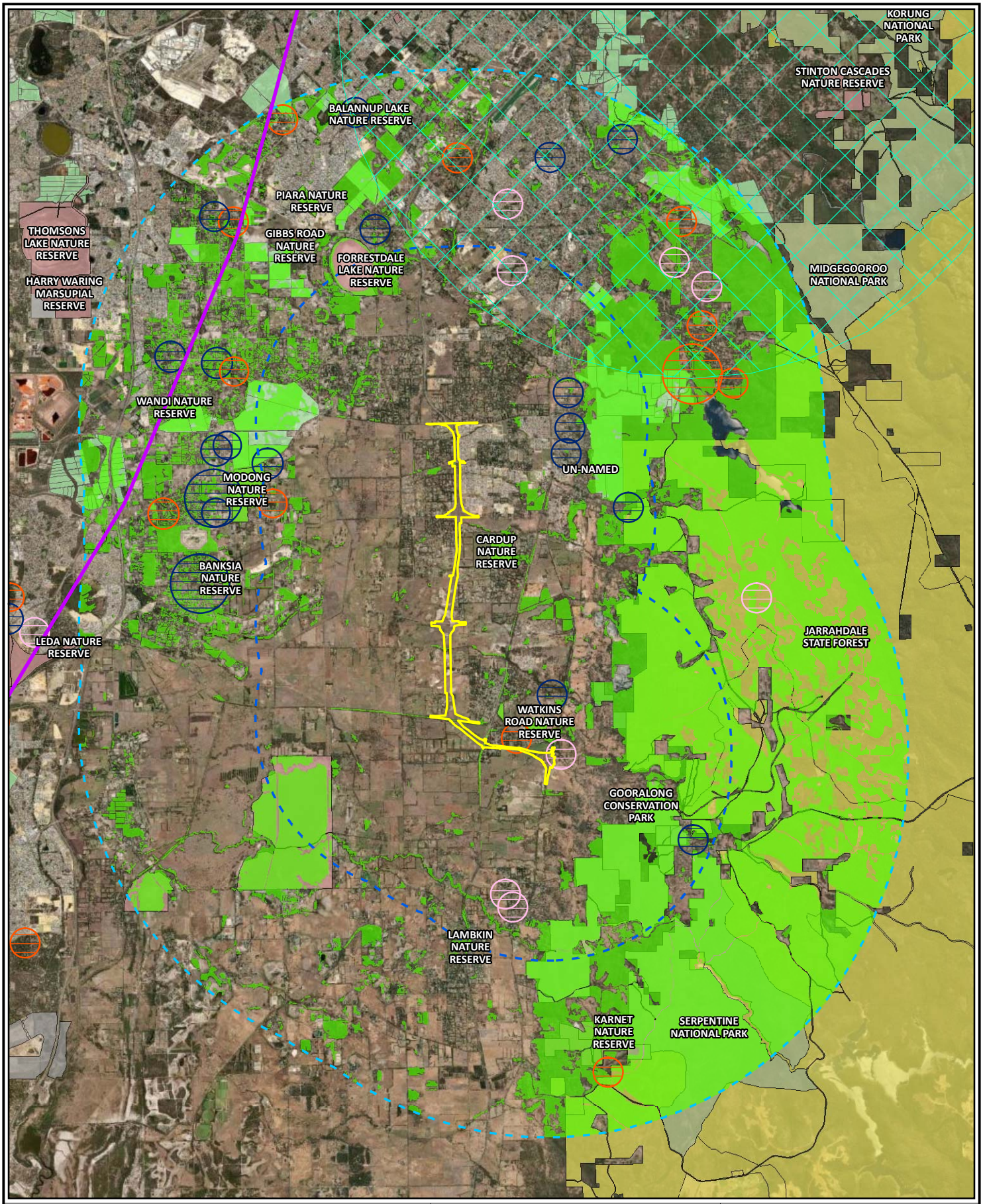


Legend

- Proposed Action
- 6 km radius of Proposed Action
- 12 km radius of Proposed Action
- Black Cockatoo foraging habitat within 12 km (29,230.13 ha)
- Carnaby's Black Cockatoo breeding site (buffered 12km)

Confirmed Black Cockatoo roost sites

- Forest red-tailed black cockatoos
- White-tailed black cockatoos
- Joint roosts

- Western extent of modeled Baudin's black cockatoo distribution

Legislated lands and waters (DBCA)

- National Park
- Crown Freehold - Dept Managed
- SCRM ACT - River Reserve
- Section 5(1)(g) Reserve
- Section 5(1)(h) Reserve
- Nature Reserve
- State Forest
- Other Reserves

Scale 1:170,000 at A4

0 1 2 Kilometers

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58910

Client: Main Roads Western Australia

Version: A | Date: 20-Jan-2021

Drawn By: hsullivan | Checked By: DN

Tonkin Highway Extension WA

BLACK COCKATOO HABITAT WITHIN 12 KM OF THE PROPOSED ACTION

FIGURE 20

strategen JBS&G

File Name: W:\Projects\1)Open\Main Roads\58910 Tonkin Extension PD\GIS\Maps\R01_Rev_A\58910_20_BCHabitat_Rgl.mxd
Image Reference: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

4.7.1.3 Quality and Importance

The Carnaby's Cockatoo Recovery Plan (DPaW 2013) identifies habitat critical for the survival of the species as:

- Eucalypt woodlands that provide nest hollows used for breeding, together with nearby vegetation that provides feeding, roosting and watering habitat that supports successful breeding
- Woodland sites known to have supported breeding in the past and which could be used in the future, provided adequate nearby food and/or water resources are available or are re-established
- In the non-breeding season, vegetation that provides food resources as well as the sites for nearby watering and night roosting that enable the cockatoos to effectively utilise the available food resources.

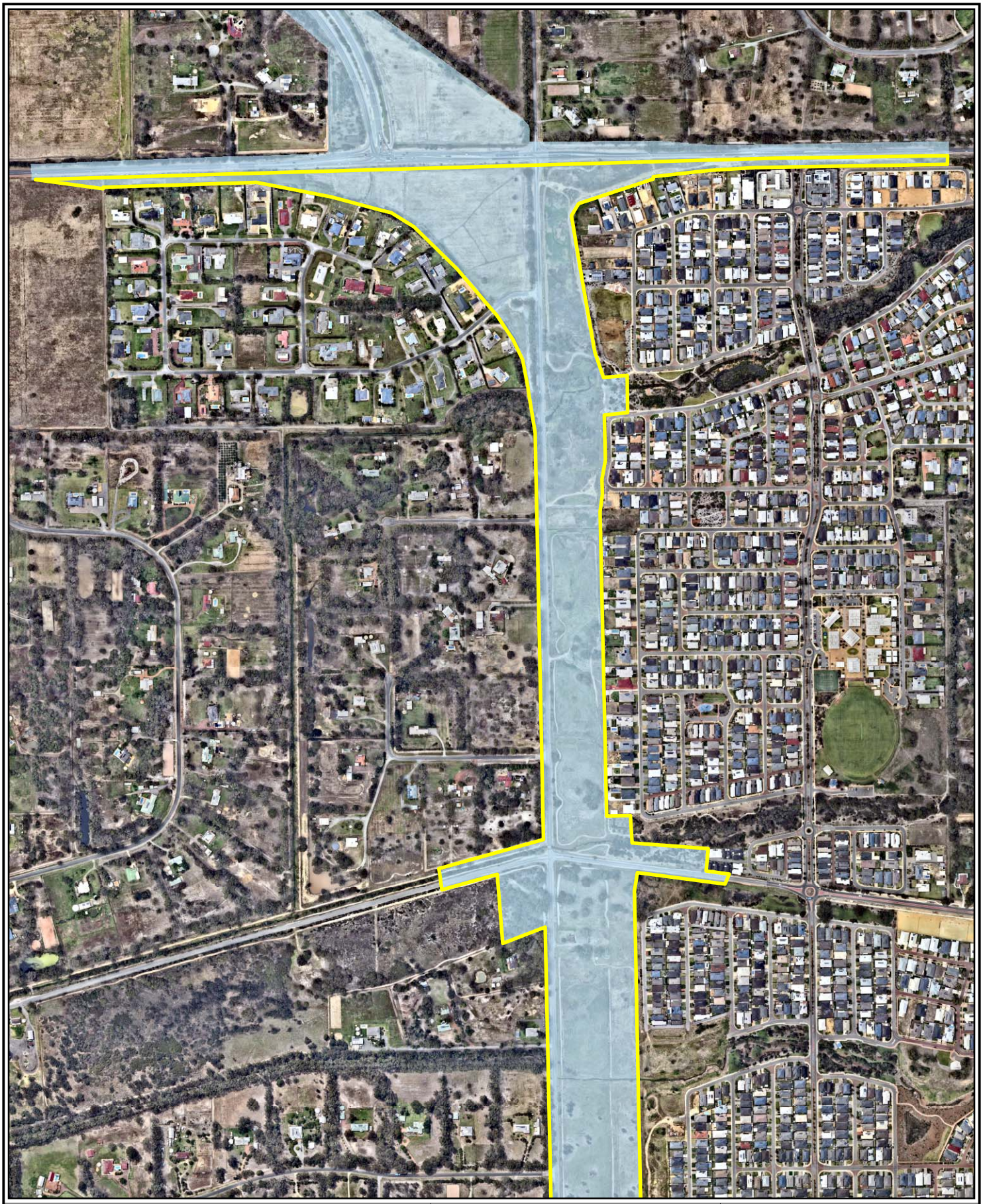
More recently, night roost sites have been recognised as important components of non-breeding habitat. The habitat within the Proposed Action area is considered critical for Carnaby's Cockatoo given it supports habitat suitable for foraging in combination with potential breeding habitat.

Based on the Black Cockatoo habitat assessment (Strategen-JBS&G 2020) the majority of the Proposed Action area (199.3 ha) was determined to be of 'Nil' foraging value (Figure 19), which comprises completely cleared areas and areas of highly disturbed vegetation. Table 4.5 provides a summary of the extent and quality of Carnaby's Cockatoo foraging habitat within the Proposed Action area. In summary, the Proposed Action area contains 34.2 ha of Carnaby's Cockatoo foraging habitat, comprising of 9.3 ha of 'Moderate' quality, 11.6 ha of 'Low to Moderate' quality, 8.7 ha of 'Low' quality and 4.5 ha of 'Negligible' quality foraging habitat. Foraging habitat with 'low' and 'negligible to low' quality is not considered further as it has negligible or no foraging value for Carnaby's Cockatoo.

Based on mapping of native vegetation extent and vegetation complexes containing species known to be used for foraging and breeding by Carnaby's Cockatoo, there is approximately 31,000 ha of potential foraging habitat available within 12km of the Proposed Action area. Of this, approximately 19,500 ha occurs within DBCA managed lands, and approximately 77% (15,000 ha) of this falls within Jarrahdale State Forest and Serpentine National Park (Figure 20). Given the extensive amount of potential foraging and breeding habitat available within 12km of the Proposed Action area, particularly to the east within the South West Jarrah Forest, the habitat within the Proposed Action area does not represent an important area of habitat for Carnaby's Cockatoos by comparison. Potential foraging habitat within surrounding National Parks and State Forest forms part of an extensive and largely continuous area of vegetation which is likely to comprise high quality foraging habitat, as well as potential breeding habitat. By comparison, foraging and potential breeding habitat occurring within the Proposed Action area is fragmented at the local scale and surrounded by predominantly cleared and degraded areas, and is not considered to be of elevated importance to Carnaby's Cockatoo when compared to habitat in the surrounding area.

4.7.1.4 Survey Adequacy and Limitations

The Black Cockatoo field surveys were undertaken by suitably qualified and experienced personnel, within appropriate seasonal times, site access and resources, in accordance with the relevant Commonwealth guidance (DSEWPaC 2012). There are nil constraints which are considered to have affected the accuracy or reliability of the survey outcomes which would affect the assessment of the Proposed Action. An assessment of the potential for constraints of the fauna field surveys is presented in Appendix G.

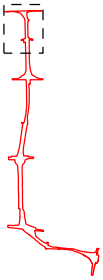


Legend

Proposed Action

Phytophthora Dieback status
Excluded

LOCALITY MAP



Scale 1:9,500 at A4

0 100 200
Meters

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58910

Client: Main Roads Western Australia

Version: A | Date: 16-Feb-2021

Drawn By: hsullivan | Checked By: DN

Tonkin Highway Extension WA

***PHYTOPHTHORA* DIEBACK STATUS**

FIGURE 21 **PAGE 1**

strategen JBS&G

File Name: W:\Projects\1)Open\Main Roads\58910 Tonkin Extension PD\GIS\Maps\R01_Rev_A\58910_21_Dieback.mxd
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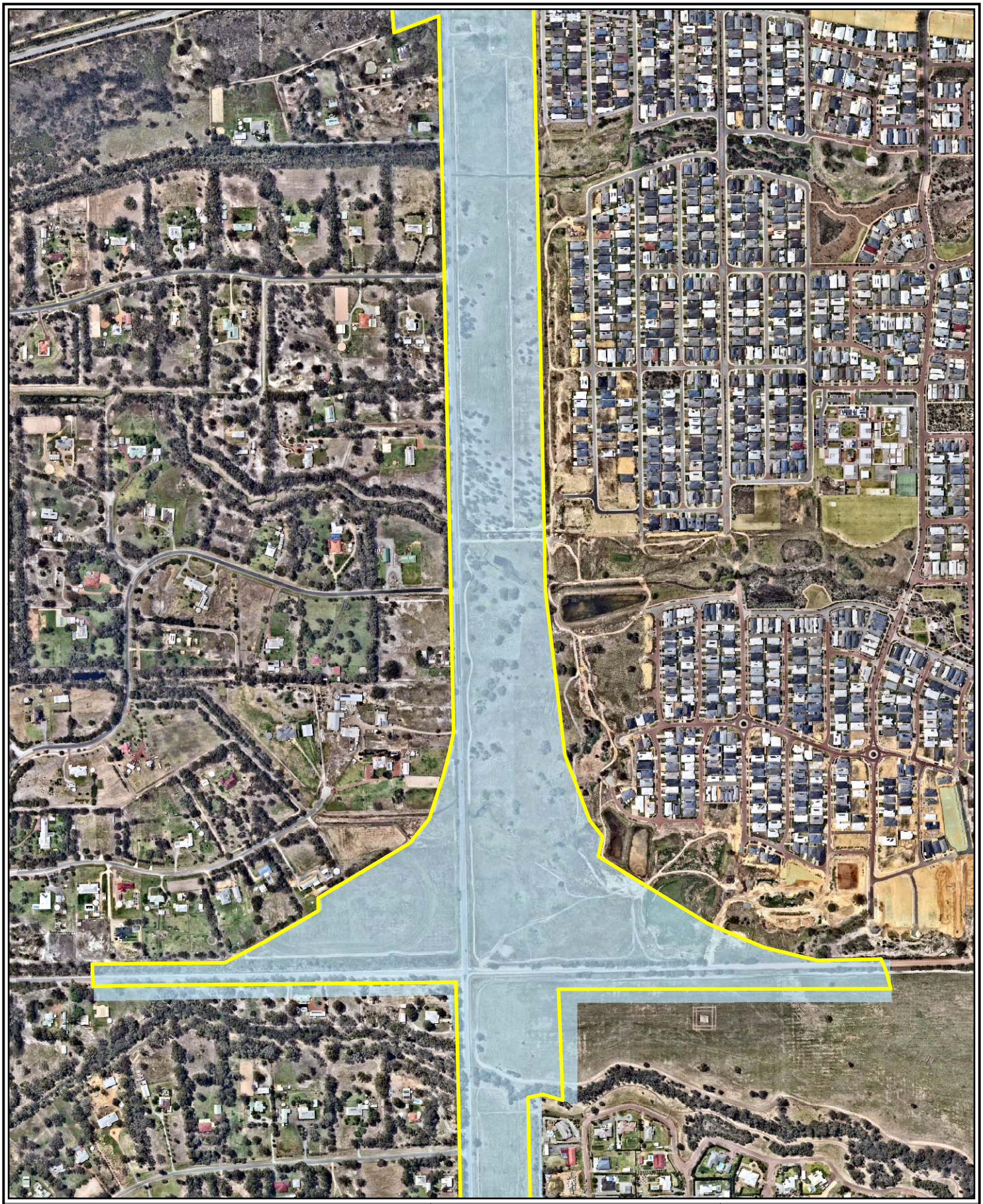

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Proposed Action

Phytophthora Dieback status
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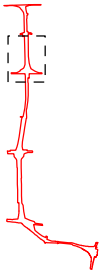
LOCALITY MAP



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Tonkin Highway Extension WA

***PHYTOPHTHORA* DIEBACK STATUS**

FIGURE 21 **PAGE 2**

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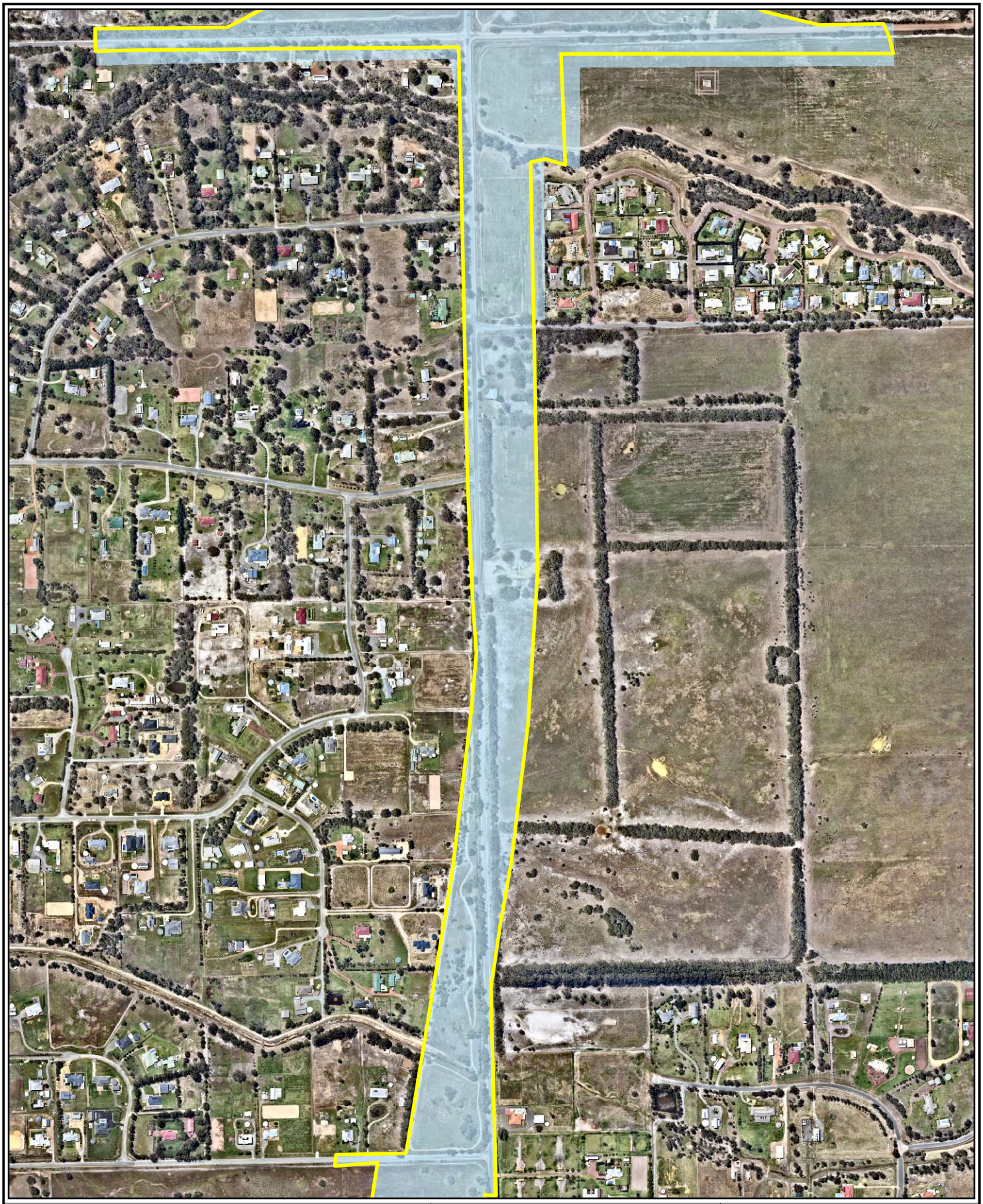

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Proposed Action

Phytophthora Dieback status
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LOCALITY MAP

Scale 1:9,000 at A4

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Meters

Coord. Sys. GDA 1994 MGA Zone 50

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Tonkin Highway Extension WA

***PHYTOPHTHORA* DIEBACK STATUS**

FIGURE 21 **PAGE 3**

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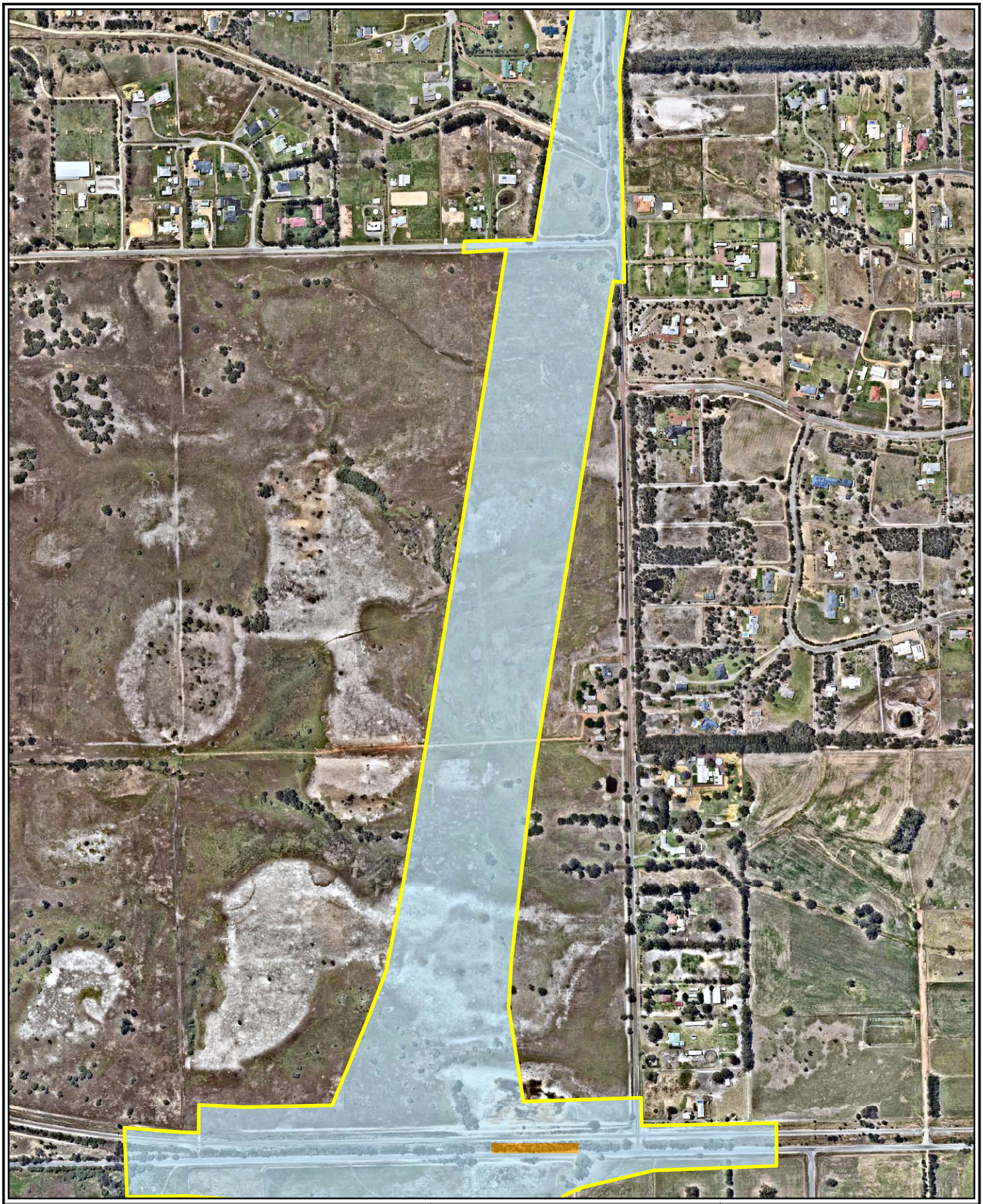

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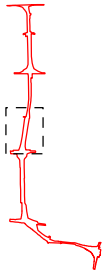
Proposed Action

Phytophthora Dieback status

Excluded

Infested

LOCALITY MAP



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Meters

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58910

Client: Main Roads Western Australia

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Tonkin Highway Extension WA

***PHYTOPHTHORA* DIEBACK STATUS**

FIGURE 21 **PAGE 4**

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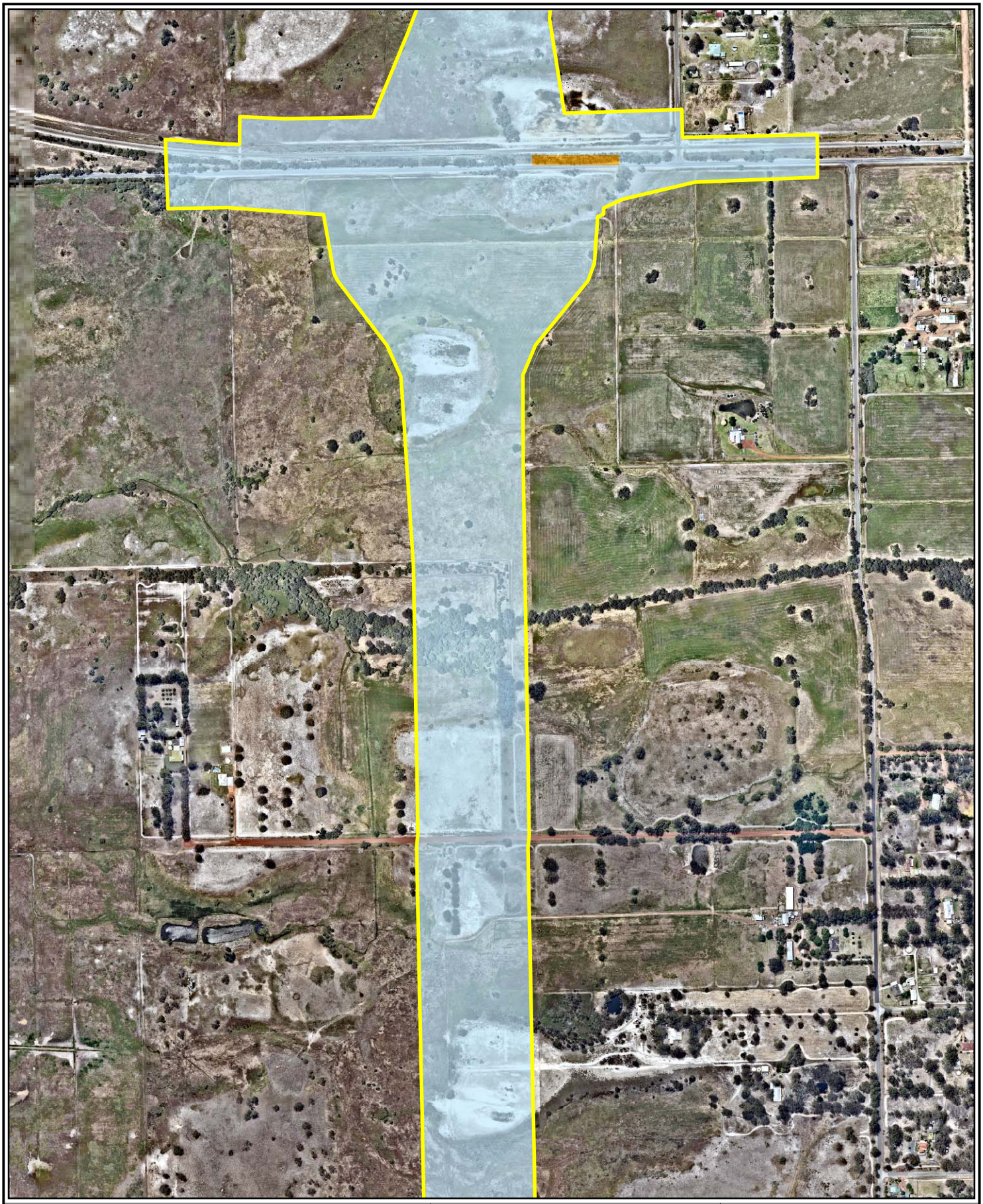

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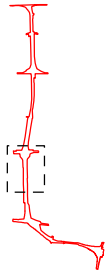
Proposed Action

Phytophthora Dieback status

Excluded

Infested

LOCALITY MAP



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Meters

Coord. Sys. GDA 1994 MGA Zone 50

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Tonkin Highway Extension WA

***PHYTOPHTHORA* DIEBACK STATUS**

FIGURE 21 **PAGE 5**

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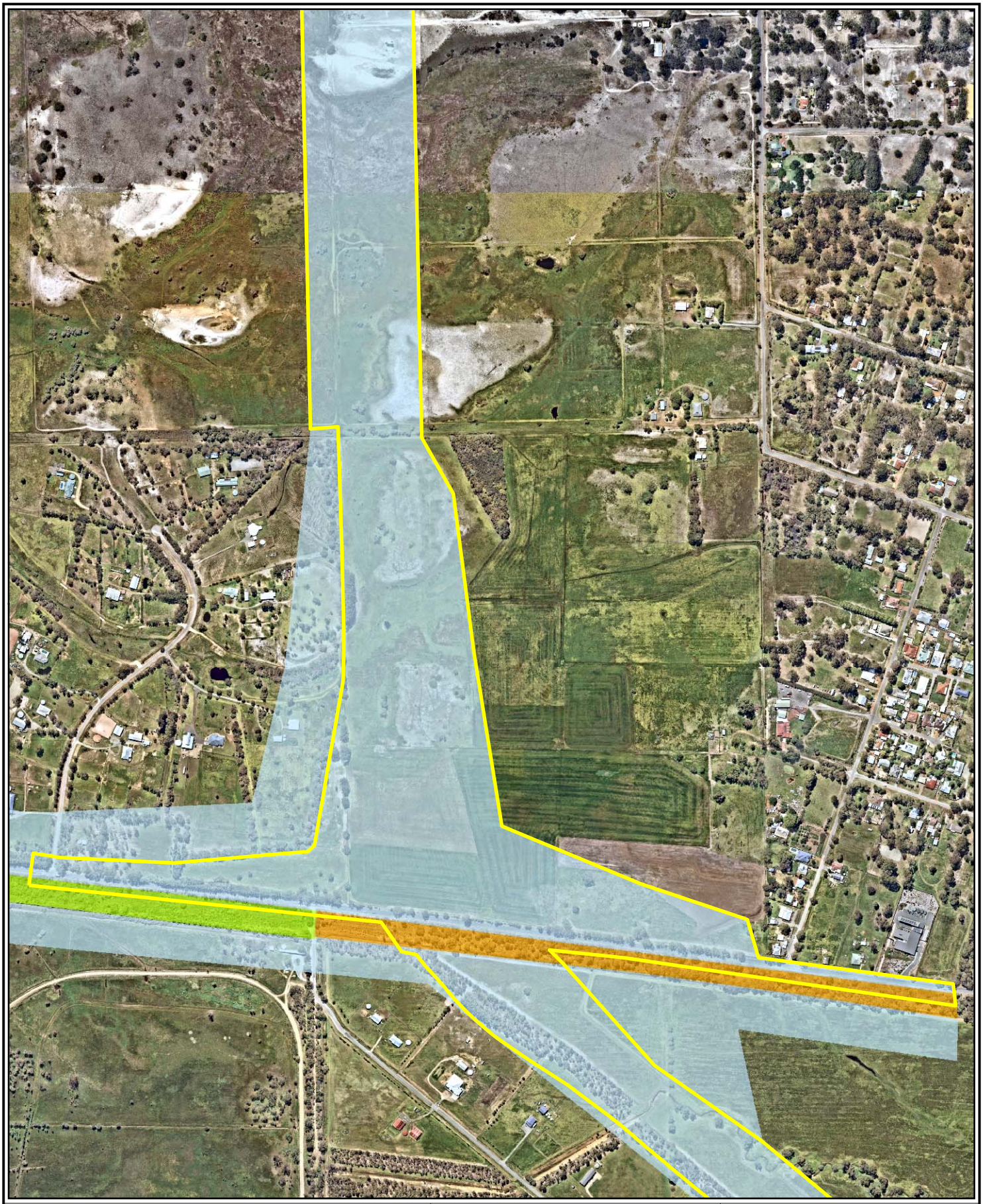


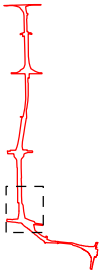
Legend

Proposed Action

Phytophthora Dieback status

- Excluded
- Infested
- Uninterpretable unprotectable

LOCALITY MAP



Scale 1:9,000 at A4

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Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58910

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Tonkin Highway Extension WA

***PHYTOPHTHORA* DIEBACK STATUS**

FIGURE 21 **PAGE 6**

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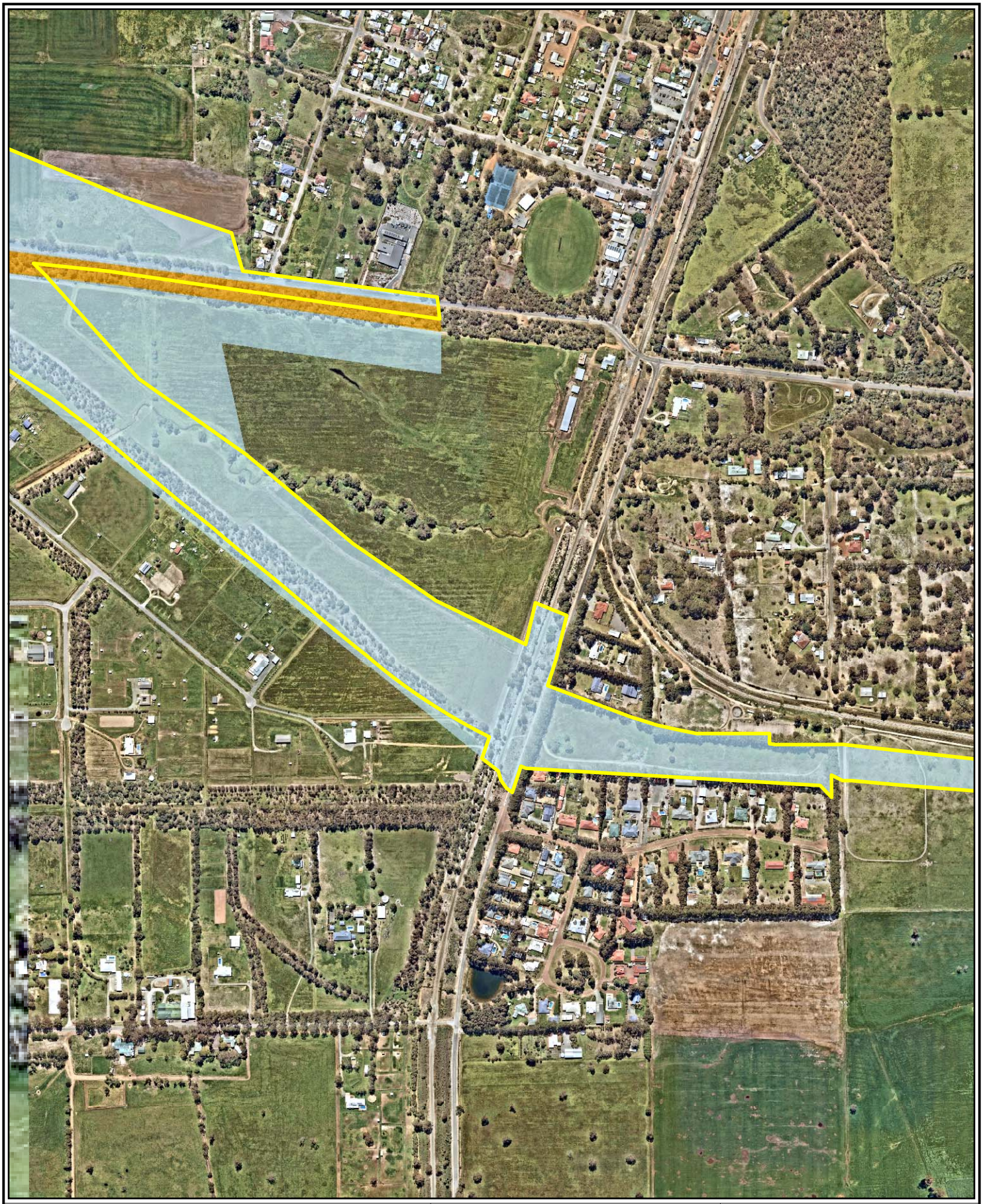
File Name: W:\Projects\1)Open\Main Roads\58910 Tonkin Extension PD\GIS\Maps\R01_Rev_A\58910_21_Dieback.mxd
Image Reference: www.nearmap.com© - Imagery Date: 18 September 2020.



Legend

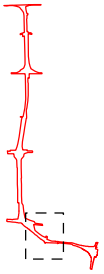
Proposed Action

Phytophthora Dieback status

Excluded

Infested

LOCALITY MAP



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Meters

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58910

Client: Main Roads Western Australia

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Date: 16-Feb-2021

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Tonkin Highway Extension WA

***PHYTOPHTHORA* DIEBACK STATUS**

FIGURE 21 **PAGE 7**

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File Name: W:\Projects\1)Open\Main Roads\58910 Tonkin Extension PD\GIS\Maps\R01_Rev_A\58910_21_Dieback.mxd

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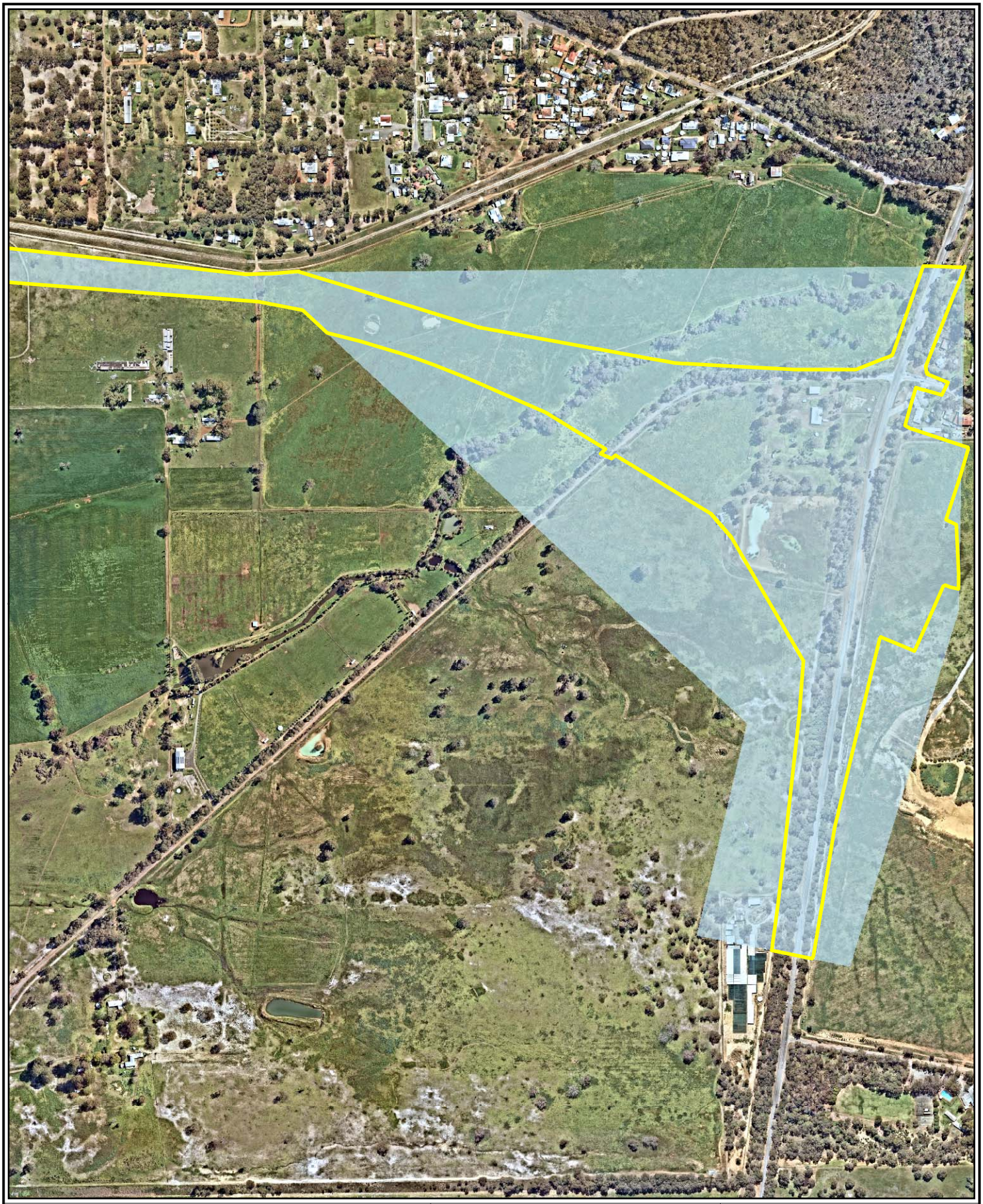
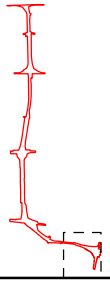


Legend

Proposed Action

Phytophthora Dieback status
Excluded

LOCALITY MAP



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Meters

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58910

Client: Main Roads Western Australia

Version: A | Date: 16-Feb-2021

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Tonkin Highway Extension WA

***PHYTOPHTHORA* DIEBACK STATUS**

FIGURE 21 **PAGE 8**

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File Name: W:\Projects\1)Open\Main Roads\58910 Tonkin Extension PD\GIS\Maps\R01_Rev_A\58910_21_Dieback.mxd
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4.7.2 Baudin's Cockatoo Calyptorhynchus baudinii

Baudin's cockatoo is classified as Endangered under the EPBC and BC Act. (DBCA 2018c, DAWE 2020).

4.7.2.1 Abundance, Distribution and Ecology

Historical distribution and abundance of Baudin's Cockatoo is relatively unknown as early published literature did not distinguish between Carnaby's Cockatoo and Baudin's Cockatoo (Higgins 1999), however the current population size for Baudin's Cockatoo is estimated to be 12,000 individuals. This species is generally contained in areas of south west Western Australia in humid and sub-humid zones in areas within the 750mm isohyet of average annual rainfall (Saunders 1979). The current known distribution range for Baudin's Cockatoo extends from Albany in the south to Gidgegannup in the north, east to Mount Helena, Wandering, Quindanning, Kojonup, Frankland and King River, and to the eastern margin of the Swan Coastal Plain (Johnstone 1997; Johnstone and Storr 1998). Baudin's Cockatoo are also known to occur in the Stirling Range (Sedgwick 1964), Porongurup Range (Abbott 1981) and near Boyup Brook (Davies 1966; Saunders 1974a, 1979; Saunders *et al.* 1985; Johnstone and Storr 1998).

While this species is most commonly known from forested areas, they are also found in open agricultural areas, where they are considered to be locally resident, but move away at the end of the breeding season around January in response to changing food resources (Saunders 1974b). Flocks visit the central and northern Darling Range and the eastern margin of the Swan Coastal Plain in March and September (Johnstone and Storr 1998) and move north through the Perth region from March to May and south from August to September (Serventy 1937; Sedgwick 1940; Serventy 1948; Heron 1970; Saunders 1979).

Baudin's Cockatoo breed in hollows of mature trees such as Marri, Karri, Jarrah and Wandoo in the lower south-west of Western Australia during the breeding season which occurs between July and November, although little is known about the breeding cycle of this species as the nests are extremely difficult to locate (DEC 2008).

Marri seeds and fruits are the dominant food source for Baudin's Cockatoo, with other foraging species comprising of *Banksia* spp., *Hakea* spp., *Erodium botrys,* Jarrah and *Dryandra* spp. This species also feeds on apple and pear seeds in domestic orchards and can be very destructive (DEC 2008).

Breeding habitat

Mapping provided in the Commonwealth document *EPBC Act referral guidelines for three threatened black cockatoo species* (DSEWPaC 2012) indicates that the Proposed Action is outside of the predicted breeding range of Baudin's Cockatoo. Baudin's Cockatoo are known to breed in low numbers in the Serpentine Hills area approximately 10km to the south of the Proposed Action and in the Wungong Catchment approximately 16km to the east, therefore it is not expected that this species currently breeds within the Proposed Action. However, tree species such as Marri, Jarrah, Flooded Gum and Blackbutt are present within the Proposed Action and are known to be used by Baudin's Cockatoo within their predicted breeding range (

Figure 22).

Foraging habitat

Based on the Black Cockatoo habitat assessment (Strategen-JBS&G 2020), the majority of the Proposed Action area (194.7 ha) was determined to be of 'Nil' foraging value (Table 4.6), which comprises completely cleared areas and areas of highly degraded vegetation.

In total, the Proposed Action area contains 35.8 ha of Baudin's Cockatoo foraging habitat, comprising of 5.6 ha of 'Moderate to High' quality, 3.7 ha of 'Moderate' quality, 11.3 ha of 'Low to Moderate' quality and 13.6 ha of 'Low' quality foraging habitat (Table 4.6). Foraging habitat with 'Low' quality is not considered further as it has low foraging value for Baudin's Cockatoo. Therefore, there is 20.6 ha of 'Moderate to High' to 'Low to Moderate' foraging habitat for Baudin's Cockatoo within the Proposed Action area.

Based on mapping of native vegetation extent and vegetation complexes containing species known to be used for foraging by Baudin's Cockatoo the estimated extent of potential foraging habitat within 12km of the Proposed Action area is approximately 28,000 ha (Strategen JBS&G 2020) (Figure 20).

Table 4.6: Baudin's Cockatoo Foraging Habitat Extent and Quality

Habitat quality and score	Extent within Proposed Action area (ha)	Proportion of Proposed Action area (%)
High foraging value (6)	0.0	0.0
Moderate to High foraging value (5)	5.61	2.4
Moderate foraging value (4)	3.70	1.6
Low to Moderate foraging value (3)	11.29	4.8
Low foraging value (2)	13.56	5.8
Negligible to low foraging value (1)	0.0	0.0
No foraging value (0)	199.33	85.4
Total	**233.50**	**100**

Roosting habitat

Regional mapping undertaken by the Department of Biodiversity, Conservation and Attractions (DBCA), BirdLife Australia and WA Museum indicates that the project area is situated within the buffer of 1 confirmed white-tailed Black Cockatoo roosting site (SERMUNR002) (DBCA 2011), although the centre-point does not fall within the Proposed Action area. No evidence or observations of night roosting was recorded within the Proposed Action area (Kirkby 2019).

Publicly available data from the most recent annual Great Cocky Count (Peck et al. 2019) indicates that there is 1 confirmed white-tail cockatoo (Carnaby's Cockatoo and/or Baudin's Cockatoo) roost within 1km of the Proposed Action area and 31 confirmed roosts within a 12km radius (Figure 20). A number of these roosts are joint roosts shared with Forest Red-tailed Black Cockatoo. Murdoch University (2015) GPS and satellite tracking data indicate a number of night roosts used by Baudin's Cockatoos are located in the vicinity, but outside of, the Proposed Action (Figure 20).

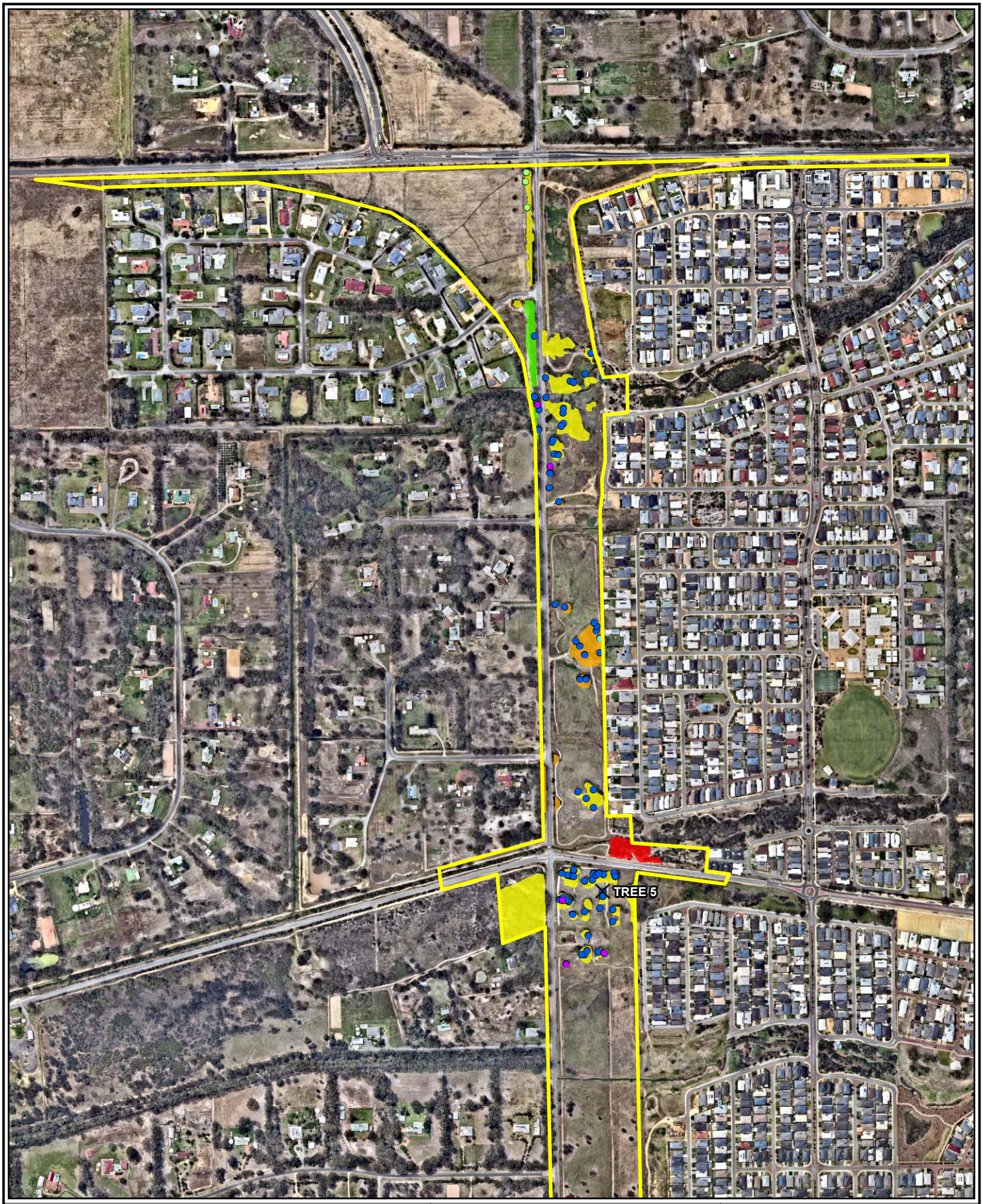
Current and historical patterns of use

Kirkby (2019) recorded foraging evidence by Baudin's Cockatoo at 24 locations within the Proposed Action area in the form of chewed Marri nuts (Kirkby 2019). In addition, evidence of foraging by Baudin's Cockatoos within and immediately adjacent to the Proposed Action was reported by Murdoch University (2015) through GPS and satellite tracking data. Heavy chewing around the entrance of one hollow contained within Tree 6 was observed by Kirkby (2020), indicating that the hollow may have been used by Black Cockatoos in the past, however given that the Proposed Action area is outside of the known breeding range for Baudin's Cockatoo the chew marks are unlikely to be attributed to Baudin's Cockatoo.

An examination of historical aerial imagery from Landgate Map Viewer illustrates that much of the vegetation within the Proposed Action area and the immediate surrounds was cleared prior to the earliest available imagery from 1953. Based on pre-European vegetation mapping, vegetation which has been cleared within the Proposed Action area is consistent with the vegetation remaining in the Proposed Action area and it is considered likely that the entire Proposed Action area would have been utilised by Baudin's Cockatoo for foraging prior to clearing.

4.7.2.2 Impact of Proposed Action

The Proposed Action area contains 20.61 ha of 'moderate to high' to 'low to moderate' quality foraging habitat for Baudin's Cockatoo as well as 346 potential breeding trees with a DBH greater than 500 mm, including two that contain potentially suitable hollows for Black Cockatoo nesting.



Legend

- Proposed Action

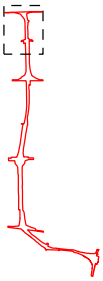
Foraging value - BBC & FRTBC

- Moderate to high (5)
- Moderate (4)
- Low to moderate (3)
- Low (2)

Black Cockatoo significant habitat trees

- Flooded Gum
- Jarrah stag
- Marri
- Marri stag
- Unsuitable breeding hollows

LOCALITY MAP



Scale 1:9,500 at A4

0 100 200
Meters

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58910

Client: Main Roads Western Australia

Version: A | Date: 20-Jan-2021

Drawn By: hsullivan | Checked By: DN

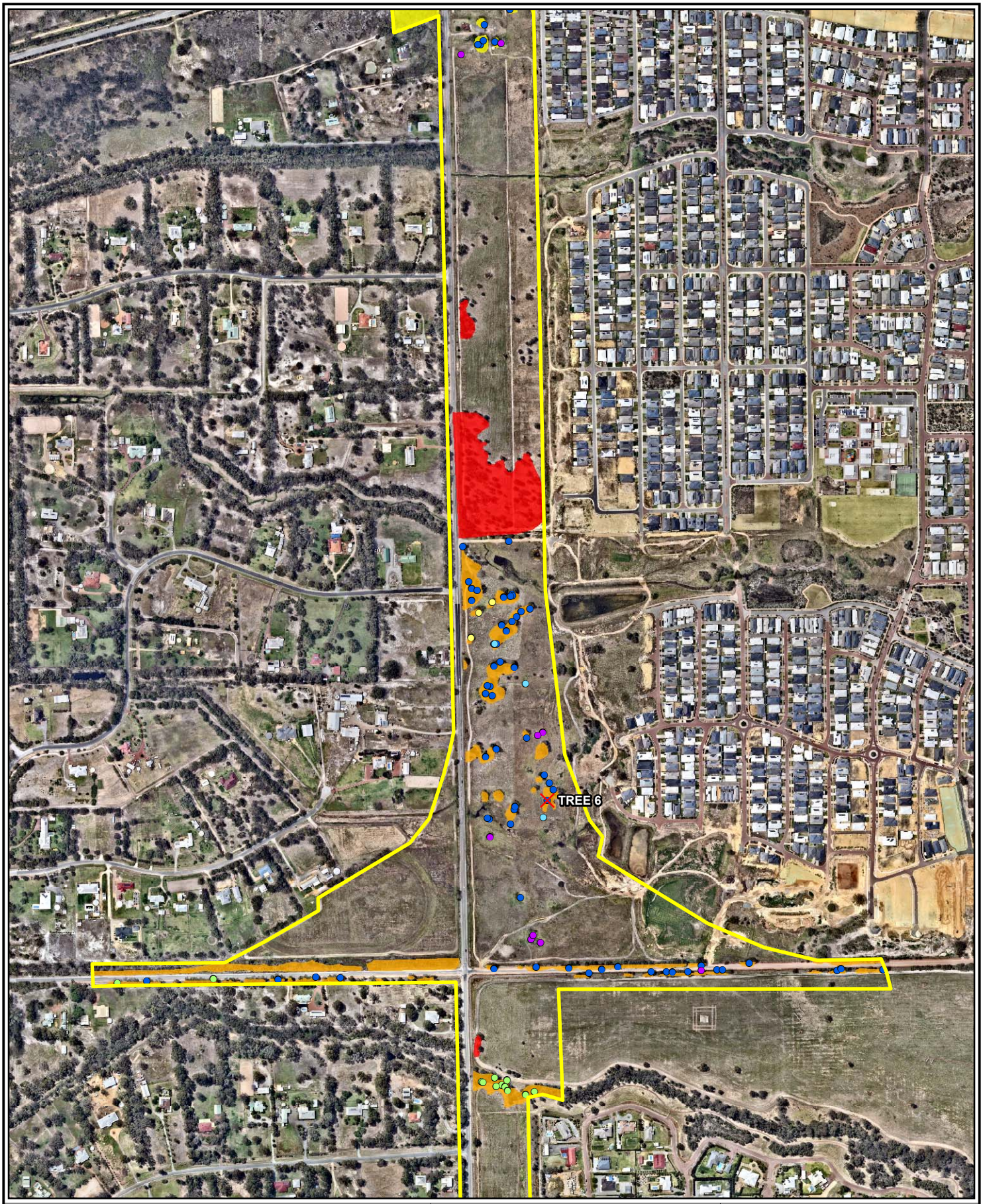
Tonkin Highway Extension WA

BAUDIN'S AND FOREST RED-TAILED BLACK COCKATOO HABITAT WITHIN THE AREA OF THE PROPOSED ACTION

FIGURE 22 **PAGE 1**

strategen JBS&G

File Name: W:\Projects\1)Open\Main Roads\58910 Tonkin Extension PD\GIS\Maps\R01_Rev_A\58910_22_BCHabitatOther.mxd
Image Reference: www.nearmap.com© - Imagery Date: 12 May 2020.



Legend

- Proposed Action

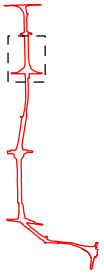
Foraging value - BBC & FRTBC

- Moderate (4)
- Low to moderate (3)
- Low (2)

Black Cockatoo significant habitat trees

- Flooded Gum
- Jarrah
- Jarrah stag
- Marri
- Marri stag
- Possible breeding hollows

LOCALITY MAP



Scale 1:9,000 at A4

0 100 200
Meters

Coord. Sys. GDA 1994 MGA Zone 50

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Tonkin Highway Extension WA

BAUDIN'S AND FOREST RED-TAILED BLACK COCKATOO HABITAT WITHIN THE AREA OF THE PROPOSED ACTION

FIGURE 22 **PAGE 2**

strategen JBS&G

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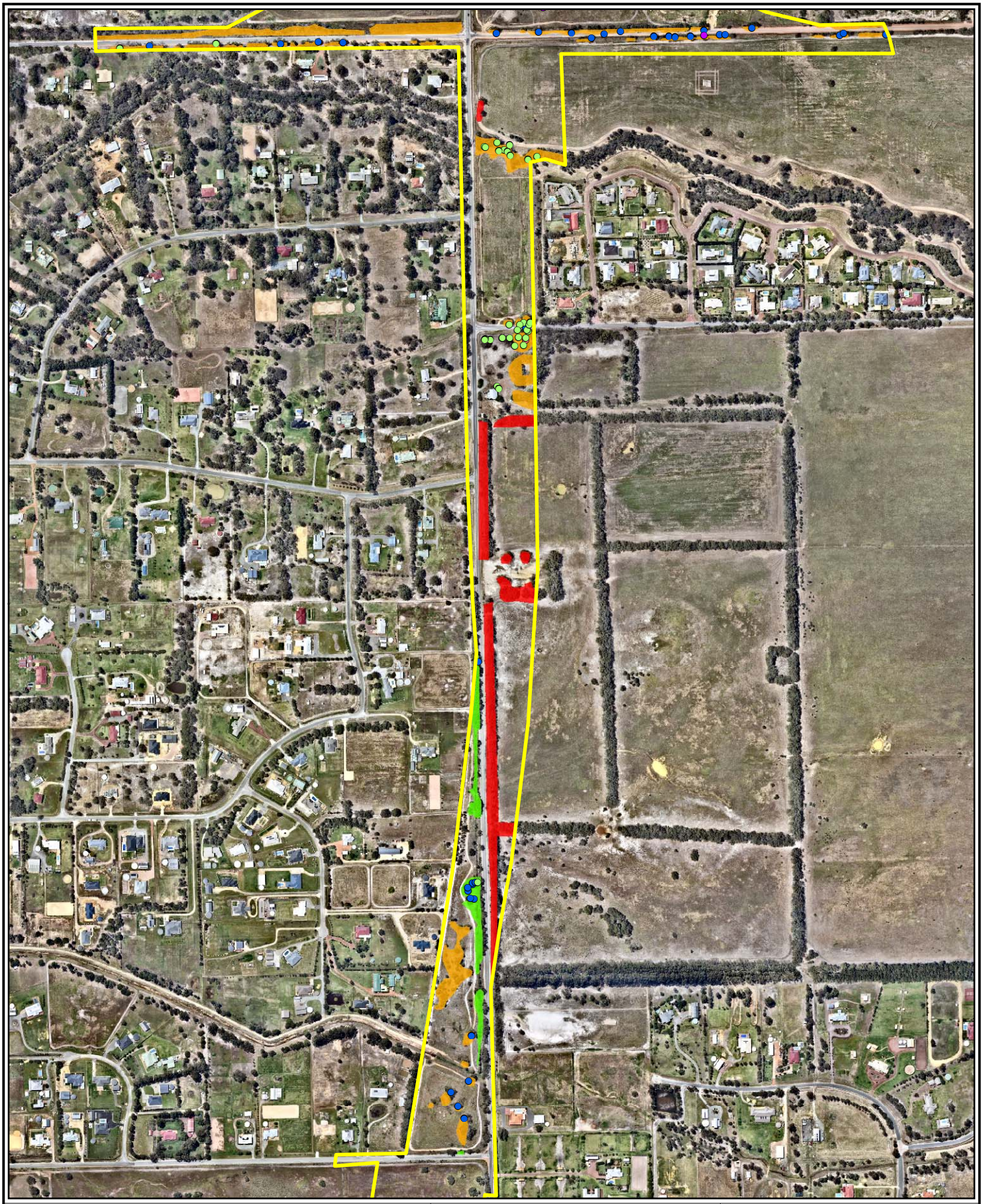

Legend

- Proposed Action

Foraging value - BBC & FRTBC

- Moderate to high (5)
- Low to moderate (3)
- Low (2)

Black Cockatoo significant habitat trees

- Flooded Gum
- Flooded Gum stag
- Marri
- Marri stag

LOCALITY MAP

Scale 1:9,000 at A4

0 100 200
Meters

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58910

Client: Main Roads Western Australia

Version: A | Date: 20-Jan-2021

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Tonkin Highway Extension WA

BAUDIN'S AND FOREST RED-TAILED BLACK COCKATOO HABITAT WITHIN THE AREA OF THE PROPOSED ACTION

FIGURE 22 **PAGE 3**

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File Name: W:\Projects\1)Open\Main Roads\58910 Tonkin Extension PD\GIS\Maps\R01_Rev_A\58910_22_BCHabitatOther.mxd
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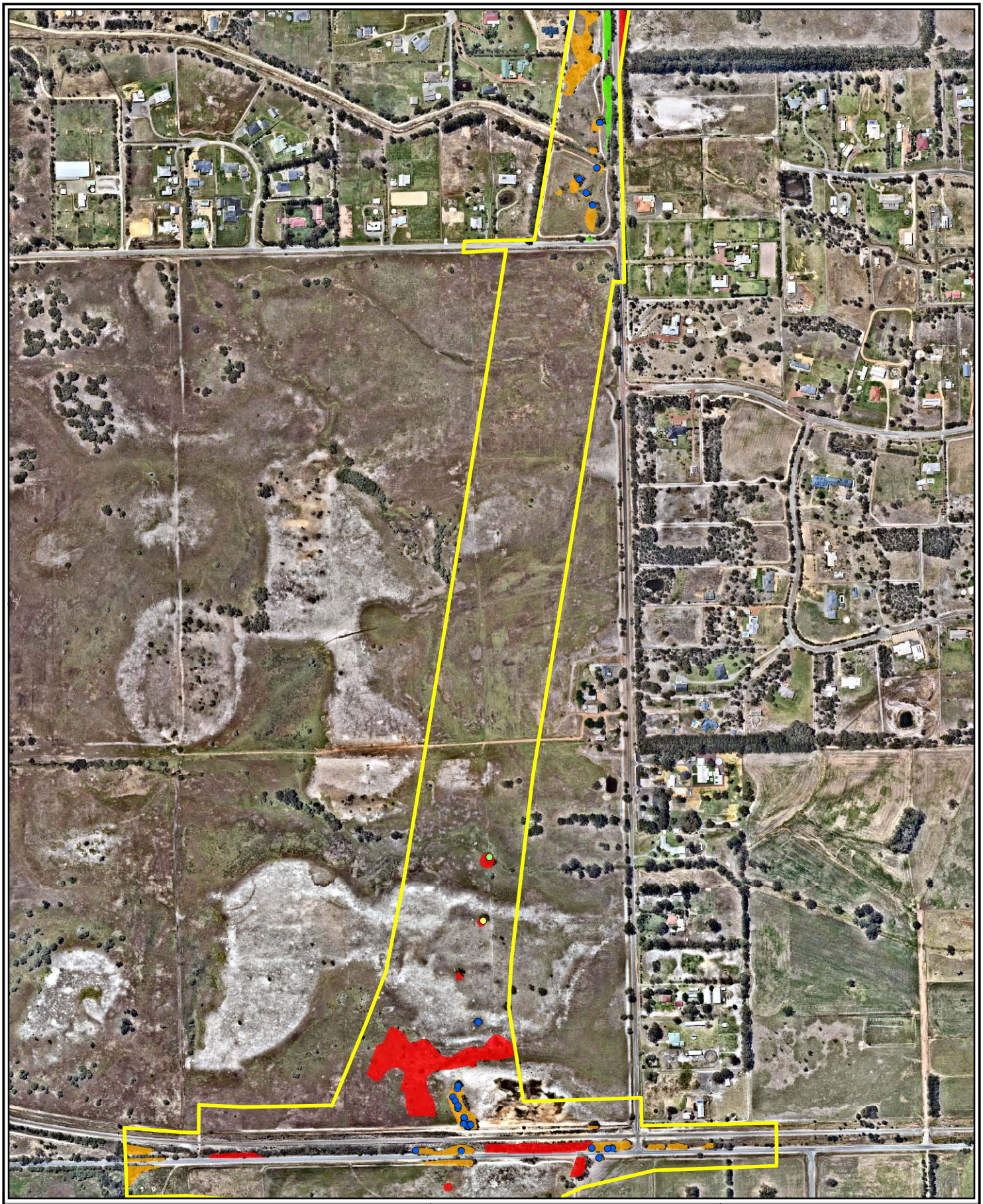


Legend

- Proposed Action

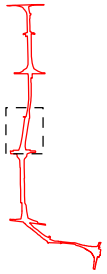
Foraging value - BBC & FRTBC

- Moderate to high (5)
- Low to moderate (3)
- Low (2)

Black Cockatoo significant habitat trees

- Flooded Gum
- Jarrah
- Marri

LOCALITY MAP



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Meters

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BAUDIN'S AND FOREST RED-TAILED BLACK COCKATOO HABITAT WITHIN THE AREA OF THE PROPOSED ACTION

FIGURE 22 **PAGE 4**

strategen JBS&G

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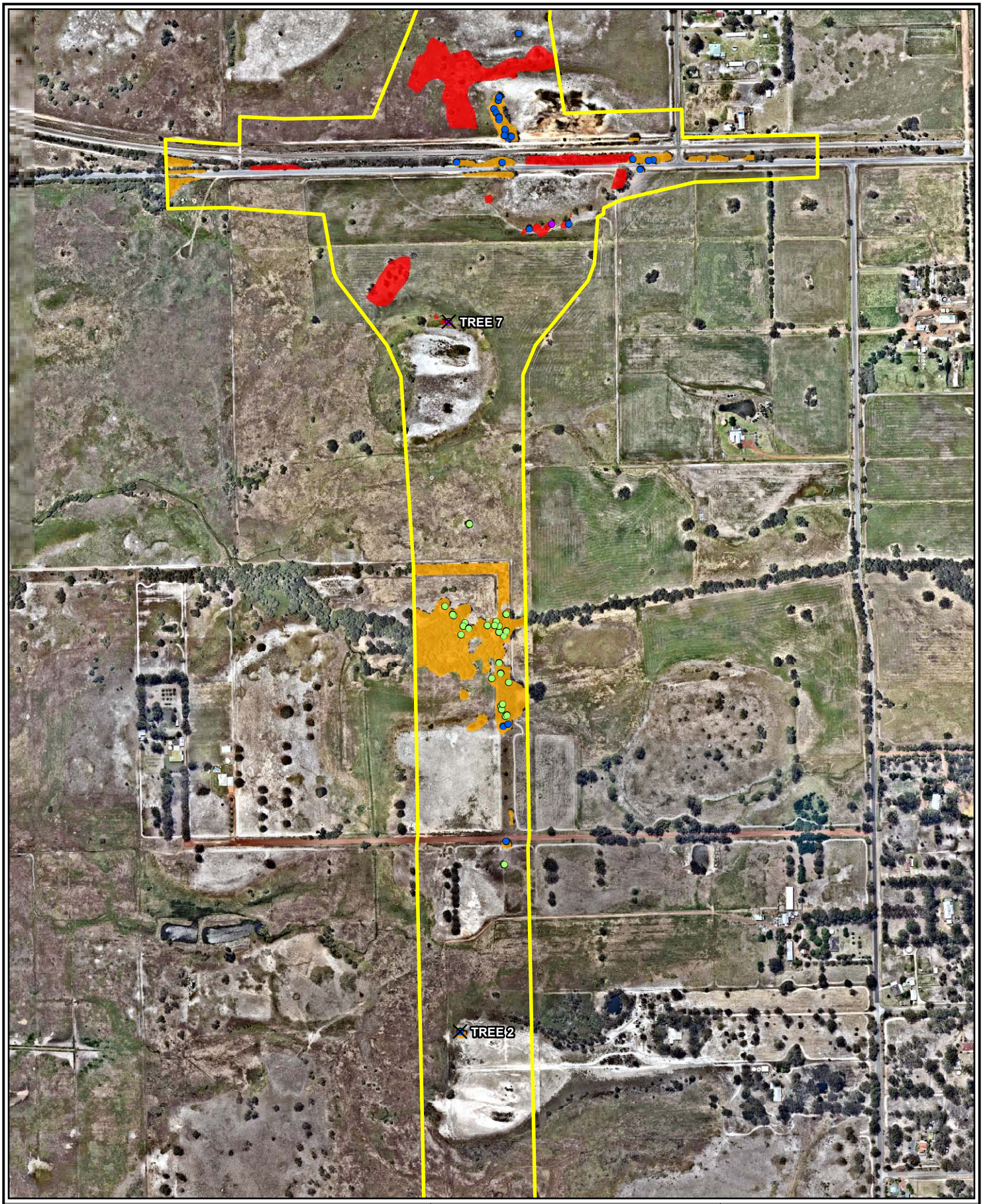


Legend

- Proposed Action

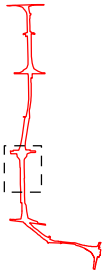
Foraging value - BBC & FRTBC

- Low to moderate (3)
- Low (2)

Black Cockatoo significant habitat trees

- Flooded Gum
- Marri
- Marri stag
- Unsuitable breeding hollows

LOCALITY MAP



Scale 1:9,000 at A4

0 100 200
Meters

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58910

Client: Main Roads Western Australia

Version: A | Date: 20-Jan-2021

Drawn By: hsullivan | Checked By: DN

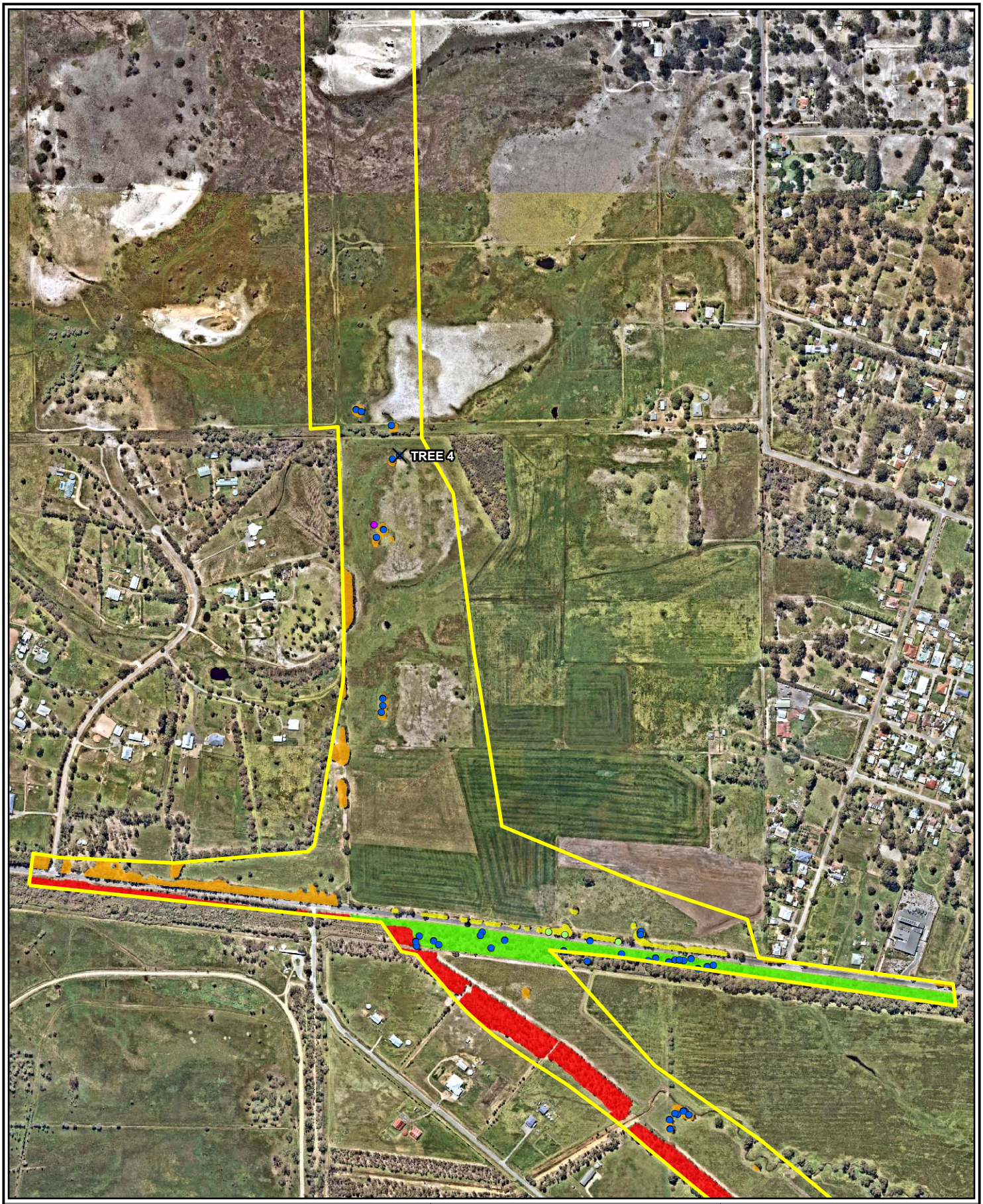
Tonkin Highway Extension WA

BAUDIN'S AND FOREST RED-TAILED BLACK COCKATOO HABITAT WITHIN THE AREA OF THE PROPOSED ACTION

FIGURE 22 **PAGE 5**

strategen JBS&G

File Name: W:\Projects\1)Open\Main Roads\58910 Tonkin Extension PD\GIS\Maps\R01_Rev_A\58910_22_BCHabitatOther.mxd
Image Reference: www.nearmap.com© - Imagery Date: 12 May 2020.



Legend

- Proposed Action

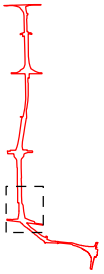
Foraging value - BBC & FRTBC

- Moderate to high (5)
- Moderate (4)
- Low to moderate (3)
- Low (2)

Black Cockatoo significant habitat trees

- Flooded Gum
- Marri
- Marri stag
- Unsuitable breeding hollows

LOCALITY MAP



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Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58910

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Version: A | Date: 20-Jan-2021

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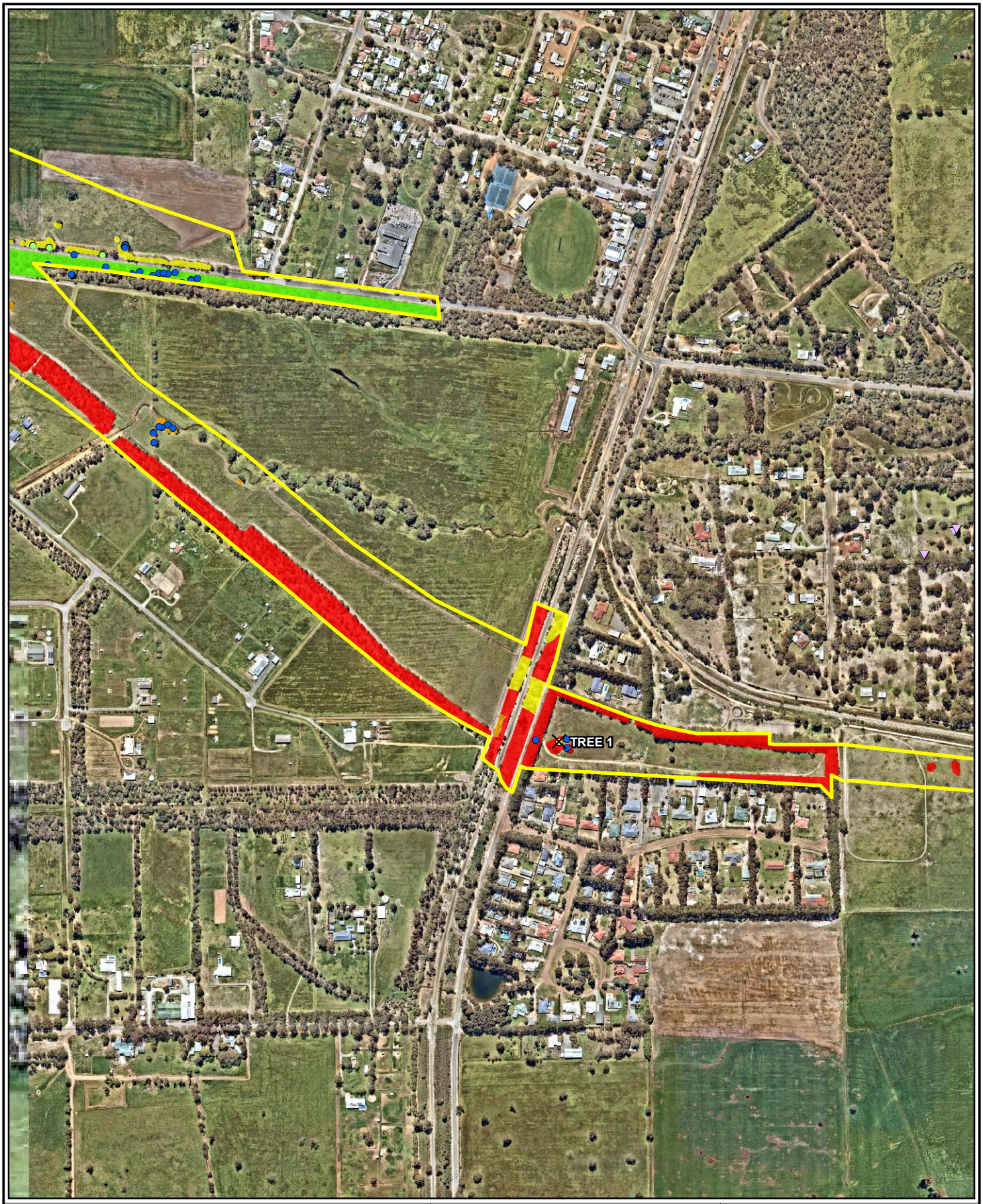
Tonkin Highway Extension WA

BAUDIN'S AND FOREST RED-TAILED BLACK COCKATOO HABITAT WITHIN THE AREA OF THE PROPOSED ACTION

FIGURE 22 **PAGE 6**

strategen JBS&G

File Name: W:\Projects\1)Open\Main Roads\58910 Tonkin Extension PD\GIS\Maps\R01_Rev_A\58910_22_BCHabitatOther.mxd
Image Reference: www.nearmap.com© - Imagery Date: 12 May 2020.



Legend

- Proposed Action

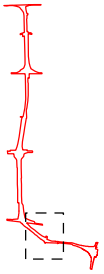
Foraging value - BBC & FRTBC

- Moderate to high (5)
- Moderate (4)
- Low to moderate (3)
- Low (2)
- Baudin's Black Cockatoo locations (Murdoch 2015)

Black Cockatoo significant habitat trees

- Flooded Gum
- Jarrah
- Marri
- Unsuitable breeding hollows

LOCALITY MAP



Scale 1:9,000 at A4

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Meters

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58910

Client: Main Roads Western Australia

Version: A | Date: 20-Jan-2021

Drawn By: hsullivan | Checked By: DN

Tonkin Highway Extension WA

BAUDIN'S AND FOREST RED-TAILED BLACK COCKATOO HABITAT WITHIN THE AREA OF THE PROPOSED ACTION

FIGURE 22 **PAGE 7**

strategen JBS&G

File Name: W:\Projects\1)Open\Main Roads\58910 Tonkin Extension PD\GIS\Maps\R01_Rev_A\58910_22_BCHabitatOther.mxd
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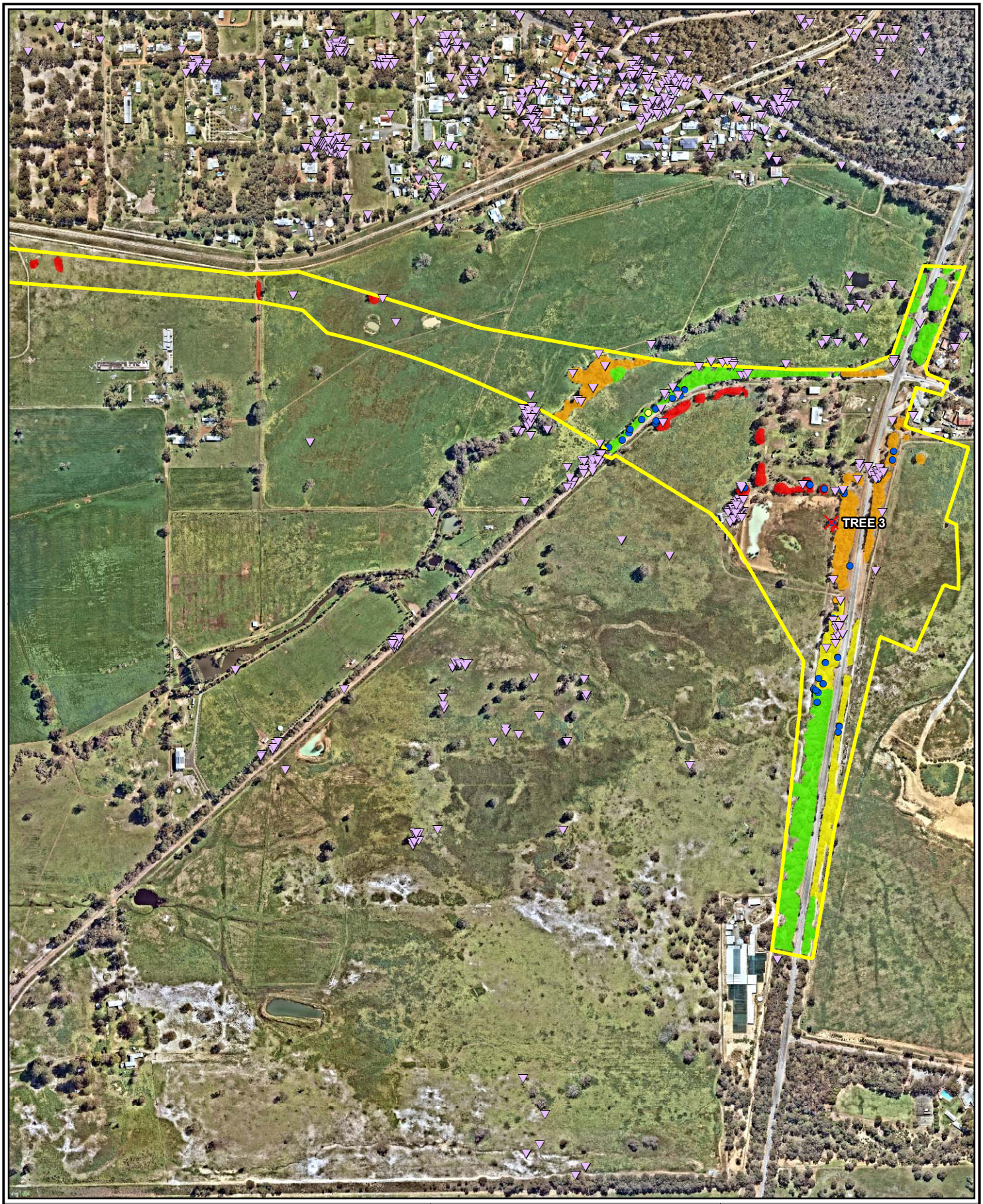


Legend

- Proposed Action

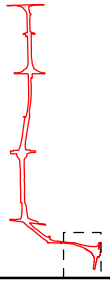
Foraging value - BBC & FRTBC

- Moderate to high (5)
- Moderate (4)
- Low to moderate (3)
- Low (2)
- Baudin's Black Cockatoo locations (Murdoch 2015)

Black Cockatoo significant habitat trees

- Jarrah
- Marri
- Wandoo
- Possible breeding hollows

LOCALITY MAP



Scale 1:9,000 at A4

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Coord. Sys. GDA 1994 MGA Zone 50

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Tonkin Highway Extension WA

BAUDIN'S AND FOREST RED-TAILED BLACK COCKATOO HABITAT WITHIN THE AREA OF THE PROPOSED ACTION

FIGURE 22 **PAGE 8**

strategen JBS&G

File Name: W:\Projects\1)Open\Main Roads\58910 Tonkin Extension PD\GIS\Maps\R01_Rev_A\58910_22_BCHabitatOther.mxd
Image Reference: www.nearmap.com© - Imagery Date: 12 May 2020.

4.7.2.3 Quality and Importance

The *Forest Black Cockatoo (Baudin's Cockatoo and Forrest Red-Tailed Black Cockatoo) Recovery Plan* (DEC 2008) identifies habitat critical for the survival of Baudin's Cockatoo as those areas:

- Currently occupied by the cockatoos
- Not currently occupied by the cockatoos due to recent fire but capable of supporting cockatoo populations when sufficiently recovered
- Of natural vegetation in which the cockatoo's nest, feed, and roost
- Of natural vegetation through which the cockatoos can move from one occupied area to another
- Of suitable vegetation within the recorded range in which undiscovered cockatoo populations may exist.

The habitat critical to survival and important populations of Baudin's Cockatoo comprises all Marri, Karri and Jarrah forests, woodlands and remnants in the south west of Western Australia receiving more than 600 mm of annual average rainfall.

Based on the Black Cockatoo habitat assessment (Strategen-JBS&G 2020), the majority of the Proposed Action area (199.3 ha) was determined to be of 'Nil' foraging value (

Figure 22), which comprises completely cleared areas and areas of highly degraded vegetation.

Table 4.6 provides a summary of the extent and quality of Baudin's Cockatoo foraging habitat within the Proposed Action area. In total, the Proposed Action area contains 34.2 ha of Baudin's Cockatoo foraging habitat, comprising of 5.6 ha of 'Moderate to High' quality, 3.7 ha of 'Moderate' quality, 11.3 ha of 'Low to Moderate' quality and 13.6 ha of 'Low' quality foraging habitat.

Based on mapping of native vegetation extent and vegetation complexes containing plant species known to be used by Baudin's Cockatoo for foraging, there is approximately 28,000 ha of potential foraging and potential breeding habitat available within 12km of the Proposed Action area. Of this, approximately 19,500 ha occurs within DBCA managed lands and approximately 77% (15,000 ha) of this is within Jarrahdale State Forest and Serpentine National Park (Figure 20).

Given the extensive amount of potential foraging and potential breeding habitat available within 12km of the Proposed Action area, particularly to the east within the South West Jarrah Forest, the habitat within the Proposed Action area does not represent an important area of habitat Baudin's Cockatoo by comparison. Potential foraging habitat within surrounding National Parks and State Forest forms part of an extensive and largely continuous area of vegetation that is likely to comprise high quality foraging habitat, as well as potential breeding habitat. By comparison, foraging and breeding habitat occurring within the Proposed Action area is fragmented at the local scale and surrounded by predominantly cleared and degraded areas, and is not considered to be of elevated importance to Baudin's Cockatoo when compared to habitat in the surrounding area.

4.7.2.4 Local Distribution

Based on data from the Great Cocky Count survey in 2019, along with the cumulative total number of white-tailed cockatoos counted at confirmed roosting sites since the commencement of the Great Cocky Count project, the highest totals recorded within 6km and 12km of the Proposed Action area have been in Byford (SERBYFR004; 118 cumulative total), and Bedfordale (ARMBEDR003; 471 cumulative total), respectively. No white-tailed Black Cockatoos were counted at confirmed roosting sites within 6km of the Proposed Action area during the 2019 Great Cocky Count, while 103 were counted at confirmed roosting sites within 6-12km of the Proposed Action. Overall, counts of white-tailed Black Cockatoos within 12km of the Proposed Action in 2019 totalled 103, and cumulatively totals 2,379 since the commencement of the Great Cocky Count project.

Baudin's Cockatoo are known to breed in low numbers in the Serpentine Hills area approximately 10km to the south of the Proposed Action and in the Wungong Catchment approximately 16km to the east.

4.7.2.5 Survey Adequacy and Limitations

The Black Cockatoo field surveys were undertaken by suitably qualified and experienced personnel, within appropriate seasonal times, site access and resources in accordance with the relevant Commonwealth guidance (DSEWPaC 2012). There are nil constraints which are considered to have affected the accuracy or reliability of the survey outcomes which would affect the assessment of the Proposed Action. An assessment of the potential for constraints of the fauna field surveys is presented in Appendix G.

4.7.3 Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso*

The Forest Red-tailed Black Cockatoo is classified as Vulnerable under the EPBC and BC Act (DBCA 2018c, DAWE 2020).

4.7.3.1 Abundance, Distribution and Ecology

As of September 2019, the total population of Forest Red-tailed Black Cockatoo is estimated to be 15,000 individuals (Peck et al. 2019).

Forest Red-tailed Black Cockatoo are a sub-species of Red-tailed Black Cockatoo characterised by the significant size of the bill (Ford 1980). They are geographically distinct from other Red-tailed Black Cockatoos, preferring the humid and sub-humid zones of south west Western Australia in an area stretching from Gingin in the north east through to Boxwood Hill in the south east (DoEE 2017).

Foraging habitat for the species is made up of almost exclusively Marri and Jarrah fruits, however the species is known to feed on the fruit of other plants. This species prefers to nest in large hollows of Marri, Jarrah, and Karri (Johnstone and Kirkby 1999), and breeding may occur at any time of the year, with peaks in April to June and August to October (DotEE 2017).

Breeding habitat

The Kirkby (2019) survey, identified a total of 7 potential Black Cockatoo breeding trees with hollows that were potentially suitable for Black Cockatoo breeding within the Proposed Action area, comprising of one Jarrah, five Marri and one Marri stag (Table 4.7). These trees were subject to further detailed inspection (Kirkby 2020) to assess their suitability for Black Cockatoo breeding. As shown in Table 4.7 only two Marri trees were considered to contain hollows suitable for Black Cockatoo breeding.

Based on mapping of native vegetation extent and vegetation complexes containing species known to be used for foraging by Forest Red-tailed Black Cockatoo the estimated extent of potential breeding habitat within 12 km of the Proposed Action area is approximately 30,000 ha (Strategen JBS&G 2020) (Figure 20).

The nearest known breeding site for Forest Red-tailed Black Cockatoo occurs 8 km to the east of the Proposed Action area at the Wungong Catchment, though breeding pairs have been observed prospecting and chewing hollow entrances at Cardup Nature Reserve which lies 1.5 km to the east of the Proposed Action (Kirkby 2019). Forest Red-tailed Black Cockatoo breeding has also been confirmed in an artificial hollow in Serpentine (Kirkby 2019).

Foraging habitat

Based on the Black Cockatoo habitat assessment (Strategen-JBS&G 2020), the majority of the Proposed Action area (194.7 ha) was determined to be of 'Nil' foraging value (Table 4.7), which comprises completely cleared areas and areas of highly degraded vegetation.

In total, the Proposed Action area contains 35.8 ha of Forest Red-tailed Black Cockatoo foraging habitat, comprising of 5.6 ha of 'Moderate to High' quality, 3.7 ha of 'Moderate' quality, 11.3 ha of 'Low to Moderate' quality and 13.6 ha of 'Low' quality foraging habitat (Table 4.7). Foraging habitat with 'Low' quality is not considered further as it has low foraging value for Baudin's Cockatoo. Therefore, there is 20.6 ha of 'Moderate to High' to 'Low to Moderate' foraging habitat for Forest Red-tailed Black Cockatoo within the Proposed Action area.

Based on mapping of native vegetation extent and vegetation complexes containing species known to be used for foraging by Baudin's Cockatoo the estimated extent of potential foraging habitat within 12 km of the Proposed Action area is approximately 28,000 ha (Strategen JBS&G 2020) (Figure 20).

Table 4.7: Forest Red-tailed Black Cockatoo Foraging Habitat Extent and Quality

Habitat quality and score	Extent within Proposed Action area (ha)	Proportion of Proposed Action area (%)
High foraging value (6)	0.0	0.0
Moderate to High foraging value (5)	5.61	2.4
Moderate foraging value (4)	3.70	1.6
Low to Moderate foraging value (3)	11.29	4.8
Low foraging value (2)	13.56	5.8
Negligible to low foraging value (1)	0.0	0.0
No foraging value (0)	199.33	85.4
Total	**233.50**	**100**

Roosting habitat

Regional mapping undertaken by the Department of Biodiversity, Conservation and Attractions (DBCA), BirdLife Australia and WA Museum indicates that the Proposed Action area is situated within the buffer of a confirmed Forest Red-tailed Black Cockatoo roosting site (SERJARR002) (DBCA 2011), although the centre-point does not fall within the Proposed Action area. No evidence or observations of night roosting was recorded within the Proposed Action area (Kirkby 2019).

Publicly available data from the most recent annual Great Cocky Count (Peck *et al.* 2019) indicates that there is one confirmed Forest Red-tailed Black Cockatoo roost within 1km of the Proposed Action area and 21 confirmed roosts within a 12 km radius (Figure 20). A number of these roosts are joint roosts shared with Carnaby's Cockatoo and Baudin's Cockatoo.

Current and historical patterns of use

Kirkby (2019) made observations of Forest Red-tailed Black Cockatoo within the Proposed Action area, in the form of chewed Marri nuts and sighting of a single female. Heavy chewing around the entrance of one hollow contained within Tree 6 was observed by Kirkby (2020), indicating that the hollow may have been used by Black Cockatoos in the past, however it could not be determined which species of Black Cockatoo.

An examination of historical aerial imagery from Landgate Map Viewer illustrates that much of the vegetation within the Proposed Action area and the immediate surrounds was cleared prior to the earliest available imagery from 1953. Based on pre-European vegetation mapping, vegetation which has been cleared within the Proposed Action area is consistent with the vegetation remaining in the Proposed Action area and it is considered likely that the entire Proposed Action area would have been utilised by Forest Red-tailed Black Cockatoo for foraging prior to clearing.

4.7.3.2 Impact of Proposed Action

The Proposed Action area contains 20.61 ha of 'moderate to high' to 'low to moderate' quality foraging habitat for Forest Red-tailed Black Cockatoo are well as 346 ha of potential breeding trees with a DBH greater than 500 mm, including two that contain potentially suitable hollows for Black Cockatoo nesting.

4.7.3.3 Quality and Importance

The *Forest Black Cockatoo Recovery Plan* (DEC 2008) identifies habitat critical for the survival of Forest Red-tailed Black Cockatoo as those areas:

- Currently occupied by the cockatoos
- Not currently occupied by the cockatoos due to recent fire but capable of supporting cockatoo populations when sufficiently recovered
- Of natural vegetation in which the cockatoos nest, feed, and roost

- Of natural vegetation through which the cockatoos can move from one occupied area to another
- Of suitable vegetation within the recorded range in which undiscovered cockatoo populations may exist.

The habitat critical to survival and important populations of Forest Red-tailed Black Cockatoos comprises all Marri, Karri and Jarrah forests, woodlands and remnants in the south west of Western Australia receiving more than 600 mm of annual average rainfall.

Based on the Black Cockatoo habitat assessment (Strategen-JBS&G 2020), the majority of the Proposed Action area (199.3 ha) was determined to be of 'Nil' foraging value (

Figure 22), which comprises completely cleared areas and areas of highly degraded vegetation. The Proposed Action area contains 20.6 ha of Forest Red-tailed Black Cockatoo foraging habitat, comprising of 5.6 ha of 'Moderate to High' quality, 3.7 ha of 'Moderate' quality, 11.3 ha of 'Low to Moderate' quality and 13.6 ha of 'Low' quality foraging habitat.

Based on mapping of native vegetation extent and vegetation complexes containing plant species known to be used by Forest Red-tailed Black Cockatoo for foraging, there is approximately 31,000 ha of potential foraging and breeding habitat available within 12km of the Proposed Action area. Of this, approximately 19,500 ha occurs within DBCA managed lands and approximately 77% (15,000 ha) of this falls within Jarrahdale State Forest and Serpentine National Park (Figure 20).

Given the extensive amount of potential foraging and breeding habitat available within 12km of the Proposed Action area, particularly to the east within the south west Jarrah Forest, the habitat within the Proposed Action area does not represent an important area of habitat for Forest Red-tailed Black Cockatoos by comparison. Potential foraging habitat within surrounding National Parks and State Forest forms part of an extensive and largely continuous area of vegetation which is likely to comprise high quality foraging habitat, as well as potential breeding habitat. By comparison, foraging and potential breeding habitat occurring within the Proposed Action area is fragmented at the local scale and surrounded by predominantly cleared and degraded areas, and is not considered to be of elevated importance to Forest Red-tailed Black Cockatoo when compared to habitat in the surrounding area.

4.7.3.4 Local Distribution

Cumulative counts derived from data from the Great Cocky Count project show that the highest totals recorded within 6km and 12km of the Proposed Action have been in Byford (SERBYFR004; 129 cumulative total), and Banjup (COCBANR002; 183 cumulative count), respectively. A total of 3 Forest Red-tailed Black Cockatoos were counted at confirmed roosting sites within 6km of the Proposed Action during the 2019 great Cocky Count, while 98 were counted at confirmed roosting sites within 6-12km of the Proposed Action. Overall, counts of Forest Red-tailed Black Cockatoos within 12km of the Proposed Action in 2019 totalled 101, and cumulatively totals 871 since the commencement of the Great Cocky Count project.

The nearest known breeding site for Forest Red-tailed Black Cockatoo occurs 8 km to the east of the Proposed Action area at in the Wungong Catchment, though breeding pairs have been observed prospecting and chewing hollow entrances at Cardup Nature Reserve which lies 1.5km to the east of the Proposed Action (Kirkby 2019). Forest Red-tailed Black Cockatoo breeding has also been confirmed in an artificial hollow in Serpentine (Kirkby 2019).

The nearest known breeding site for Forest Red-tailed Black Cockatoo occurs 8 km to the east of the Proposed Action in the Wungong Catchment, though breeding pairs have been observed prospecting and chewing hollow entrances at Cardup Nature Reserve which lies 1.5 km to the east of the Proposed Action (Kirkby 2019). Forest Red-tailed Black Cockatoo breeding has also been confirmed in an artificial hollow in Serpentine (Kirkby 2019).

4.7.3.5 Survey Adequacy and Limitations

The Black Cockatoo field surveys were undertaken by suitably qualified and experienced personnel, within appropriate seasonal times, site access and resources in accordance with the relevant Commonwealth guidance (DSEWPaC 2012). There are nil constraints which are considered to have affected the accuracy or reliability of the survey outcomes which would affect the assessment of the Proposed Action. An assessment of the potential for constraints of the fauna field surveys is presented in Appendix G.

5. Assessment of Impacts

5.1 Clay Pans TEC

5.1.1 Quantum and Quality of Habitat

The Proposed Action will not directly impact the Clay Pans TEC.

A minimum of 0.05 ha of the TEC will remain immediately adjacent to the Proposed Action area (Figure 11) which may be subject to indirect impacts from the Proposed Action including from the introduction or spread of weeds and *Phytophthora* Dieback, increased incidence of fire, hydrological change and other edge impacts.

5.1.2 Indirect Impacts

One occurrence of Clay Plans TEC is located within the Proposed Action. This occurrence will be retained (Figure 10). Potential impacts to this occurrence are limited to indirect impacts including altered surface and groundwater hydrology, dust and vibration caused by construction, potential spread of *Phytophthora* dieback and/or weeds, and increased instances of fire.

Consistent with the DAWE (2020b) request, an assessment of the potential for an indirect environmental impact via changes in surface or groundwater levels to the 0.05 ha of Clay Pans TEC is provided below:

- **Fragmentation:** The Proposed Action will not result in fragmentation of the 0.05 ha of Clay Pans TEC which will be retained adjacent to the Proposed Action. As identified by Figure 10 the Clay Pans TEC is fragmented at the local scale between occurrences.
- **Hydrological change:** The Proposed Action can be expected to result in a change to the current surface water hydrology through the introduction of new/ larger impervious road surfaces, with accompanying road drainage structures to control surface water flows and surface water quality (sedimentation, turbidity, siltation). The current surface water hydrological regime for the occurrence of the Clay Pans TEC is not considered 'natural' given the surrounding road network, presence of artificial drainage, and agricultural lands. Accordingly, the objectives for surface water management should be to maintain the existing altered surface water hydrological regime. As noted above, the condition of the Clay Pans TEC adjacent to the existing Mundijong Road has maintained a *'Very Good'* condition, which may indicate the current surface water hydrological regime has been effective in maintaining the condition of the ecological community. Subject to the design and installation of appropriate road drainage structures which maintain the current surface water hydrology outcomes for the Mundijong Road, the Proposed Action can be expected to result in no significant detrimental impacts to the retained area of the ecological community from surface water hydrology changes.

  As outlined in the Main Roads (2019a) referral document, subject to detailed engineering design, the construction works for the Proposed Action may require excavations at depths below the groundwater table, and therefore, a requirement for the abstraction (dewatering) of groundwater to enable dry-floor construction conditions. The abstraction of groundwater is expected to be temporary (< 1 year) across the whole Proposed Action area and in shorter duration at any one location, such that a long-term impact to the groundwater levels on which the ecological community may rely would not be expected. The abstraction of groundwater will be restricted to 0.5m during dry months in order to align with the conservation advice.

  Management measures will be implemented to further reduce the risk of impact. These include:

- Abstraction in proximity to Clay Pans TEC avoided during drier months -December to May
- The abstracted groundwater would be temporarily stored in constructed holding basins in proximity to the dewatering activities where it will infiltrate back into the groundwater and/or be disposed of through dust suppression activities, with nil disposal directly into the ecological community.

If groundwater abstraction is required, the abstraction locations and volume will be regulated by the State Department of Water and Environmental Regulation (DWER) in accordance with a Licence granted under s5C of the *Rights in Water and Irrigation Act 1914* (WA).

- **Introduced flora:** The landscape surrounding the Proposed Action includes existing disturbances from agricultural, urban and industrial developments. Woodman (2020) recorded a total of 50 introduced flora taxa within the native vegetation of the Survey Area, of which 28 introduced flora taxa occur within and immediately surrounding the Clay Pans TEC. As such, the ecological community already has a significant infestation of introduced flora taxa.
- Whilst construction works for the Proposed Action will disturb soils through which introduced flora taxa may spread, such risk can be appropriately managed in accordance with standard operational controls. The implementation of standard operational controls can be expected to appropriately control introduced flora taxa within the ecological community during construction works.
- **Disease Phytophthora dieback:** The presence and spread of Dieback *P. cinnamomi* is a potential construction risk due to the region having known susceptibility (rainfall and vegetation type).
- Glevan Consulting (2020) (Appendix F) undertook a dieback assessment within the area of the Proposed Action and surrounds. The field survey for *P. cinnamomi* detected the presence of *P. cinnamomi* infestation within the ecological community and determined that approximately 0.5 ha was infested (Figure 21). Main Roads will implement standard operational controls to appropriately control the risk of the introduction or spread of *P. cinnamomi* within the ecological community during construction works.
- **Damage by construction equipment:** The clearing of native vegetation will be confined to within the area of the Proposed Action. No clearing/construction equipment will operate beyond the boundaries of the Proposed Action (i.e. not into areas of retained Clay Pans TEC). Accordingly, there is nil risk of direct damage by construction equipment to the ecological community beyond the area of the Proposed Action.

  In relation to the specific risk of *'soil compaction'* identified by DAWE (2020b), there is no evidence from previous Main Roads construction works to suggest that equipment used in road construction would likely result in soil compaction leading to a detrimental impact to vegetation beyond the Proposed Action.
- **Wastes:** Standard operational controls, such as the collection and disposal/recycling of waste materials will be implemented during construction. The implementation of standard operational controls can be expected to appropriately control the risk of waste disposal to the ecological community during construction works.

  In relation to the specific risk of *'Illegal rubbish dumping and litter'* identified by DAWE (2020b), the potential for future illegal waste disposal by third-parties during operation of the road is beyond the scope of the Proposed Action. In broad terms, however, the risk of illegal waste disposal to the ecological community would not be expected to be

less than the current risk presented by the existing Mundijong Road. The road reserve around Tonkin Highway will be fenced to reduce unauthorised access off the highway. Passive surveillance by other road users will help to minimise illegal dumping on the main alignment.

- **Fire:** Fire may have a significant direct impact to the condition of native vegetation and may further alter the vegetation structure through native flora mortality and the colonisation/spread of introduced flora. The risk of a fire ignition source is most notable for *'hot works'* such as grinding/welding of steel in bridge construction, or where construction vehicles may drive over grassy vegetation. Having regard to the potential significance of fire to vegetation, and noting the potential ignition sources, the risk and management of fire is incorporated into standard operation controls for all Main Roads construction works. The risk of fire during construction is a short-term risk and will not significantly alter fire regimes in the area.

  The implementation of standard operational controls can be expected to appropriately control the risk of fire to the ecological community during construction works.

5.1.3 Assessment against MNES Significant Impact Guidelines

The DoE document Matters of National Environmental Significance: Significant Impact Guidelines 1.1 identifies 'significant impact criteria' for TECs to assist in determining whether the environmental impacts of a Proposal are likely to be significant (DoE 2013). The criteria are in addition to the general test for significance as to whether an impact is 'important, notable or of consequence, having regard to its context or intensity'.

Table 5.1 provides an assessment of the potential impact of the Proposed Action to the Clay Pans TEC using the 'Critically Endangered' and 'Endangered' ecological communities significant impact criteria (DoE 2013).

The assessment concludes that the potential for indirect impacts to the Clay Pans TEC is not significant and can be adequately managed and as such an offset is not proposed.

Table 5.1: Assessment of the potential impacts to the Clay Pans TEC

Significant impact criteria	Assessment for Clay Pans of the Swan Coastal Plain ecological community (Critically Endangered)
Reduce the extent of an ecological community	Not significant. The Proposed Action will not require any clearing of the TEC, and as such will not reduce the extent of the community.
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines	Not significant. The Proposed Action will not require any clearing of the TEC, and as such will not result in any increased fragmentation of the community. Some adjacent vegetation will be required to be cleared for the project, but that is not the Clay Pans TEC.
Adversely affect habitat critical to the survival of an ecological community	Not significant. The Proposed Action will not affect habitat critical to the survival of the Clay Pans TEC, as no clearing of habitat for the community will be required.
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	Not significant. While construction works for the Proposed Action may require abstraction (dewatering) of groundwater, dewatering is expected to be temporary and limited to less than 0.5m, such that a long-term effect to the groundwater levels on which the TEC may rely are not expected. Some adjacent vegetation will be required to be cleared for the project, but changes to surface water hydrology and drainage due to the Proposed Action are considered unlikely.

Significant impact criteria	Assessment for Clay Pans of the Swan Coastal Plain ecological community (Critically Endangered)
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	Not significant. No substantial change in species composition of the Clay Pans TEC will result from the Proposed Action given there will be no direct clearing, and any potential indirect impacts will be managed through the implementation of standard hygiene measures.
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	Not significant. There will be no increased threat to the TEC posed by the spread of weeds or *Phytophthora* dieback, as these factors will be managed through standard implementation measures. There may be the potential for an increased risk of indirect impacts through implementation of the project and clearing of adjacent vegetation. However, these can be adequately managed through routine road maintenance.
Interfere with the recovery of an ecological community	Not significant. Standard management measures will be implemented throughout construction for the Proposed Action, including controls for the management of water quality, sedimentation, dust, weeds, dieback, fire, hazardous chemicals and waste, dewatering and drainage. The implementation of such controls will ensure the recovery of the ecological community is not indirectly impacted by implementation of the Proposed Action.

5.2 *Corymbia-Kingia* TEC

5.2.1 Quantum of Impacts

The Proposed Action will result in the following impacts to the *Corymbia-Kingia* TEC:

- Clearing of up to 0.13 ha of *Corymbia-Kingia* TEC within one patch, of which 0.10 ha is in 'Very Good' condition and 0.03 ha is in 'Degraded' condition.
- Fragmentation of one patch of the TEC.
- Potential indirect impacts from the introduction or spread of weeds and *Phytophthora* Dieback, increased incidence of fire, hydrological change and other edge impacts.

5.2.2 Direct Impacts

A total of 0.13 ha of *Corymbia-Kingia* TEC will be cleared to enable the implementation of the Proposed Action. The Proposed Action will fragment a 2.08 ha patch of the TEC with 1.95 ha remaining following implementation of the Proposal.

As outlined above, the DAWE (2017a) identifies the regional extent of the *Corymbia-Kingia* TEC at approximately 192 ha across 41 occurrences.

At a local scale, regional mapping indicates > 150 ha (~80 %) of the *Corymbia-Kingia* TEC within a 5 km radius of the Proposed Action (DBCA 2019).

0.13 ha represents 0.07% of the recorded regional distribution (192 ha) and 0.09% of the local distribution of the *Corymbia-Kingia* TEC (> 150 ha). This TEC occurrence is located in an isolated area between an existing road and an agricultural drain.

To note, the direct impact to 0.13 ha of the *Corymbia-Kingia* TEC outlined above is a reduction from the 1.8 ha identified in the previously submitted Main Roads (2019a) referral document and the accompanying Strategen-JBS&G (2019) environmental assessment report. This reduction in area is a result of revised mapping of the *Corymbia-Kingia* TEC by Woodman (2020).

5.2.3 Indirect Impacts

Assessment of Potential Indirect Environmental Impacts

A minimum of 1.95 ha of the *Corymbia-Kingia* TEC occurrence will be retained, which may be subject to indirect impacts from the Proposed Action.

Consistent with the DAWE (2020b) request, an assessment of the potential for an indirect impact to the 1.95 ha *Corymbia-Kingia* TEC occurrence retained is provided below:

- **Fragmentation / Reduction of TEC occurrences:** The Proposed Action will remove part of one occurrence of the *Corymbia-Kingia* TEC totalling 2.08 ha, with 1.95 ha of this occurrence to be retained.

  As identified by Figure 12 this occurrence of the *Corymbia-Kingia* TEC is currently internally fragmented as three small areas, divided by areas of other native vegetation (not TEC) and a local road (Lampiter Drive). The Proposed Action will result in a 0.51 ha patch being fragmented to leave 0.38 ha remaining. The other two patches (1.50 ha and 0.07 ha in area) will not be impacted.

  As identified by Figure 13, the *Corymbia-Kingia* TEC is fragmented at the local scale (5 km) between occurrences. The Proposed Action will result in fragmentation to one existing patch, reducing its size from 0.51 ha to 038 ha.

  As identified in the biological surveys by Woodman (2020) the condition of *Corymbia-Kingia* TEC adjacent to the existing Mundijong Road has maintained a 'Very Good' condition (with the 'Degraded' condition vegetation occurring farther from the road infrastructure) as shown in Figure 12. Therefore, construction and operation of Mundijong Road does not appear to have resulted in an 'edge effect' decline in the health condition of the ecological community. Similarly, subject to appropriate road engineering design (e.g. surface water drainage) the Proposed Action may be expected to result in the maintenance of the health and condition of the adjacent TEC. Notwithstanding this, it is acknowledged that the edge effects experienced by such small areas of vegetation have the potential to result in vegetation condition decline.

  The Proposed Action is not expected to remove areas of the *Corymbia-Kingia* TEC to an extent that the retained area (1.95 ha) is no longer representative of the ecological community. As the *Corymbia-Kingia* TEC has no minimum 'patch size' or 'condition thresholds' under the DAWE (2000a, 2017a) and DBCA (2000a) criteria, all of the retained area (1.95 ha) will continue to be representative of the ecological community.

- **Hydrological change:** The Proposed Action can be expected to result in a change to the current surface water hydrology through the introduction of new/ larger impervious road surfaces, with accompanying road drainage structures to control surface water flows and surface water quality (sedimentation, turbidity, siltation). The current surface water hydrological regime for the occurrence of the *Corymbia-Kingia* TEC is not considered 'natural' given the surrounding road network, presence of artificial drainage, and agricultural lands. Accordingly, the objectives for surface water management should be to maintain the existing altered surface water hydrological regime As noted above, the condition of the *Corymbia-Kingia* TEC adjacent to the existing Mundijong Road has maintained a 'Very Good' condition, which may indicate the current surface water hydrological regime has been effective in maintaining the condition of the ecological community. Subject to the design

and installation of appropriate road drainage structures which maintain the current surface water hydrology outcomes for the Mundijong Road, the Proposed Action can be expected to result in no significant detrimental impacts to the retained area of the ecological community from surface water hydrology changes.

As outlined in the Main Roads (2019a) referral document, subject to detailed engineering design, the construction works for the Proposed Action may require excavations at depths below the groundwater table, and therefore, a requirement for the abstraction (dewatering) of groundwater to enable dry-floor construction conditions. The abstraction of groundwater is expected to be temporary (< 1 year) across the whole Proposed Action area and in shorter duration at any one location, such that a long-term impact to the groundwater levels on which the ecological community may rely would not be expected. Groundwater drawdown will be restricted to 0.5m during dry months to align with the conservation advice.

Management measures will be employed to further reduce the risk of impact including:

- Abstraction in proximity to *Corymbia-Kingia* TEC avoided during drier months (December to May)
- The abstracted groundwater would be temporarily stored in constructed holding basins in proximity to the dewatering activities where it will infiltrate back into the groundwater and/or be disposed of through dust suppression activities, with nil disposal directly into the ecological community.

To note, if groundwater abstraction is required, the abstraction locations and volume will be regulated by the State Department of Water and Environmental Regulation (DWER) in accordance with a Licence granted under s5C of the *Rights in Water and Irrigation Act 1914* (WA).

- **Introduced flora:** The landscape surrounding the Proposed Action includes existing disturbances from agricultural, urban and industrial developments. Woodman (2020) recorded a total of 50 introduced flora taxa within the native vegetation of the Survey Area, of which 28 introduced flora taxa occur within and immediately surrounding the *Corymbia-Kingia* TEC. As such, the ecological community already has a significant infestation of introduced flora taxa.

  Whilst construction works for the Proposed Action will disturb soils through which introduced flora taxa may spread, such risk can be appropriately managed in accordance with standard operational controls. The implementation of standard operational controls can be expected to appropriately control introduced flora taxa within the ecological community during construction works.

- **Disease Phytophthora dieback:** The presence and spread of Dieback *P. cinnamomi* is a potential construction risk due to the region having known susceptibility (rainfall and vegetation type).

  Glevan Consulting (2020) (Appendix F) undertook a dieback assessment within the area of the Proposed Action and surrounds. The field survey for *P. cinnamomi* detected 0.368 ha of the retained area of the TEC is currently infested.

  Main Roads will implement standard operational controls to appropriately control the risk of the introduction or spread of *P. cinnamomi* within the ecological community during construction works.

- **Damage by construction equipment:** The clearing of native vegetation will be confined to within the area of the Proposed Action. No clearing/construction equipment will operate beyond the boundaries of the Proposed Action (i.e. not into areas of retained

Corymbia-Kingia TEC). Accordingly, there is nil risk of direct damage by construction equipment to the ecological community beyond the area of the Proposed Action.

In relation to the specific risk of *'soil compaction'* identified by DAWE (2020b), there is no evidence from previous Main Roads construction works to suggest that equipment used in road construction would likely result in soil compaction leading to a detrimental impact to vegetation beyond the Proposed Action. Whilst it may be possible for large trees within the ecological community (i.e. *C. calophylla*) to have root systems which traverse under the Proposed Action area, soil compaction above these root systems has not resulted in a measurable impact to vegetation health. This, in part, can be evidenced by the *Corymbia-Kingia* TEC directly adjacent to the existing Mundijong Road maintaining *'Very Good'* condition despite its proximity to the constructed road.

- **Wastes:** Main Roads will implement standard operational controls, such as the collection and disposal/recycling of waste materials during construction to appropriately control the risk of waste disposal to the ecological community during construction works.

  In relation to the specific risk of 'Illegal rubbish dumping and litter' identified by DAWE (2020b), the potential for future illegal waste disposal by third-parties during operation of the road is beyond the scope of the Proposed Action. In broad terms, however, the risk of illegal waste disposal to the ecological community would not be expected to be less than the current risk presented by the existing Mundijong Road. The road reserve around Tonkin Highway will be fenced to reduce unauthorised access off the highway. Passive surveillance by other road users will help to minimise illegal dumping on the main alignment.

- **Fire:** Fire may have a significant direct impact to the condition of native vegetation and may **further** alter the vegetation structure through native flora mortality and the colonisation/spread of introduced flora.

  The risk of a fire ignition source is most notable for 'hot works' such as grinding/welding of steel in bridge construction, or where construction vehicles may drive over grassy vegetation. Having regard to the potential significance of fire to vegetation, and noting the potential ignition sources, the risk and management of fire is incorporated into standard operation controls for all Main Roads construction works. The risk of fire during construction is short-term and will not significantly alter fire regimes in the area in the long-term.

  Main Roads will implement standard operational controls for fire, such as restrictions on the timing and locations of 'hot works', all vehicles to be fitted with fire extinguishers, and the induction and training of all site personnel on fire risks and response. These controls can be expected to appropriately control the risk of fire to the ecological community during construction works.

5.2.4 Cumulative impacts

0.13 ha represents 0.07% of the recorded regional distribution (192 ha) and 0.09% of the local distribution of the *Corymbia-Kingia* TEC (153 ha). As described above, there is currently 192 ha remaining of regionally of this TEC with approximately 30% (48 ha) of protected within conservation reserves (DBCA 2019, 2020). Although the Proposed Action is only clearing a small proportion of the total distribution of this TEC (i.e. < 1 %), it is adding to the cumulative impact of clearing for development on this TEC. Given its highly restricted distribution, the loss of this small area has the potential to be significant if combined cumulatively with clearing of other occurrences.

5.2.5 Assessment against MNES Significant Impact Guidelines

The DoE document Matters of National Environmental Significance: Significant Impact Guidelines 1.1 identifies 'significant impact criteria' for TECs to assist in determining whether the environmental impacts of a Proposal are likely to be significant (DoE 2013). The criteria are in addition to the general test for significance as to whether an impact is 'important, notable or of consequence, having regard to its context or intensity'.

Table 5.2 provides an assessment of the potential impact of the Proposed Action to the *Corymbia-Kingia* TEC using the 'Critically Endangered' and 'Endangered' ecological communities significant impact criteria (DoE 2013).

The assessment concludes that the proposed impact to the *Corymbia-Kingia* TEC is significant and therefore an offset is identified for this MNES in Section 8.

Table 5.2: Assessment of the potential impacts to the Corymbia-Kingia TEC

Significant impact criteria	Assessment for *Corymbia calophylla – Kingia australis* woodlands on heavy soils, Swan Coastal Plain Threatened Ecological Community (Endangered)
Reduce the extent of an ecological community	Significant. The Proposed Action will require the clearing of up to 0.13 ha of the TEC within one occurrence, which encompasses 2.08 ha in total. The removal of 0.13 ha of the TEC constitutes a local reduction (within 5 km of the Proposed Action) of 0.09%, however, this TEC is restricted to approximately 192 ha in area, and all individual occurrences form part of the ecological community. Although the area to be cleared is relatively small, it is likely to constitute a significant impact to the community due to the highly constrained nature of the TEC.
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines	Significant. The Proposed Action will require the clearing of up to 0.13 ha of the TEC within one occurrence, which encompasses 2.08 ha in total. This clearing is of the TEC that occurs along Mundijong Road and will therefore fragment the ecological community occurring west and east of the Proposed Action. As the TEC occurs within a thin linear strip of vegetation adjacent to the road it is already fragmented, and the Proposed Action will further fragment it into smaller patches.
Adversely affect habitat critical to the survival of an ecological community	Significant. Critical habitat for this TEC is defined within the interim recovery plan (DEC 2011) as: "…the heavy soils on which the community occurs, the fresh superficial groundwater, and/or surface water that helps sustain flora species in this wetland community, and the catchment for this groundwater and surface water". The *Corymbia-Kingia* TEC present within the area of the Proposed Action meets the criteria for critical habitat for the TEC, as stated above. As such, the Proposed Action will impact on 0.13 ha of habitat within one occurrence that demonstrates critical habitat for the survival of the 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	Not significant. While construction works for the Proposed Action may require abstraction (dewatering) of groundwater, dewatering is expected to be temporary and limited to less than 0.5m, such that a long-term effect to the groundwater levels on which the TEC may rely are not expected. Changes to surface water hydrology and drainage due to the Proposed Action are considered unlikely.
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	Not significant. There will be no increased threat to the TEC posed by the spread of weeds, *Phytophthora* dieback, or potential increased instance of fire as these factors will be managed through standard hygiene measures.

Significant impact criteria	Assessment for *Corymbia calophylla – Kingia australis* woodlands on heavy soils, Swan Coastal Plain Threatened Ecological Community (Endangered)
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	Not significant. There will be no increased threat to the TEC posed by the spread of weeds or *Phytophthora* dieback, as these factors will be managed through standard implementation measures.
Interfere with the recovery of an ecological community	Significant. As stated within the Interim Recovery Plan (DEC 2000A), recovery will be considered unsuccessful if there is significant loss of area or further modification of occurrences of the threatened ecological community. The loss of up to 0.13 ha of the TEC is considered to modify an occurrence, and therefore it is likely that the Proposed Action will interfere with the recovery of the species.

5.3 *Corymbia-Xanthorrhoea* TEC

5.3.1 Quantum of impacts

The Proposed Action will result in the following impacts to the *Corymbia-Xanthorrhoea* TEC:

- Clearing of up to 3.94 ha of *Corymbia- Xanthorrhoea* TEC within eight patches of varying condition including:
    - 1.16 ha in 'Very Good' condition;
    - 0.29 ha in 'Good' condition;
    - 1.92 ha in 'Degraded' condition; and
    - 0.57 ha in 'Completely Degraded' condition.
- Complete removal of two patches, and fragmentation of six patches of the TEC; and
- Potential indirect impacts from the introduction or spread of weeds and *Phytophthora* Dieback, increased incidence of fire, hydrological change and other edge impacts.

5.3.2 Direct Impacts

A total of 3.96 ha of *Corymbia-Xanthorrhoea* TEC will be cleared to enable the implementation of the Proposed Action. The Proposed Action will fragment and remove 3.94 ha of the TEC with 4.92 ha remaining following the implementation of the proposal.

DAWE (2017b) identifies the regional extent of the C*orymbia-Xanthorrhoea* TEC at approximately 115 ha across 29 occurrences.

Within a 5 km radius of the Proposed Action, regional scale mapping indicates <60 ha (~50 %) of the *Corymbia-Xanthorrhoea* TEC occurs across ten occurrences (DBCA 2019).

The Proposed Action will require the clearing of 3.94 ha of the *Corymbia-Xanthorrhoea* TEC, representing approximately 3.4 % of the total recorded regional distribution (115 ha) and 6.4 % of the local distribution within 5km (< 60 ha).

5.3.3 Indirect Impacts

At least 4.92 ha of the *Corymbia-Xanthorrhoea* TEC within the Survey area will be retained across six occurrences, which may be subject to indirect impacts from the Proposed Action.

Consistent with the DAWE (2020b) request, an assessment of the potential for indirect impacts to the 4.92 ha retained of the *Corymbia-Xanthorrhoea* TEC is provided below:

- **Fragmentation / Reduction of TEC occurrences:** The Proposed Action will remove part or all of seven occurrences of the *Corymbia-Xanthorrhoea* TEC totalling 3.94 ha, with 4.92 ha of the ecological community across six occurrences to be retained including one complete patch. As identified by Figure 14, the occurrences of the *Corymbia-Xanthorrhoea* TEC are currently fragmented, ranging from 0.13 ha to 4.31 in size.

  Woodman (2020) indicate the largest occurrence has maintained a better condition ('Good' to 'Very Good' – Occurrence 6) compared to the smaller occurrences as shown in Figure 14.

  Occurrence 6 (along Mundijong road) will be fragmented through implementation of the Proposed Action which may cause the condition to decline within the remaining portion. 2.92 ha of this patch will be retained to the east of the Proposed Action including 0.68 ha in 'Very Good' condition and 1.70 ha in 'Good' condition. Given the high quality of retained vegetation and management measures implemented to prevent indirect impacts, the condition of this patch will be retained.

  As identified by Table 4.3, Occurrences 1 and 5 will be entirely removed by the Proposed Action, and as such will not introduce any 'new' fragmentation to these occurrences (as the occurrences will be removed). As identified by Table 4.3, Occurrence 2 has been entirely avoided by the Proposed Action.

  Whilst it is noted the removal of parts/all of some of the occurrences of this ecological community may increase the distance between other occurrences, the increase in the separation distance between occurrences is not expected to be significant to an extent that the values of the ecological community will be detrimentally affected as the occurrences are naturally fragmented.

  More generally, the vegetation condition for Occurrence 6 along Mundijong Road has generally maintained a 'Good' to 'Very Good' condition, such that the construction and operation of these roads do not appear to have resulted in an 'edge effect' decline in the health condition of the ecological community. Subject to appropriate road engineering design (e.g. surface water drainage), the Proposed Action may equally not be expected to result in a decline in the health condition of the adjacent retained areas of the ecological community.

  While Occurrences 3 and 8 will not be entirely removed by the Proposed Action there is potential for them to be severely impacted such that the retained areas may not represent the ecological community. Occurrence 3 will be reduced from 0.48 ha to 0.07 ha with the remaining patch in 'Degraded' to 'Completely Degraded' condition. Similarly, Occurrence 8 will be reduced from 0.73 ha to 0.02 ha with the remaining patch in 'Completely Degraded' condition. As such, it is unlikely these patches will retain the characteristics of the TEC following implementation of the Proposed Action.

- **Hydrological change:** The Proposed Action can be expected to result in a change to the current surface water hydrology through the introduction of new/ larger impervious road surfaces, with accompanying road drainage structures to control surface water flows and surface water quality (sedimentation, turbidity, siltation). The current surface water hydrological regime for the occurrences of the *Corymbia-Xanthorrhoea* TEC is not considered 'natural' given the surrounding road network and agricultural lands, and accordingly, the objectives for surface water management should be to maintain the existing altered surface water hydrological regime on which these occurrences have continued to survive. The condition of *Corymbia-Xanthorrhoea* TEC within Occurrences 2 and 6 have generally maintained some 'Good' to 'Very Good' condition vegetation, which may indicate the

current surface water hydrological regime has been effective in maintaining the condition of the ecological community. Subject to the design and installation of appropriate road drainage structures which maintain surface water hydrology outcomes consistent with that for Occurrences 2 and 6 (and applied to all occurrences), the Proposed Action can be expected to result in no significant detrimental impact to retained areas of the ecological community from surface water hydrology changes.

As outlined in the Main Roads (2019a) referral, subject to detailed engineering design, the construction works for the Proposed Action may require excavations at depths below the groundwater table, and therefore, a requirement for the abstraction (dewatering) of groundwater to enable dry-floor construction conditions. The abstraction of groundwater is expected to be temporary (< 1 year) across the whole Proposed Action area and therefore in shorter duration at any one location, such that a long-term impact to the groundwater levels on which the ecological community may rely would not be expected.

Management measures will be implemented to further reduce the risk of impact including:

- Abstraction in proximity to *Corymbia-Xanthorrhoea* TEC avoided during drier months - December to May; and
- The abstracted groundwater would be temporarily stored in constructed holding basins in proximity to the dewatering activities where it will infiltrate back into the groundwater and/or be disposed of through dust suppression activities, with nil disposal directly into the ecological community.

To note, if groundwater abstraction is required, the abstraction locations and volume will be regulated by the State Department of Water and Environmental Regulation (DWER) in accordance with a Licence granted under s5C of the *Rights in Water and Irrigation Act 1914* (WA).

- **Introduced flora:** The landscape surrounding the Proposed Action includes existing disturbances from agricultural, urban and industrial developments. Woodman (2020) recorded a total of 50 introduced flora taxa within the native vegetation of the Survey Area, of which 26 introduced flora taxa occur within and immediately surrounding the *Corymbia-Xanthorrhoea* TEC vegetation. As such, the ecological community already has a significant infestation of introduced flora taxa.

  Whilst construction works for the Proposed Action will disturb soils through which introduced flora taxa may spread, such risk can be appropriately managed in accordance with standard operational controls. Main Roads will implement standard operational controls such as herbicide application to control identified infestations (where appropriate), and vehicle hygiene procedures for construction works to minimise the risk of introduced flora spread. The implementation of standard operational controls can be expected to appropriately control introduced flora taxa within the ecological community during construction works.

- ***Phytophthora* dieback:** The presence and spread of Dieback *P. cinnamomi* is a potential construction risk due to the region having known susceptibility (rainfall and vegetation type).

  Glevan Consulting (2020) to undertake a dieback assessment within the area of the Proposed Action area and surrounds The field survey for *P. cinnamomi* detected the presence of *P. cinnamomi* infestation within the ecological community and determined that approximately 3.8 ha was infested.

  Standard operational controls will be implemented, including hygiene procedures for equipment/personnel and the sequence for native vegetation clearing (generally with clearing of 'Dieback-free' areas first) to minimise the risk of introduction and spread

of *P. cinnamomi*. The implementation of standard operational controls can be expected to appropriately control the risk of the introduction or spread of *P. cinnamomi* within the ecological community during construction works.

- **Damage by construction equipment:** The clearing of native vegetation will be confined to within the area of the Proposed Action. No clearing/construction equipment will operate beyond the boundaries of the Proposed Action (i.e. not into areas of retained *Corymbia-Xanthorrhoea* TEC). Accordingly, there is nil risk of direct damage by construction equipment to the ecological community beyond the area of the Proposed Action.

  In relation to the specific risk of 'soil compaction' identified by DAWE (2020b), there is no evidence from previous Main Roads construction works to suggest that equipment used in road construction would likely result soil compaction leading to a detrimental impact to vegetation beyond the Proposed Action. Whilst it may be possible for large trees within the ecological community (i.e. *C. calophylla* and *E. wandoo*) to have root systems which traverse under the Proposed Action, previous experience by Main Roads would suggest that soil compaction above these root systems does not result in a measurable impact to vegetation health. This, in part, can be evidenced by the *Corymbia-Xanthorrhoea* TEC vegetation adjacent to the existing Mundijong Road which has maintained 'Good' to 'Very Good' health condition despite its close proximity to the constructed road.

- **Wastes:** Standard operational controls will be implemented, such as the collection and disposal/recycling of waste materials during construction. The implementation of standard operational controls can be expected to appropriately control the risk of waste disposal to the ecological community during construction works.

- In relation to the specific risk of 'Illegal rubbish dumping and litter' identified by DAWE (2020b), the potential for future illegal waste disposal by third-parties during operation of the road is beyond the scope of the Proposed Action. In broad terms, however, the risk of illegal waste disposal to the ecological community would not be expected to be less than the current risk presented by the existing Mundijong Road. The road reserve around Tonkin Highway will be fenced to reduce unauthorised access off the highway. Passive surveillance by other road users will help to minimise illegal dumping on the main alignment.

- **Fire:** Fire may have a significant direct impact to the health condition of native vegetation and may further alter the vegetation structure through native flora mortality and the colonisation/spread of introduced flora.

  For road construction works, the risk of a fire ignition source is most notable for 'hot works' such as grinding/welding of steel in bridge construction, or where construction vehicles may drive over grassy vegetation. Having regard to the potential significance of fire to vegetation, and noting the potential ignition sources, the risk and management of fire is incorporated into standard operation controls for all Main Roads construction works.

  Main Roads will implement standard operational controls for fire, such as restrictions on the timing and locations of 'hot works', all vehicles to be fitted with fire extinguishers, and the induction and training of all site personnel on fire risks and response. The implementation of standard operational controls can be expected to appropriately control the risk of fire to the ecological community during construction works.

5.3.4 Cumulative Impacts

The Proposed Action will require the clearing of 3.94 ha of the *Corymbia-Xanthorrhoea* TEC, representing approximately 3.4% of the total recorded regional distribution (115 ha) and 6.4% of the local distribution within 5km (<60 ha). As described above within a 5 km radius of the Proposed

Action approximately 10% (7.8 ha) is protected within conservation reserves (DBCA 2019, 2020). Although the Proposed Action is only clearing a small proportion of the total distribution of this TEC (<4%) it is adding to the cumulative impact of clearing for development on this TEC. Given its highly restricted distribution the loss of this small area has the potential to be significant if combined cumulatively with clearing of other occurrences.

5.3.5 Assessment against MNES Significant Impact Guidelines

Table 5.3 provides an assessment of the potential impact of the Proposal to the *Corymbia-Xanthorrhoea* TEC using the 'Critically Endangered' and 'Endangered' ecological communities significant impact criteria (DoE 2013).

The assessment concludes that the proposed impact to the *Corymbia-Xanthorrhoea* TEC is significant and therefore an offset is identified for this MNES in Section 7.

Table 5.3: Assessment of the potential impacts to the *Corymbia-Xanthorrhoea* TEC

Significant impact criteria	Assessment for *Corymbia calophylla - Xanthorrhoea preissii* woodlands and shrublands of the Swan Coastal Plain Threatened Ecological Community (Endangered)
Reduce the extent of an ecological community	Significant. The Proposed Action will require the clearing of up to 3.94 ha of this TEC across seven occurrences, which represents approximately 6.4% of the TEC remaining within a 5km radius (local area) of the Proposed Action.
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines	Significant. The Proposed Action will require the clearing of up to 3.94 ha of this TEC across four occurrences, which represents approximately 6.4% of the TEC remaining within a 5 km radius of the Proposed Action area. This involves the complete removal of two patches and fragmentation of five remaining patches. Two occurrences that will be fragmented by the Proposed Action will be left with patch sizes 0.07 ha and 0.02 in 'Degraded' to 'Completely Degraded' condition and as such may not be viable following development. One patch fill be fragmented however will remain of a viable size. This occurrence is located along Mundijong Road and will be fragmented from 4.31 ha to 2.92 ha. The patch occurs as a thin, linear strip of vegetation adjacent to the road.
Adversely affect habitat critical to the survival of an ecological community	Significant. The Proposed Action will require the clearing of up to 3.94 ha of this TEC across seven occurrences, which represents approximately 6.4% of the TEC remaining within a 5km radius of the Proposed Action.
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	Not significant. While construction works for the Proposed Action may require abstraction (dewatering) of groundwater, dewatering is expected to be temporary, such that a long-term effect to the groundwater levels on which the TEC may rely would not be expected. Changes to surface water hydrology and drainage as a result of the Proposed Action are considered unlikely.
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 of flora or fauna harvesting	Not significant. There will be no increased threat to the TEC posed by the spread of *Phytophthora* dieback, or potential increased instance of fire as these factors will be managed through the implementation of standard management measures.
Cause a substantial reduction in the quality or integrity of an occurrence of	Not significant.

Significant impact criteria	Assessment for *Corymbia calophylla - Xanthorrhoea preissii* woodlands and shrublands of the Swan Coastal Plain Threatened Ecological Community (Endangered)
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	There will be no increased threat to the TEC posed by the spread of weeds or *Phytophthora* dieback, as these factors will be managed through the preparation and implementation of standard management measures. Specifically, measures will include controls for the management of water quality, erosion and sedimentation, dust, weeds and dieback, fire, hazardous chemicals and waste, dewatering and drainage. In addition, a Landscape and Revegetation Strategy and Plan and a Vegetation Mitigation Strategy will also be implemented. These plans are currently in preparation and are required by Ministerial Approval Statement 595.
Interfere with the recovery of an ecological community	Significant. As stated within the Recovery Plan (English and Blyth 2000) recovery will be considered unsuccessful if there is significant loss of area or further modification of occurrences of the threatened ecological community. The Proposed Action will result in the permanent removal of 3.94 ha of this TEC which is considered to be significant and will likely interfere with the recovery of this TEC.

5.4 *Synaphea* sp. Serpentine

5.4.1 Quantum of Impacts

The Proposed Action will result in the following impacts to *Synaphea* sp. Serpentine:

- Loss of three individuals from one location on Mundijong road.
- Clearing of up to 0.13 ha of suitable habitat
- Potential indirect impacts from altered hydrological regimes, the introduction or spread of weeds and Phytophthora Dieback, impacts of construction equipment, increased incidence of fire, and other edge impacts.

5.4.2 Direct Impacts

Up to 0.13 ha of suitable habitat for *Synaphea* sp. Serpentine is proposed to be cleared within the Proposed Action area, comprising 0.10 ha in Very Good, and the remainder in Degraded condition Figure 16). A total of three individuals of *Synaphea* sp. Serpentine are proposed to be taken. Given that the point data associated with the DBCA mapping for Population 5 (i.e. the population is represented by a single point location) it is unclear exactly how much of the population will be impacted. Based on the revised total known population of *Synaphea* sp. Serpentine (4,801 mature individuals), clearing for the Proposed Action will impact on 0.06% of the known population.

5.4.3 Indirect Impacts

- **Hydrological change:** The Proposed Action can be expected to result in a change to the current surface water hydrology through the introduction of new/ larger impervious road surfaces, with accompanying road drainage structures to control surface water flows and surface water quality (sedimentation, turbidity, siltation). Given the current alignment of Mundijong road, the mapped individuals of *Synaphea* sp. Serpentine are not currently expected to experience a 'natural' hydrological regime, and the Proposed Action is not expected to have a detrimental impact to retained individuals of *Synaphea* sp. Serpentine.
- **Introduced flora:** The introduction and/or spread of invasive weed species through ground-disturbing activities has the potential to compete with retained individuals of *Synaphea* sp.

Serpentine. Main Roads will implement appropriate hygiene and management measures to limit weed infestation.

- **Phytophthora Dieback:** *Phytophthora* Dieback is listed as a threatening process for *Synaphea* sp. Serpentine (TSSC 2018). Glevan Consulting identified the presence of *P. cinnamomi* within the area of the Proposed Action and within the area where 514 *Synaphea* sp. Serpentine plants occur along Mundijong road. A total of 13 *Synaphea* sp. Serpentine plants occur within uninfested area and will not be cleared for the Proposed Action. The remaining 24 individuals that will not be cleared for the Proposed Action are mapped in areas of excluded vegetation, or outside of the Dieback survey area. Standard hygiene measures will be implemented to minimise the risk of *P. cinnamomi* spread to unaffected individuals of the species.
- **Damage from construction equipment:** Elements of construction including dust generation and deposition, periods of increased vehicle movements and vibration from plant equipment may cause indirect impacts to retained individuals of *Synaphea* sp. Serpentine. Main Roads will implement standard measures to minimise the risk of increased access, dust and vibration on the species.
- **Shading:** In order to minimise the direct impact to *Synaphea* sp. Serpentine, the Proposed Action will incorporate a retaining wall adjacent to the population. This has the potential to reduce the amount of sunlight received by the retained individuals in the area, comprising 522 individuals.

5.4.4 Cumulative Impacts

The Proposed Action will require the clearing of three individuals of *Synaphea* sp. Serpentine, representing approximately 0.06% of the total known population (4,801 mature individuals). It is not known whether other individuals of the species have been lost due to land clearing across its distribution, however given a large proportion of occurrences occur within the Perth Metropolitan area it is considered threatened by development pressure. Therefore, the impact to three individuals will add to the cumulative impact to this species.

5.4.5 Assessment of the potential impacts to the *Synaphea* sp. Serpentine

Table 6.4 provides an assessment of the potential impact of the Proposal to the *Synaphea* sp. Serpentine using the 'Critically Endangered' and 'Endangered' species significant impact criteria (DoE 2013).

The assessment concludes that the proposed impact to the *Synaphea* sp. Serpentine is not significant and therefore an offset is not identified for this MNES in Section 8.

Table 5.4: Assessment of the potential impacts to *Synaphea* sp. Serpentine (Critically Endangered)

Significant impact criteria	Assessment for *Synaphea* sp. Serpentine (Critically Endangered)
Lead to a long-term decrease in the size of a population	Not significant. The Proposed Action will require the removal of up to three individuals out of a total 551 individuals of *Synaphea* sp. Serpentine from one population. The removal of three individuals constitutes a reduction of approximately 0.2% of the currently known total population of the species, being 1,834 mature plants.
Reduce the area of occupancy of the species	Not significant. The Proposed Action will require the removal of up to three individuals out of a total 551 individuals of *Synaphea* sp. Serpentine from one population. The removal of three individuals which constitutes a reduction of approximately 0.2% of the currently known total population of the species, being 1,834 mature plants. It is therefore unlikely to reduce the area of occupancy of the species.

Significant impact criteria	Assessment for *Synaphea* sp. Serpentine (Critically Endangered)
Fragment an existing population into two or more populations	Not significant. The Proposed Action will require the removal of up to three individuals out of a total 551 individuals of *Synaphea* sp. Serpentine from one population. This will leave 549 individuals remaining in this one population and will not fragment it into two or more populations.
Adversely affect habitat critical to the survival of a species	Potentially significant. As described above, the 0.13 ha of suitable habitat for *Synaphea* sp. Serpentine within the Proposed Action area is considered critical habitat as it is located adjacent to an existing population (TPFL Population 5). The Proposed Action will impact on 0.13 ha of critical habitat for the species.
Disrupt the breeding cycle of a population	Not significant. The Proposed Action will require the removal of up to three individuals out of a total 551 individuals of *Synaphea* sp. Serpentine from one population, representing 0.5% of that population. The impact is therefore considered unlikely to disrupt the breeding cycle of this population as 99.5% will remain.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Potentially significant. The Proposed Action will decrease the availability of suitable habitat for the species by 0.13 ha, which is considered critical. The habitat is known to support many individuals of the species in the immediately surrounding area. This may cause the decline of this population by reducing available habitat for the species.
Result in invasive species that are harmful to a critically endangered species becoming established in the critically endangered species' habitat	Not significant. The spread of weeds with the potential to impact retained individuals (adjacent to Mundijong Road) will be managed through the implementation of standard management measures.
Introduce disease that may cause the species to decline	Not significant. The spread of disease such as *Phytophthora* dieback with the potential to impact retained individuals (adjacent to Mundijong Road) will be managed through the implementation of standard management measures.
Interfere with the recovery of the species	Not Significant. As stated within the Interim Recovery Plan (DPaW 2017), recovery will be considered unsuccessful if the number of mature plants has decreased by > 10%. The removal of three individuals constitutes a reduction of approximately 0.2% of the currently known total population of the species, being 1,834 mature plants, and it is therefore not considered likely that the Proposed Action will interfere with the recovery of the species.

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5.5 *Synaphea* sp. Pinjarra Plain

5.5.1 Quantum of Impacts

The Proposed Action will result in no direct impacts to *Synaphea* sp. Pinjarra Plain, however given the close proximity of the species to the construction and operational footprint, potential indirect impacts may result from the introduction or spread of weeds and *Phytophthora* Dieback, increased incidence of fire, and other edge impacts.

5.5.2 Direct Impacts

No suitable habitat or individuals of *Synaphea* sp. Pinjarra Plain are proposed to be cleared within the Proposed Action area.

5.5.3 Indirect Impacts

- **Hydrological change:** The Proposed Action can be expected to result in a change to the current surface water hydrology through the introduction of new/ larger impervious road surfaces, with accompanying road drainage structures to control surface water flows and surface water quality (sedimentation, turbidity, siltation). Given the current alignment of Mundijong road, the mapped individuals of *Synaphea* sp. Pinjarra Plain are not currently expected to experience a 'natural' hydrological regime, and the Proposed Action is not expected to have a detrimental impact to retained individuals of the species.
- **Introduced flora**: The introduction and/or spread of invasive weed species through ground-disturbing activities has the potential to compete with retained individuals of *Synaphea* sp. Pinjarra. Main Roads will implement hygiene and management measures to limit weed infestation.
- ***Phytophthora* Dieback**: *Phytophthora* Dieback is listed as a threatening process for *Synaphea* sp. Pinjarra Plain (DPaW 2016). Glevan Consulting identified the presence of *P. cinnamomi* within the area of the Proposed Action, however the area where *Synaphea* sp. Pinjarra Plain was recorded is unprotectable uninterpretable. Standard hygiene measures will be implemented to minimise the risk of *P. cinnamomi* spread to unaffected individuals of the species.
- **Damage from construction equipment**: Elements of construction including dust generation and deposition, periods of increased vehicle movements and vibration from plant equipment may cause indirect impacts to retained individuals of *Synaphea* sp. Pinjarra Plain. Given the proximity of the 61 retained individuals of *Synaphea* sp. Pinjarra Plain to the Proposed Action, Main Roads will implement standard measures to minimise the risk of increased access, dust and vibration on the species.
- **Shading:** In order to minimise the direct impact to *Synaphea* sp. Pinjarra Plain, the Proposed Action will incorporate a retaining wall adjacent to the population. This has the potential to reduce the amount of sunlight received by the retained individuals in the area, comprising 69 individuals.

5.5.4 Cumulative Impacts

As the Proposed Action will not impact any individuals or suitable habitat for *Synaphea* sp. Pinjarra Plain, it will not contribute to any cumulative impacts on the species.

5.5.5 Assessment of the potential impacts to *Synaphea* sp. Pinjarra Plain

Table 5.5provides an assessment of the potential impact of the Proposal to *Synaphea* sp. Pinjarra Plain using the 'Critically Endangered' and 'Endangered' species significant impact criteria (DoE 2013). The assessment concludes that the potential for indirect impacts to Synaphea sp. Pinjarra Plain is not significant and can be adequately managed and as such an offset is not proposed.

Table 5.5: Assessment of potential impacts to *Synaphea* sp. Pinjarra Plain

Significant impact criteria	*Synaphea* sp. Pinjarra Plain (Endangered)
Lead to a long-term decrease in the size of an important population of a species	Not significant. The Proposed Action will not require the removal of any *Synaphea* sp. Pinjarra Plain individuals and will therefore not lead to a decrease in the size of any important population of the species.
Reduce the area of occupancy of an important population	Not significant The Proposed Action will not require the removal of any individuals or habitat of *Synaphea* sp. Pinjarra Plain. The Proposed Action will therefore not reduce the area of occupancy of any important population of the species.
Fragment an existing important population into two or more populations	Not significant. The Proposed Action will not remove any *Synaphea* sp. Pinjarra Plain individuals, and as such will not result in any population fragmentation.
Adversely affect habitat critical to the survival of a species	Not significant. The Proposed Action will not require the removal of any individuals or suitable habitat for *Synaphea* sp. Pinjarra Plain. As such, the Proposed Action will not adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	Not significant. The Proposed Action will not require the removal of any individuals of *Synaphea* sp. Pinjarra Plain, and as such will not disrupt the breeding cycle of any population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Not significant. The Proposed Action will not require the removal of any *Synaphea* sp. Pinjarra Plain individuals or suitable habitat. Given the presence of *Synaphea* sp. Pinjarra Plain immediately south of the area to be impacted by the Proposed Action area, there is potential for the species to be indirectly impacted during construction. Standard management measures will be implemented throughout construction including controls over water quality, erosion and sedimentation, dust, weeds, dieback, fire, hazardous chemicals, waste, dewatering and drainage. As such, the Proposed Action will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Not significant. Standard management measures will be implemented throughout construction and operation to ensure that invasive species do not become established in *Synaphea* sp. Pinjarra Plain habitat south of Mundijong Road.
Introduce disease that may cause the species to decline	Not significant. The spread of disease such as *Phytophthora* dieback with the potential to indirectly impact retained individuals of *Synaphea* sp. Pinjarra Plain south of Mundijong Road will be managed through the implementation of standard management measures throughout construction.

Significant impact criteria	*Synaphea* sp. Pinjarra Plain (Endangered)
Interfere substantially with the recovery of the species	Not significant. Given that no individuals or suitable habitat for *Synaphea* sp. Pinjarra Plain will be removed for the Proposed Action, none of the criteria outlined in the Interim Recovery Plan will be triggered (DPaW 2016): • Loss of important populations • Decrease of mature plants by >10% • Decrease of area of occupancy by >15% with loss of mature plants. Standard hygiene measures including controls for water quality, erosion and sedimentation, dust, weeds, dieback, fire, hazardous chemicals and waste, dewatering and drainage will be implemented throughout construction to avoid potential indirect impacts.

5.6 *Tetraria australiensis*

5.6.1 Quantum of Impacts

The Proposed Action will result in the clearing of up to 3.44 ha of suitable habitat for *Tetraria australiensis*:

- Loss of 165 individuals from one location (TFPL population 10) with 1,049 plants to be retained at this location.
- Clearing of up to 3.44 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.

Targeted surveys will be conducted in other known populations of this species, and in other areas of suitable habitat identified in a desktop study, to more accurately quantify the species population.

5.6.2 Direct Impacts

Up to 3.44 ha of suitable habitat for *Tetraria australiensis* is proposed to be cleared within the Proposed Action area, comprising 1.27 ha in 'Very Good', 0.29 ha in 'Good', 1.58 ha in 'Degraded' and 0.30 ha in 'Completely Degraded' condition (Figure 18). A total of 165 individuals of *Tetraria australiensis* are proposed to be taken. This constitutes approximately 13.6% of TPFL Population 10. Based on the revised total known population of *Tetraria australiensis* (21,500 mature individuals), clearing for the Proposed Action will impact on 0.8% of the known population.

5.6.3 Indirect Impacts

- **Hydrological change:** The Proposed Action can be expected to result in a change to the current surface water hydrology through the introduction of new/ larger impervious road surfaces, with accompanying road drainage structures to control surface water flows and surface water quality (sedimentation, turbidity, siltation). Given the current alignment of Mundijong road, the mapped individuals of *Tetraria australiensis* are not currently expected to experience a 'natural' hydrological regime, and the Proposed Action is not expected to have a detrimental impact to retained individuals of the species.
- **Introduced flora:** The introduction and/or spread of invasive weed species through ground-disturbing activities has the potential to compete with retained individuals of *Tetraria australiensis*. Main Roads will implement appropriate hygiene and management measures to limit weed infestation.
- **Phytophthora Dieback:** *Phytophthora* Dieback is listed as a threatening process for *Tetraria australiensis* (TSSC 2018). Glevan Consulting identified the presence of *P. cinnamomi* within the area of the Proposed Action and within the area where 1,205 *Tetraria australiensis* plants occur along Mundijong road. A total of three *Tetraria australiensis* plants occur within the excluded area and will not be cleared for the Proposed Action. Main Roads will implement standard hygiene measures to minimise the risk of *P. cinnamomi* spread to unaffected individuals of the species.
- **Damage from construction equipment:** Elements of construction including dust generation and deposition, periods of increased vehicle movements and vibration from plant equipment may cause indirect impacts to retained individuals of *Tetraria australiensis*. Main Roads will implement standard measures to minimise the risk of increased access, dust and vibration on the species.
- **Shading:** To minimise the direct impact to *Tetraria australiensis*, the Proposed Action will incorporate a retaining wall adjacent to the population. This has the potential to reduce the

amount of sunlight received by the retained individuals in the area, comprising 1,049 individuals.

- **Fire:** Fire may have a significant direct impact to the health condition of native vegetation and may further alter the vegetation structure through native flora mortality and the colonisation/spread of introduced flora.

  For road construction works, the risk of a fire ignition source is most notable for 'hot works' such as grinding/welding of steel in bridge construction, or where construction vehicles may drive over grassy vegetation. Having regard to the potential significance of fire to vegetation, and noting the potential ignition sources, the risk and management of fire is incorporated into standard operation controls for all Main Roads construction works.

  Main Roads will implement standard operational controls for fire, such as restrictions on the timing and locations of 'hot works', all vehicles to be fitted with fire extinguishers, and the induction and training of all site personnel on fire risks and response. The implementation of standard operational controls can be expected to appropriately control the risk of fire to *Tetraria australiensis* during construction works.

  In addition, Main Roads has prepared a *Tetraria australiensis* Fire Management Plan to address risks and fire management actions specifically for the species (see Appendix L).

5.6.4 Cumulative Impacts

The Proposed Action will require the clearing of three individuals of *Tetraria australiensis*, representing approximately 0.8% of the total known population (21,500 mature individuals). It is not known whether other individuals of the species have been lost due to land clearing across its distribution, however given a large proportion of occurrences occur within the Perth Metropolitan area it is considered threatened by development pressure. Therefore, the impact to 165 individuals will add to the cumulative impact to this species.

5.6.5 Assessment of the potential impacts to *Tetraria australiensis*

Table 5.6 provides an assessment of the potential impact of the Proposal to the *Tetraria australiensis* using the 'Critically Endangered' and 'Endangered' species significant impact criteria (DoE 2013).

The assessment concludes that the proposed impact to the *Tetraria australiensis* is significant and therefore an offset is identified for this MNES in Section 8.

Important populations of *Tetraria australiensis* have not been identified within the approved Conservation Advice (DEWHA 2008), however, DEC (2007) notes that all known subpopulations are regarded as essential for the species' long-term survival. Therefore, as both TPFL Populations 8 and 10 are considered to be sub-populations of the same population, both are considered to be an important population of the species.

Table 5.6: Assessment of potential impacts to *Tetraria australiensis*

Significant impact criteria	*Tetraria australiensis* (Vulnerable)
Lead to a long-term decrease in the size of an important population of a species	Significant. The Proposed Action will require the permanent removal of up to 165 individuals of *Tetraria australiensis* from one important population, 13.6% of TPFL Population 10. This constitutes a maximum reduction of 0.8% of the total currently known species population, which is estimated to be 21,500 individuals (DBCA 2020).
Reduce the area of occupancy of an important population	Significant The Proposed Action will require the removal of up to 165 individuals of *Tetraria australiensis* from one important population. This constitutes a maximum

Significant impact criteria	*Tetraria australiensis* (Vulnerable)
	reduction of 0.8% of the total currently known species population, which is estimated at 21,500 individuals.
Fragment an existing important population into two or more populations	Not significant. The Proposed Action will result in the permanent removal of up to 165 individuals forming part of one important population. This will reduce the number of individuals within one population but will not fragment it into two or more populations.
Adversely affect habitat critical to the survival of a species	Significant. The Proposed Action will require the permanent removal of up to 165 individuals of *Tetraria australiensis* from one important population, which constitutes a maximum reduction of 0.8% of the total currently known species population and 13.6% of TPFL Population 10. Given the retention of 86.4% of
Disrupt the breeding cycle of an important population	Not significant. The impacted individuals are considered to form part of TPFL Population 10 comprising 1,054 individuals. The Proposed Action will impact on 165 individuals, representing 13.6% of this population and 0.8% of the total known population. It is considered that the Proposed Action will not disrupt the breeding cycle of an important population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Not significant. The Proposed Action will require the permanent removal of up to 165 individuals of *Tetraria australiensis* from one of 18 populations, which constitutes a maximum reduction of 0.8% of the total currently known species population. It is therefore not considered that the Proposed Action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. Woodman (2020) note that there have been several new populations recently found during field observations, and that there is no accurate population and abundance information publicly available for the species.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Not significant. The spread of weeds with the potential to impact retained individuals (adjacent to Mundijong Road) will be managed through the implementation of standard management measures.
Introduce disease that may cause the species to decline	Not significant. The spread of disease such as *Phytophthora* dieback with the potential to impact retained individuals (adjacent to Mundijong Road) will be managed through the implementation of standard management measures.
Interfere substantially with the recovery of the species	Not significant. There is currently no recovery plan for this species, however, the removal of up to 165 individuals is not considered to have the potential to interfere with the recovery of the species as it constitutes a maximum reduction of only 0.8% of the total currently known species population.

5.7 Carnaby's Cockatoo *Calyptorhynchus latirostris*, Baudin's Cockatoo *Calyptorhynchus baudinii* and Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso*

5.7.1 Quantum of Impacts

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

- Clearing of up to 20.9 ha 'Low to Moderate' to 'Moderate' quality foraging habitat for Carnaby's Cockatoo
- Clearing of up to 20.6 ha of 'Low to Moderate' to 'Moderate to High' value foraging habitat for Baudin's Cockatoo and Forest Red-tailed Black Cockatoo
- Loss of up to 346 potential Black Cockatoo breeding trees (DBH>500 mm), including two trees containing potentially suitable hollows 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.

5.7.2 Nature of Impacts (Timing, Temporary/Permanent)

5.7.2.1 Indirect Impacts

Construction activities may have the potential to indirectly impact adjacent and retained Black Cockatoo habitat through:

- **Introduced flora:** The introduction and/or spread of invasive weed species through ground-disturbing activities has the potential to reduce the quality of foraging species for the cockatoo species. Standard hygiene and management measures will be implemented to limit weed infestation.
- **Phytophthora Dieback:** *Phytophthora* Dieback is listed as a threatening process for some Black Cockatoo foraging and breeding species (TSSC 2018). Glevan Consulting identified the presence of *P. cinnamomi* within the area of the Proposed Action. Standard hygiene measures will be implemented to minimise the risk of *P. cinnamomi* spread to unaffected individuals of the species.
- **Damage from construction equipment:** Elements of construction including dust generation and deposition, periods of increased vehicle movements and vibration from plant equipment may cause indirect impacts to surrounding vegetation. Standard measures to minimise the risk of increased access, dust and vibration will be implemented to minimise the risk of impacts to surrounding vegetation.
- **Fire:** Fire may have an indirect impact to the health condition of native vegetation and may further alter the vegetation structure through native flora mortality and the colonisation/spread of introduced flora.

Management measures will be implemented at each stage of construction to ensure that the risk of the above impacts is minimised as much as possible.

Following completion of the Proposed Action, higher traffic volumes in the area may increase the risk of traffic collisions and mortality of Black Cockatoos.

5.7.2.2 Cumulative Impacts

The below presents broad analysis of cumulative impacts to Black Cockatoos, considering the estimated extent of Black Cockatoo habitat present within 6km and 12km of the Proposed Action area. The extent of Black Cockatoo habitat within the surrounding area has been calculated based on the remaining extent of native vegetation within vegetation complexes comprising of species suitable for foraging, breeding and roosting, for all three species of Black Cockatoo.

Within 12km of the Proposed Action area, it is estimated that there is approximately 31,000 ha of native vegetation providing potential Black Cockatoo habitat, of which approximately 19,500 ha occurs within conservation reserves.

Removal of 20.9 ha of quality habitat for Carnaby's Cockatoo and 20.6 ha of quality habitat for Baudin's Cockatoo and Forest Red-tailed Black Cockatoo within the Proposed Action area represents less than 0.1% of the estimated maximum amount of habitat within 12km, however will contribute to cumulative impacts through impacting habitat within the constrained Swan Coastal Plain.

5.7.3 Impact of Recent Fire on Foraging, Roosting and Breeding Habitat

Figure 23 presents prescribed burns and bushfires/wildfires which have occurred within 12 km of the Proposed Action area from 2010 to present, based on DBCA fire scar spatial mapping. Intersecting this with areas of Black Cockatoo potential foraging habitat within 12 km of the Proposed Action area, approximately 11,800 ha of potential Black Cockatoo foraging habitat have been burnt since 2010, occurring predominantly to the east within National Parks and State Forest. The impact of fires on Black Cockatoo habitat is dependent on the intensity of the fire, with low intensity fires representing a limited impact to the primary habitat types for this species in the region of the Proposed Action.

Prescribed burns are controlled, low intensity fires which are designed to remove understorey fuel loads and are not designed to impact canopy layers where Black Cockatoos breed and roost. It is not considered likely that prescribed burning has a significant negative impact on potential Black Cockatoo foraging, breeding and roosting habitat. DBCA fire scar spatial mapping indicates that approximately 1,500 ha of potential Black Cockatoo foraging habitat has been impacted by bushfires (i.e. not prescribed burns) over the past 10 years. Other fires that have been recorded are insignificant in the context of the 12 km area with sufficient available foraging resources that have not been burnt.

5.7.4 Impact of *Phytophthora* Dieback on Cockatoo Habitat

Glevan Consulting (2020) undertook a *Phytophthora* Dieback occurrence assessment (Appendix F) on 16th June 2020, which identified two *Phytophthora* dieback infestations covering an area of 5 ha and a further 7.8 ha of unprotectable uninterpretable vegetation within the Survey Area. The majority of the Survey Area (428.9 ha) was excluded from the assessment due to the absence of vegetation or the vegetation condition being assessed as degraded.

The majority of the foraging habitat for the area is within the excluded area (19.4 ha of Carnaby's Cockatoo and 19.3 ha of Forest Red-tailed Black Cockatoo and Baudin's Cockatoo). The remainder is located in dieback affected areas. There are no dieback-free areas located within the Proposed Action. Standard management procedures will be in place to manage areas of known dieback and minimise the risk of spread. As the Proposed Action is known to contain dieback, and the remainder of the site is uninterpretable or excluded, it is unlikely that dieback will impact on the long-term viability of black cockatoos using the project area. Assessment of the potential impacts to Carnaby's Cockatoo.

5.7.5 Assessment of the potential impacts to Carnaby's Cockatoo

Table 5.7 provides an assessment of the potential impact of the Proposal to the Carnaby's Cockatoo using the 'Critically Endangered' and 'Endangered' species significant impact criteria (DoE 2013). The

assessment concludes that the proposed impact to the Carnaby's Cockatoo is potentially significant and therefore an offset is identified for this MNES in Section 8.

Table 5.7: Assessment of potential impacts to Carnaby's Cockatoo

Significant impact criteria	Carnaby's Cockatoo *Calyptorhynchus latirostris* (Endangered)
Lead to a long-term decrease in the size of a population	Not significant. The removal of up to 20.9 ha of 'Low to Moderate' to 'Moderate' value foraging habitat and 346 potential Black Cockatoo breeding trees (DBH ≥500mm) including two trees containing potentially suitable hollows for breeding, is not expected to lead to a long-term decrease in the size of a population. Removal of up to 20.9 ha represents less than 0.1% of the estimated maximum amount of potential foraging habitat within 12km of the Proposed Action, being 31,000 ha. Of the 31,000 ha of potential foraging habitat within 12km of the Proposed Action, 19,500 ha occurs within conservation reserves. Carnaby's Cockatoos are highly mobile species and are expected to forage outside the Proposed Action area amongst foraging resources in the vicinity and are not dependent on a particular patch of foraging habitat within the Proposed Action area. In addition, the Proposed Action will not result in clearing of any known breeding trees, hollows, or roosting sites.
Reduce the area of occupancy of the species	Not Significant The Proposed Action is located within the mapped distribution of the species (DSEWPaC 2012, DotEE 2017), and will reduce the area of habitat available for Carnaby's Cockatoo and therefore the area of occupancy. However, the species is unlikely to occupy or rely on the habitat within the Proposed Action area on a permanent basis as there is only scattered 'moderate to low' quality foraging habitat and potential breeding trees surrounding by mostly cleared farmland.
Fragment an existing population into two or more populations	Not significant. The Proposed Action is not expected to fragment populations of this species into two or more populations, as they are a highly mobile species and are not dependent upon the 'Low to Moderate' to 'Moderate' value foraging habitat to be removed by the Proposed Action. A gap of more than 4km between patches of habitat for this species will not be created as a result of the Proposed Action.
Adversely affect habitat critical to the survival of a species	Potentially significant As outlined within the *Carnaby's Cockatoo (Calyptorhynchus latirostris) Recovery Plan* (DPaW 2013), critical habitat for the survival of this species is defined as: • The eucalypt woodlands that provide nest hollows used for breeding, together with nearby vegetation that provides feeding, roosting and watering habitat that supports successful breeding • Woodland sites known to have supported breeding in the past and which could be used in the future, provided adequate food and/or water resources are available or re-established • In the non-breeding season, the vegetation that provides food resources as well as the sites for nearby watering and night roosting that enable the cockatoos to effectively utilise the available food resources. There is a high risk of significant impact where a proposed action will involve the clearing of more than 1 ha of quality foraging habitat (DSEWPaC 2012). The area to be impacted by the Proposed Action supports foraging and potential breeding, with up to 20.9 ha of 'Low to Moderate' to 'Moderate' value foraging habitat and 346 potential Black Cockatoo breeding trees (DBH ≥500mm) including two trees containing potentially suitable hollows for breeding. Given that the Proposed Action area supports foraging habitat of 'Moderate' quality, at best, and that the nearest known breeding site is 10 km east, the habitat to be impacted it not considered critical for the survival of the species. Whilst there is a roosting site within 1 km of the Proposed Action, the availability of foraging habitat within conservation reserves within 6 km means the habitat within the Proposed Action is unlikely to be critical in supporting this site.

Significant impact criteria	Carnaby's Cockatoo *Calyptorhynchus latirostris* (Endangered)
	On this basis, the Proposed Action may adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of a population	Not significant. While the Proposed Action will result in the removal of 346 potential Black Cockatoo breeding trees (DBH ≥500mm), including two trees containing potentially suitable hollows for Black Cockatoo breeding, it is not expected that this impact will disrupt the breeding cycle of a population. The closest known breeding site to the Proposed Action is approximately 10km to the east in the Wungong Catchment. The Proposed Action is located within close proximity to the Jarrah Forest of the Darling Scarp, which is considered to provide more suitable breeding habitat.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Not significant. While the Proposed Action will result in the removal of 346 potential Black Cockatoo breeding trees (DBH ≥ 500mm), including two trees containing potentially suitable hollows for Black Cockatoo breeding, it is not expected that this impact is likely to cause the species to decline. Removal of up to 20.9 ha of foraging habitat represents less than 0.1% of the estimated maximum amount of potential foraging habitat within 12km of the Proposed Action, being 31,000 ha. Of the 31,000 ha of potential foraging habitat within 12km of the Proposed Action, 19,500 ha occurs within conservation reserves.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat	Not significant. The Proposed Action is not considered likely to result in establishment of species such as Corellas (*Cacatua* sp.), Galahs (*Cacatua roseicapilla*) or feral bees (*Apis mellifera*) which are known to compete with Black Cockatoos for nest hollows. The spread of weeds with the potential to impact Black Cockatoo habitat will be managed through the implementation of standard management measures throughout construction.
Introduce disease that may cause the species to decline	Not significant. The spread of disease such as *Phytophthora* dieback with the potential to impact Black Cockatoo habitat will be managed through the implementation of standard management measures throughout construction.
Interfere with the recovery of the species	Not significant. The Proposed Action is not inconsistent with the *Carnaby's Cockatoo (Calyptorhynchus latirostris) Recovery Plan* (DPaW 2013).

5.7.6 Assessment of the potential impacts to Baudin's Cockatoo

Table 5.8 provides an assessment of the potential impact of the Proposal to the Baudin's Cockatoo using the 'Critically Endangered' and 'Endangered' species significant impact criteria (DoE 2013).

The assessment concludes that the proposed impact to the Baudin's Cockatoo is significant and therefore an offset is identified for this MNES in Section 8.

Table 5.8: Assessment of potential impacts to Baudin's Cockatoo

Significant impact criteria	Baudin's Cockatoo *Calyptorhynchus baudinii* (Endangered)
Lead to a long-term decrease in the size of a population	Not significant. The removal of up to 20.6 ha of 'Low to Moderate' to 'Moderate to High' value foraging habitat and 346 potential Black Cockatoo breeding trees (DBH ≥ 500mm) including two trees containing potentially suitable hollows for breeding, is not expected to lead to a long-term decrease in the size of a population. Removal of up to 20.6 ha represents less than 0.1% of the estimated maximum amount of potential foraging habitat within 12km of the Proposed Action, being 28,000 ha (with 19,500 ha occurring within conservation reserves).

Significant impact criteria	Baudin's Cockatoo *Calyptorhynchus baudinii* (Endangered)
	Baudin's Cockatoos are highly mobile species and are expected to forage outside the Proposed Action area amongst foraging resources in the vicinity and are not dependent on a particular patch of foraging habitat within the Proposed Action area. In addition, the Proposed Action will not result in clearing of any known breeding trees or hollows or roosting sites.
Reduce the area of occupancy of the species	Significant The Proposed Action is located within the mapped distribution of the species (DSEWPaC 2012, DotEE 2017), and will reduce the area of habitat available for Baudin's Cockatoo and therefore the area of occupancy. However, the species is only likely to use the habitat within the Proposed Action area for foraging as it is not located within the mapped breeding range. Mapping provided in the Commonwealth document *EPBC Act referral guidelines for three threatened black cockatoo species* (DSEWPaC 2012) indicates that the Proposed Action is outside of the predicted breeding range of Baudin's Cockatoo. Baudin's Cockatoo are known to breed in low numbers in the Serpentine Hills area approximately 10km to the south of the Proposed Action and in the Wungong Catchment approximately 16km to the east, therefore it is not expected that this species breeds within the Proposed Action area.
Fragment an existing population into two or more populations	Not significant. The Proposed Action is not expected to fragment populations of this species into two or more populations, as they are a highly mobile species and are not dependent upon the 'Low to Moderate' to 'Moderate to High' value foraging habitat to be removed by the Proposed Action. A gap of more than 4km between patches of habitat for this species will not be created as a result of the Proposed Action.
Adversely affect habitat critical to the survival of a species	Significant. The *Forest Black Cockatoo Recovery Plan* (DEC 2008) identifies habitat critical for the survival of Baudin's Cockatoo as those areas: • Currently occupied by the cockatoos • Not currently occupied by the cockatoos due to recent fire but capable of supporting cockatoo populations when sufficiently recovered • Of natural vegetation in which the cockatoo's nest, feed and roost • Of natural vegetation through which the cockatoos can move from one occupied area to another • Of suitable vegetation within the recorded range in which undiscovered cockatoo populations may exist. The habitat critical to survival and important populations of Forest Black Cockatoos comprises all Marri, Karri and Jarrah forests, woodlands and remnants in the south west of Western Australia receiving more than 600 mm of annual average rainfall. The is a high risk of significant impact where a proposed action will involve the clearing of more than 1 ha of quality foraging habitat (DSEWPaC 2012). The Proposed Action supports foraging and potential breeding, and will result in the permanent removal up to 20.6 ha of 'Low to Moderate' to 'Moderate to High' value foraging habitat and 346 potential Black Cockatoo breeding trees (DBH ≥500mm) including two trees containing potentially suitable hollows for breeding. Kirkby (2019) recorded foraging evidence by Baudin's Cockatoo at 24 locations within the Proposed Action in the form of chewed Marri nuts. In addition, evidence of foraging by Baudin's Cockatoos within and immediately adjacent to the Proposed Action was reported by Murdoch University (2015) through GPS and satellite tracking data.

Significant impact criteria	Baudin's Cockatoo *Calyptorhynchus baudinii* (Endangered)
	No confirmed roosting sites for this species occur within the Proposed Action. Based on DEC (2008) it is considered that the Proposed Action contains habitat critical for Baudin's Cockatoo given that the species is known to feed within the area (Kirkby 2019), and individuals have been demonstrated to use the site to move between occupied areas (Murdoch 2015). On this basis, the Proposed Action may adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of a population	Not significant. While the Proposed Action will result in the removal of 346 potential Black Cockatoo breeding trees (DBH ≥500mm), including two trees containing potentially suitable hollows for Black Cockatoo breeding, it is not expected that this impact will disrupt the breeding cycle of a population. DSEWPaC (2012) indicates that the Proposed Action is outside of the predicted breeding range of Baudin's Cockatoo. Baudin's Cockatoo are known to breed in low numbers in the Serpentine Hills area approximately 10km to the south of the Proposed Action and in the Wungong Catchment approximately 16km to the east, therefore it is not expected that this species breeds within the Proposed Action.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Not significant. While the Proposed Action will result in the removal of 346 potential Black Cockatoo breeding trees (DBH ≥500mm), including two trees containing potentially suitable hollows for Black Cockatoo breeding, it is not expected that this impact is likely to cause the species to decline. Removal of up to 20.6 ha of foraging habitat represents less than 0.1% of the estimated maximum amount of potential foraging habitat, as well as potential breeding and roosting habitat within 12km of the Proposed Action, being 28,000 ha. Of the 28,000 ha of potential foraging habitat within 12km of the Proposed Action, 19,500 ha occurs within conservation reserves.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat	Not significant. The Proposed Action is not considered likely to result in establishment of species such as Corellas (*Cacatua* sp.), Galahs (*Cacatua roseicapilla*) or feral bees (*Apis mellifera*) which are known to compete with Black Cockatoos for nest hollows. The spread of weeds with the potential to impact Black Cockatoo habitat will be managed through the implementation of standard management measures.
Introduce disease that may cause the species to decline	Not significant. The spread of disease such as *Phytophthora* dieback with the potential to impact Black Cockatoo habitat will be managed through the implementation of standard management measures.
Interfere with the recovery of the species	Not significant. The Proposed Action is not inconsistent with the *Forest Black Cockatoo Recovery Plan (DEC 2008)*.

5.7.7 Assessment of the potential impacts to Forest Red-tailed Black Cockatoo

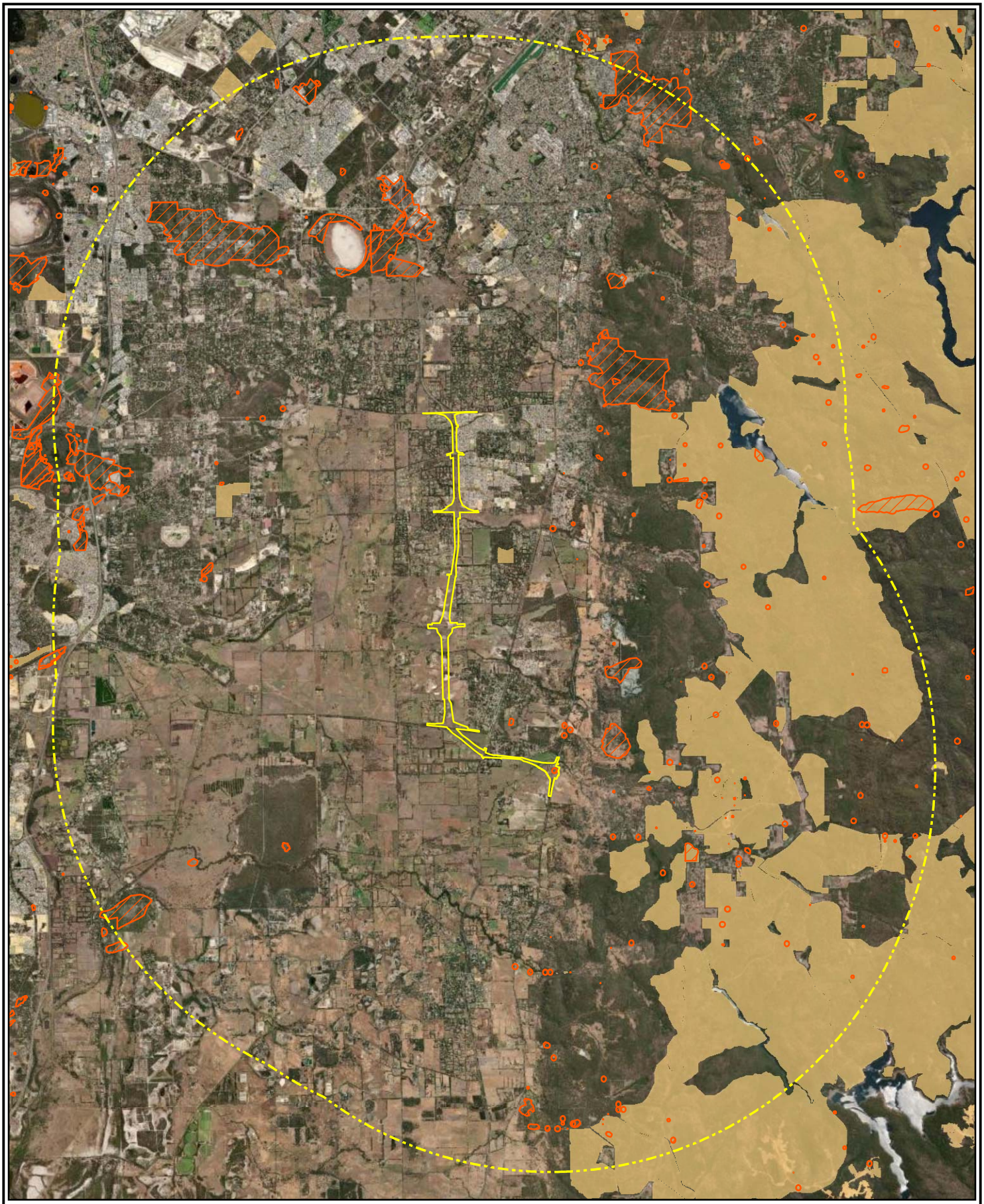
Table 5.9 provides an assessment of the potential impact of the Proposal to the Forest Red-tailed Black Cockatoo using the 'Critically Endangered' and 'Endangered' species significant impact criteria (DoE 2013).

The assessment concludes that the proposed impact to the Forest Red-tailed Black Cockatoo is significant and therefore an offset is identified for this MNES in Section 8.

Table 5.9: Assessment of potential impacts to Forest Red-tailed Black Cockatoo

Significant impact criteria	Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso* (Vulnerable)
Lead to a long-term decrease in the size of an important population of a species	Not significant. The removal of up to 20.6 ha of 'Low to Moderate' to 'Moderate to High' value foraging habitat and 346 potential Black Cockatoo breeding trees (DBH ≥500mm) including two trees containing potentially suitable hollows for breeding, is not expected to lead to a long-term decrease in the size of a population. Removal of up to 20.6 ha of foraging habitat represents less than 0.1% of the estimated maximum amount of potential foraging habitat within 12km of the Proposed Action, being 28,000 ha. Of the 28,000 ha of potential foraging habitat within 12km of the Proposed Action, 19,500 ha occurs within conservation reserves. Forest Red-tailed Black Cockatoos are highly mobile species and are expected to forage outside the Proposed Action area amongst foraging resources in the vicinity and are not dependent on a particular patch of foraging habitat within the Proposed Action area. In addition, the Proposed Action will not result in clearing of any known breeding trees or hollows or roosting sites.
Reduce the area of occupancy of an important population	Significant The Proposed Action is located within the mapped distribution of the species (DSEWPaC 2012, DotEE 2017), and will reduce the area of habitat available for Forest Red-tailed Black Cockatoo and therefore the area of occupancy. However, the species is unlikely to occupy or rely on the habitat in the Proposed Action area on a permanent basis as there is only scattered 'Moderate to low' quality foraging habitat and potential breeding trees surrounded by mostly cleared farmland.
Fragment an existing important population into two or more populations	Not significant. The Proposed Action is not expected to fragment populations of this species into two or more populations, as they are a highly mobile species and are not dependent upon the 'High to moderate value foraging habitat to be removed by the Proposed Action. A gap of more than 4km between patches of habitat for this species will not be created as a result of the Proposed Action.
Adversely affect habitat critical to the survival of a species	Significant. The *Forest Black Cockatoo Recovery Plan* (DEC 2008) identifies habitat critical for the survival of Forest Red-tailed Black Cockatoo as those areas: • Currently occupied by the cockatoos • Not currently occupied by the cockatoos due to recent fire but capable of supporting cockatoo populations when sufficiently recovered • Of natural vegetation in which the cockatoo's nest, feed and roost • Of natural vegetation through which the cockatoos can move from one occupied area to another • Of suitable vegetation within the recorded range in which undiscovered cockatoo populations may exist. The habitat critical to survival and important populations of Forest Black Cockatoos comprises all Marri, Karri and Jarrah forests, woodlands and remnants in the south west of Western Australia receiving more than 600 mm of annual average rainfall. There is a high risk of significant impact where a proposed action will involve the clearing of more than 1 ha of quality foraging habitat. The Proposed Action supports foraging and potential breeding, with 20.6 ha of 'Low to Moderate' to 'Moderate to High' value foraging habitat and 346 potential Black Cockatoo breeding trees (DBH ≥500mm) including two trees with potentially suitable hollows for breeding. Given that Kirkby (2019) sighted the species just beyond the boundary of the Proposed Action, it is expected to be used by Forest Red-tailed Black Cockatoos.

Significant impact criteria	Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso* (Vulnerable)
	On this basis it is considered that the Proposed Action will adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	Not significant. While the Proposed Action will result in the removal of 346 potential Black Cockatoo breeding trees (DBH ≥500mm), including two trees containing potentially suitable hollows for Black Cockatoo breeding, it is not expected that this impact will disrupt the breeding cycle of a population. The nearest known breeding site for Forest Red-tailed Black Cockatoo occurs 8 km to the east of the Proposed Action area at the Wungong Catchment, though breeding pairs have been observed prospecting and chewing hollow entrances at Cardup Nature Reserve which lies 1.5km to the east of the Proposed Action (Kirkby 2019). Forest Red-tailed Black Cockatoo breeding has also been confirmed in an artificial hollow in Serpentine (Kirkby 2019).
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Not significant. While the Proposed Action will result in the removal of 346 potential Black Cockatoo breeding trees (DBH ≥500mm), including two trees containing potentially suitable hollows for Black Cockatoo breeding, it is not expected that this impact is likely to cause the species to decline. Removal of up to 20.6 ha of foraging habitat represents less than 0.1% of the estimated maximum amount of potential foraging habitat, as well as potential breeding and roosting habitat within 12km of the Proposed Action, being 31,000 ha. Of the 31,000 ha of potential foraging habitat within 12km of the Proposed Action, 19,500 ha occurs within conservation reserves.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Not significant. The Proposed Action is not considered likely to result in establishment of species such as Corellas (*Cacatua* sp.), Galahs (*Cacatua roseicapilla*) or feral bees (*Apis mellifera*) which are known to compete with Black Cockatoos for nest hollows. The spread of weeds with the potential to impact Black Cockatoo habitat will be managed through the preparation and implementation of a Construction EMP.
Introduce disease that may cause the species to decline	Not significant. The spread of disease such as *Phytophthora* dieback with the potential to impact Black Cockatoo habitat will be managed through the implementation of standard management measures.
Interfere substantially with the recovery of the species	Not significant. The Proposed Action is not inconsistent with the *Forest Black Cockatoo Recovery Plan (DEC 2008)*.



Legend

- Proposed Action
- 12 km radius of Proposed Action

Bushfire history (2010 - 2020)

- Wildfire / bushfire
- Prescribed burn

Scale 1:160,000 at A4 (0 1 2 Kilometers)		**Tonkin Highway Extension WA**
Coord. Sys. GDA 1994 MGA Zone 50		**BUSHFIRE OCCURRENCE WITHIN 12 KM OF THE PROPOSED ACTION**
Job No: 58910		
Client: Main Roads Western Australia		**FIGURE 23**
Version: A	Date: 20-Jan-2021	strategen JBS&G
Drawn By: hsullivan	Checked By: DN	

File Name: W:\Projects\1)Open\Main Roads\58910 Tonkin Extension PD\GIS\Maps\R01_Rev_A\58910_23_Bushfire.mxd
Image Reference: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

6. Avoidance and Mitigation Measures

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

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

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

6.1 Clay Pans TEC

6.1.1 Avoidance

Changes to the Proposal design have been made since referral in 2019 to reduce impacts to the Clay Pans TEC. As discussed in section 2.6, changes to the design have included a range of refinements to minimise the impacts to the environment such as reducing median widths and changing the design of interchanges to reduce clearing requirements. The resulting Proposal reflects the minimum land area required for the road corridor. Impacts to MNES and other environmental values have been reduced to the maximum extent possible and the remaining impact cannot be avoided if the Proposal is to proceed. A summary of the original impact, and resulting impact post design changes and the net reduction in clearing area of TEC's is presented in Table 6.1.

Table 6.1: Design changes to avoid Clay Pans TEC

Aspect	Original Proposal as referred	Revised Proposal at Concept Design	Reduction in impact
Clay Pans of the Swan Coastal Plain Threatened Ecological Community (Critically Endangered)	0.05 ha	0 ha	0.05 ha

6.1.2 Mitigation

Standard construction management procedures will be implemented to avoid indirect impacts to the Clay Pans TEC. As there are no direct impacts to the Clay Pans TEC, no offset is proposed.

6.2 *Corymbia-Kingia* TEC

6.2.1 Avoidance

Changes to the Proposal design have been made since referral in 2019 to reduce impacts to the *Corymbia-Kingia* TEC. As discussed in section 2.6, changes to the design have included a range of refinements to minimise the impacts to the environment such as reducing median widths and changing the design of interchanges to reduce clearing requirements. The resulting Proposal reflects the minimum land area required for the road corridor. Impacts to MNES and other environmental

values have been reduced to the maximum extent possible and the remaining impact cannot be avoided if the Proposal is to proceed. A summary of the original impact, and resulting impact post design changes and the net reduction in clearing area of TEC's is presented in

Table 6.2.

Table 6.2: Design changes to avoid *Corymbia-Kingia* TEC

Aspect	Original Proposal as referred	Revised Proposal at Concept Design	Reduction in impact
Corymbia calophylla – Kingia australis woodlands on heavy soils, Swan Coastal Plain Threatened Ecological Community (Endangered)	1.3 ha	0.13 ha	1.2 ha

6.2.2 Mitigation

Actions to be implemented to manage indirect impacts to remaining *Corymbia-Kingia* TEC vegetation directly adjacent to the Proposal Area are detailed in Appendix I. Standard management measures will sufficiently manage any indirect impacts. Main Roads intends to further counterbalance the residual impacts of the Proposal through implementation of an environmental offset strategy (Appendix H).

6.3 *Corymbia- Xanthorrhoea* TEC

6.3.1 Avoidance

Changes to the Proposal design have been made since referral in 2019 to reduce impacts to the *Corymbia-Xanthorrhoea* TEC. As discussed in section 2.6, changes to the design have included a range of refinements to minimise the impacts to the environment such as reducing median widths and changing the design of interchanges to reduce clearing requirements. The resulting Proposal reflects the minimum land area required for the road corridor. Impacts to MNES and other environmental values have been reduced to the maximum extent possible and the remaining impact cannot be avoided if the Proposal is to proceed. A summary of the original impact and resulting impact post design changes and the net reduction in clearing area of TEC's is presented in Table 6.3.

Table 6.3: Design changes to avoid *Corymbia- Xanthorrhoea* TEC

Aspect	Original Proposal as referred	Revised Proposal at Concept Design	Reduction in impact
Corymbia calophylla - Xanthorrhoea preissii woodlands and shrublands of the Swan Coastal Plain (Endangered)	5.3 ha	3.94 ha	1.36 ha

6.3.2 Mitigation

Actions to be implemented to manage indirect impacts to remaining *Corymbia-Xanthorrhoea* TEC vegetation directly adjacent to the Proposal Area are detailed in Appendix I. Standard management measures will sufficiently manage any indirect impacts. Main Roads intends to further counterbalance the residual impacts of the Proposal through implementation of an environmental offset strategy (Appendix H).

6.4 *Synaphea* sp. Serpentine

6.4.1 Avoidance

Changes to the Proposal design have been made since referral in 2019 to reduce impacts to *Synaphea* sp. Serpentine. As discussed in section 2.6, changes to the design have included a range of refinements to minimise the impacts to the environment such as reducing median widths and changing the design of interchanges to reduce clearing requirements. The resulting Proposal reflects the minimum land area required for the road corridor. Impacts to MNES and other environmental

values have been reduced to the maximum extent possible and the remaining impact cannot be avoided if the Proposal is to proceed. A summary of the original impact, and resulting impact post design changes and the net reduction in clearing area of the species is presented in Table 6.4.

Table 6.4: Design changes to avoid *Synaphea* sp. Serpentine

Aspect	Original Proposal as referred	Revised Proposal at Concept Design	Reduction in impact
Synaphea sp. Serpentine (Critically Endangered)	538	3	535

6.4.2 Mitigation

Actions to be implemented to manage indirect impacts to remaining *Synaphea* sp. Serpentine directly adjacent to the Proposal Area are detailed in Appendix I. Standard management measures will sufficiently manage any indirect impacts. Main Roads intends to further counterbalance the residual impacts of the Proposal through implementation of an environmental offset strategy (Appendix H).

6.5 *Synaphea* sp. Pinjarra Plain

6.5.1 Avoidance

Changes to the Proposal design have been made since referral in 2019 to reduce impacts to *Synaphea* sp. Pinjarra Plain. As discussed in section 2.6, changes to the design have included a range of refinements to minimise the impacts to the environment such as reducing median widths and changing the design of interchanges to reduce clearing requirements. The resulting Proposal reflects the minimum land area required for the road corridor. Impacts to MNES and other environmental values have been reduced to the maximum extent possible and the remaining impact cannot be avoided if the Proposal is to proceed. A summary of the original impact, and resulting impact post design changes and the net reduction in clearing area of the species is presented in Table X.

Table 6.5: Design changes to avoid *Synaphea* sp. Pinjarra Plain

Aspect	Original Proposal as referred	Revised Proposal at Concept Design	Reduction in impact
Synaphea sp. Pinjarra Plain (Endangered)	6	0	6

6.5.2 Mitigation

Standard construction management procedures will be implemented to avoid indirect impacts to the *Synaphea* sp. Pinjarra Plain individuals and habitat. As there are no direct impacts to *Synaphea* sp. Pinjarra Plain, no offset is proposed.

6.6 *Tetraria australiensis*

6.6.1 Avoidance

Changes to the Proposal design have been made since referral in 2019 to reduce impacts to *Tetraria australiensis*. As discussed in section 2.6, changes to the design have included a range of refinements to minimise the impacts to the environment such as reducing median widths and changing the design of interchanges to reduce clearing requirements. The resulting Proposal reflects the minimum land area required for the road corridor. Impacts to MNES and other environmental values have been reduced to the maximum extent possible and the remaining impact cannot be avoided if the Proposal is to proceed. A summary of the original impact, and resulting impact post design changes and the net reduction in clearing area of the species is presented in Table 6.6.

Table 6.6: Design changes to avoid *Tetraria australiensis*

Aspect	Original Proposal as referred	Revised Proposal at Concept Design	Reduction in impact
Tetraria australiensis (Vulnerable)	1,131	165	966

6.6.2 Mitigation

Actions to be implemented to manage indirect impacts to remaining *Tetraria australiensis* directly adjacent to the Proposal Area are detailed in Appendix I. Standard management measures will sufficiently manage any indirect impacts. Main Roads intends to further counterbalance the residual impacts of

6.7 Carnaby's Cockatoo *Calyptorhynchus latirostris*, Baudin's Cockatoo *Calyptorhynchus baudinii* and Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso*

6.7.1 Avoidance

Changes to the Proposal design have been made since referral in 2019 to reduce potential impacts to Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo foraging and breeding habitat. As discussed in section 2.6, changes to the design have included a range of refinements to minimise the impacts to the environment such as reducing median widths and changing the design of interchanges to reduce clearing requirements. The resulting Proposal reflects the minimum land area required for the road corridor. Impacts to MNES and other environmental values have been reduced to the maximum extent possible and the remaining impact cannot be avoided if the Proposal is to proceed. A summary of the original impact, and resulting impact post design changes and the net reduction in clearing area of the species is presented in Table 6.7.

Table 6.7: Design changes to avoid Black Cockatoo Habitat

Aspect	Original Proposal as referred	Revised Proposal at Concept Design	Reduction in impact
Carnaby's Cockatoo foraging habitat	22.1 ha	20.93 ha	1.17 ha
Baudin's Cockatoo foraging habitat	22.1 ha	20.6 ha	1.5 ha
Forest Red-tailed Black Cockatoo foraging habitat	23.8 ha	20.6 ha	3.2 ha
Potential breeding trees	351 trees 7 potentially suitable hollows	346 trees 2 potentially suitable hollows	5 trees 5 potentially suitable hollows

6.7.2 Mitigation

Actions to be implemented to manage indirect impacts to retained vegetation that is suitable for Black Cockatoo foraging adjacent to the Proposal Area are detailed in Appendix I. Standard management measures will sufficiently manage any indirect impacts through the spread of weeds or dieback, damage from construction, and fire. Main Roads intends to further counterbalance the residual impacts of the Proposal through implementation of an environmental offset strategy (Appendix H).

6.8 Preparation of Management Plans

Main Roads will prepare and implement a series of management plans to mitigate the impacts of the Proposed Action, including a Landscape and Revegetation Strategy and Plan, and a Vegetation Mitigation Strategy. A summary of the requirements and actions included within each management is provided in the following sections.

6.8.1 Landscape and Revegetation Strategy and Plan

A Landscape and Revegetation Strategy and Plan will be prepared and implemented to ensure the persistence of natural areas and visual amenity. This will include measures including the sourcing of plants or seeds including propagation measures, required fertilisation and irrigation, topsoil management (including compaction), mulching and soil stabilisation, and weed control. The Plan will also include a schedule of timing for implementation, as well as monitoring and compliance criteria, requirements for landscaping maintenance, as well as progress and compliance reporting.

6.8.2 Vegetation Mitigation Strategy

A Vegetation Mitigation Strategy will be required to manage the potential indirect impacts of the Proposal, including within the interface with Tonkin Highway and around the intersection of Mundijong Road. The Strategy will include measures of weed and access control, the rehabilitation of vegetation along Mundijong Road, and the rehabilitation or acquisition of other suitable sites to mitigate dryland Threatened Ecological Communities. Further, the Strategy will undertake professional seed collection for use in future rehabilitation. For the purpose of community information, educational signage will be included in the Vegetation Mitigation Strategy.

6.9 Justification of Avoidance and Mitigation Measures

Following the avoidance and mitigation measures presented in Section 7.1, the Proposed Action will result in the direct impacts detailed in Section 6. These direct impacts will be reduced where practicable through detailed design and construction planning, however, cannot be further reduced at the current stage.

Further reduction and avoidance of impacts is limited by the requirement for the Proposed Action to meet current road safety standards. Required lane widths, vertical and horizontal road geometry, the gradient 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 maximum impact area of the Proposed Action and has been minimised as far as practicable.

The direct impacts presented in Section 6 are required to provide the required functionality of the proposed Action in fulfilling the social and economic objectives presented in Section 9, and with consideration to stakeholder objectives and concerns as outlined in Section 9.2. The Proposed Action is consistent with strategic transport planning for the Perth metropolitan region and reflects the MRS corridors for Tonkin Highway. Main Roads has undertaken detailed design assessments to reduce the quantum of impact wherever possible. Further avoidance or reduction of impacts is not considered practicable or achievable given the current planning and design for the Proposed Action.

6.10 Rehabilitation Procedures

Revegetation for the Proposed Action area will comply with MRWA Vegetation Placement within the Road Reserve Doc. No. 6707/022 (MRWA, 2013). 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 within three years after the rehabilitation works are completed. Revegetation would not include species of foraging habitat for black cockatoos, including but not limited to, *Banksia* spp., *Hakea* spp., *Grevillea* spp. and *Eucalyptus* spp. within 10 m of the constructed road carriageway (to minimise the risk of vehicle strike).

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.

6.11 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 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. Risk Assessment

A risk assessment was conducted of the potential impacts of the Proposed Action has been completed and is located in the Action Management Plan Appendix I. The results of the risk determined that the highest risks associated with following:

- Clearing outside of the approved clearing boundaries
- Clearing of more than the approved number of potential Black Cockatoo habitat trees with a DBH greater than 500 mm
- Introduction or spread of weed species and pathogens to new areas
- Clearing of Threatened or Priority Flora outside of the approved boundary

8. Environmental Offset Strategy

8.1 Purpose of Environmental Offsets

Under the EPBC Act, offsets are required where a Controlled Action results in significant residual environmental impacts to MNES.

This section identifies the significant residual environmental impacts to MNES expected from the Proposed Action and identifies the strategy for potential offsets to facilitate the assessment and potential approval under the EPBC Act.

8.2 Draft Environmental Offset Strategy

A Draft Environmental Offset Strategy (Appendix H) has been developed for the Proposed Action with reference to the following documents:

- Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy (DSEWPC 2012b);
- Offset Assessments Guide (DSEWPC 2012c);
- Offset Calculator Guidelines (DSEWPC 2012d); and
- Guidance for delivering 'risk of loss' estimates when evaluating biodiversity offset proposals under the EPBC Act (DEE 2017).

Following consideration and application of avoidance, minimisation and mitigation measures, and based on the results of current studies, the following residual environmental impacts outlined in Table 8.1 are considered significant and Main Roads are proposing offsets to counterbalance these impacts.

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

Table 8.1: Proposed Environmental Offsets

Environmental value/MNES	Commonwealth listing	Significant residual environmental impact to be offset	Proposed offsets strategy
Threatened Ecological Communities			
Corymbia calophylla - Xanthorrhoea preissii woodlands and shrublands of the SCP	Endangered	3.94 ha	Direct - Land Acquisition
Corymbia calophylla – Kingia australis woodlands on heavy soils	Endangered	0.13 ha	Direct – Funding of revegetation and management activities in DBCA Managed Land
Threatened Flora Species			
Tetraria australiensis	Vulnerable	165 individuals 3.44 ha suitable habitat	Translocation: Seed collection and propagation Research/management funding
Threatened Fauna Species			
Carnaby's Cockatoo foraging habitat	Endangered	20.93 ha	Direct offset - land acquisition and management (90%) Indirect offset - Funding to Murdoch University for the advanced indirect Black Cockatoo research proposal (10%)
Baudin's Cockatoo foraging habitat	Endangered	20.61 ha	Direct offset - land acquisition and management (90%) Indirect offset - Funding to Murdoch University for the advanced indirect Black Cockatoo research proposal (10%)
Forest Red-tailed Black Cockatoo foraging habitat	Vulnerable	20.61 ha	Direct offset - land acquisition and management (90%) Indirect offset - Funding to Murdoch University for the advanced indirect Black Cockatoo research proposal (10%)
Black Cockatoo potential breeding trees	N/A	346 potential breeding trees Two trees with suitable hollow	Direct Offset - Installation of 9 artificial hollows

9. Economic and Social Aspects

9.1 Costs and Benefits

The Proposed Action has an estimated capital cost of $505 million, of which $404 million has been committed by the Australian Government. This cost has been estimated based on engineering design and current industry rates provided by the construction industry.

The construction of 14 km of four lane dual carriage way, along with upgraded intersections and bridges over the existing freight rail line and Perth to Bunbury rail line, will improve road safety and reduce congestion along Tonkin Highway.

The south-east corridor is a fast-growing urban area, with population expected to increase by at least 35 per cent by 2031. The increase in population will lead to significant pressure on the current road network, with estimated volumes exceeding the recommended capacity of the network. The Proposed Action will alleviate this pressure while improving fright efficiency, connectivity and travel time, for the south-east corridor.

9.1.1 Costs

The government has committed $505 million of funding toward construction of the Tonkin Highway Extension. This includes costs for property acquisition Environmental Management and the environmental offset package. In addition to this, the project will incur ongoing maintenance costs for the life of the road network.

9.1.2 Benefits

The Tonkin Highway Extension aims to decrease congestion, reduce travel times for freight vehicles and improve safety outcomes on the existing road network.

Once complete this Proposed Action will:

- Reduce congestion for all road users on South Western Highway
- Reduce the % of heavy vehicle traffic volumes on South Western Highway;
- Improve safety and journey times in Perth's eastern suburbs;
- Enhance freight efficiency by allowing more efficient, reliable movement; and
- Improve safety for pedestrians and cyclists.

9.2 Stakeholder Consultation

Communication and stakeholder liaison extend back several years. In 2002, preliminary planning and engagement work was undertaken as part of the development, design and construction of the section of Tonkin Highway from Mills Road West in Martin to Thomas Road in Oakford. At this time, the extension south of Thomas Road was included as part of the state environmental approval for the Mills Road West to Thomas Road works.

Further planning and engagement work for the extension from Thomas Road in Oakford was undertaken in 2012/2013, when a Stakeholder Working Group (SWG) was formed (August 2012) to assist government's understanding of local community priorities in an aim to address the anticipated rapid growth of Perth's south-east metropolitan area over the proceeding 20 years.

The SWG considered a range of options for the future highway extension and determined a preferred solution to address the traffic issues in the area, particularly those raised by the Byford

community. The Working Group finalised its work with the production of a Strategic Business Case in 2013.

Stakeholder consultation remains a key component of the development of the Proposed Action. To-date consultation undertaken has largely been with government agencies. A wider community consultation program was undertaken in July / August 2020. The overarching objectives of the engagement program are:

- Generate awareness of and support for the Proposed Action, including its core objectives;
- Understand stakeholder and community aspirations, opportunities, issues and concerns associated with the Proposed Action;
- Obtain community buy-in to the development, design and construction methodology, ensuring where possible that the Proposed Action reflects the wishes of the community;
- Inform stakeholders about the impacts to the environmental values and describe how stakeholder feedback was used in the Proposed Action design; and
- Build strong, ongoing relationships with the local community, improving levels of trust and confidence in Main Roads and our vision for the road network.

9.2.1 Key Stakeholders

Stakeholder profiling as part of the planning process has identified key environmental and indigenous stakeholders to-date in Table 9.1 below. To note, Main Roads has additionally undertaken further consultation with non-environmental / non-indigenous stakeholders (not listed below).

Table 9.1: Key Environment and Heritage Stakeholders

Stakeholder	Consultation undertaken or planned
Department of Agriculture, Water and the Environment (DAWE) (C'th)	Regular meetings
Department of Biodiversity, Conservation and Attractions (DBCA)	Meetings
Department of Planning, Lands and Heritage	Regular meetings Co-attendance at community meeting with Shire of Serpentine Jarrahdale (December 2019).
Environmental Protection Authority	Meeting in 2019
Serpentine Jarrahdale Land Conservation Committee (SJLCDC)	Briefing to be held in late 2020 Stakeholder workshop – sustainability and environmental plans – early 2021
SJ Landcare	Briefing to be scheduled in 2020/21 Stakeholder workshop – sustainability and environmental plans –2021
Urban Bushland Council / Wildflower Society of WA	Briefing – held in December 2019 Stakeholder workshop – sustainability and environmental plans –2021
South West Land and Sea Council (SWALSC)	Ongoing consultation from May 2020 under the Noongar Standard Heritage Agreement to identify Aboriginal Consultants for Aboriginal heritage surveys. Group identification - Aboriginal heritage surveys – 2019, 2020 (delayed due to COVID-19)

9.2.2 Stakeholder Engagement Process

An engagement strategy has been designed to facilitate input from the community and stakeholders in relation to the Proposed Action, as well as the environmental plans / strategies pertaining to the

construction, forming one part of an overall engagement strategy, which is adaptive to the needs of the community.

9.2.3 Communication and Stakeholder Engagement Methodology

Stakeholder and community engagement for the Proposed Action is being undertaken in stages:

- Development – to identify issues and constraints, develop a shared understanding of constraints and develop solutions and scope;
- Pre-construction – continue to build on work undertaken in development; and
- Construction – inform the community about construction requirements and build understanding of the implications on them.

This reflects the development work and the Design and Construct contract requirements.

9.2.4 Indigenous Stakeholders

Main Roads undertook consultation with representatives of Gnaala Karla Booja (GKB) WC1998/085 Native Title Claim (NTC) group on 7 and 8 November 2019, as part of an ethnographic survey under the Aboriginal Heritage Act 1972 (AH Act). the NTC group representatives were nominated by the South West Aboriginal Land and Sea Council, in response to an Activity Notice submitted by Main Roads under their Noongar Standard Heritage Agreement with the Gnaala Karla Booja people.

Economic Benefits

A Cost-Benefit Analysis (CBA) was undertaken for the Proposed Action to support a Business Case submission to Infrastructure Australia. Benefits have been calculated with a Proposed Action life of 30 years excluding construction and a 7% annual base discount rate. Benefits quantified include:

- Travel Time Cost Savings (all vehicles) of $546 million;
- Vehicle Operating Cost Savings of $160 million; and
- Crash Cost Savings of $149 million.

Economic Costs

The project is estimated to cost $505 million for the design and construction of the proposal. The maintenance of the life of the project is will be an additional cost.

Social Impacts

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

- Improve operational performance by alleviating capacity pressures on the existing road network (improved road access and reduction in travel times for public transport, private and freight traffic);
- Public transport will be improved through the optimisation of the network and implementation of improved bus stops on South Western Highway from spare capacity freed up by the Tonkin Highway extension;
- Improve safety performance by transferring traffic from local distributor roads to a safer highway environment (reduction in heavy vehicle traffic through the Byford town site, and emerging activity centre of Mundijong – Whitby);
- Reduce impacts on residential amenity from traffic, particularly truck movements, by providing an alternative route around Byford and the developing residential areas to the south;

- Improve operational efficiency and social amenity by providing a viable vehicle transport link (with a key focus on heavy vehicle freight movements) to enhance connectivity, increase capacity and divert traffic from the emerging growth centres in the Shire of Serpentine Jarrahdale including the town sites of Byford and Mundijong;
- Improve accessibility to social amenities such as hospitals, schools, parks and shops;
- Improve economic prosperity and productivity by attracting investment and growth through reduction in urban congestion and improved travel times;
- Increased residential, commercial and business investment potential in the southern sub-region;
- Encourage greater investment and intensification of surrounding developments;
- Create opportunities for the attraction of jobs within the southern sub-region; and
- Cycling facilities adjacent to the highway, with additional arterial connections, will be extended to Bishop Road with provision for further extension in the future.

A desktop assessment of the area identified 5 registered sites and 8 other heritages places intersected by the Tonkin Highway Corridor. Ethnographic and Archaeological surveys were conducted on 7 and 8 November 2019. The NTC group identified one new ethnographic site. The Registered and lodged Aboriginal Sites include:

- Registered Site South-East Corridor 01 (SEC/A1) Site ID 448
- Registered Site South-East Corridor 02 (SEC/A2) Site ID 449
- Registered Site South-East Corridor 03 (SEC/A3) Site ID 450
- Registered Site Tonkin highway - Mundijong Road scatter # 11 (THMR-11) Site ID 18187
- Registered Site Tonkin Highway - Mundijong Road scatter # 12 (THMR-12) Site ID 18188
- Lodged Site Byford Archaeological Survey 006 Site ID 23919
- Lodged Site MJ-03 Site ID 32616
- Lodged Site MJ-06 Site ID 32617
- Lodged Site MJ-07 Site ID 37117
- Lodged Site Medulla Brook Site ID Newly Identified Site

The Proposal will directly impact on part of or the entire sites mentioned above. Main Roads will be required to seek ministerial consent under Section 18 of the Aboriginal Heritage Act to impact these sites.

10. Relevant Policies and Publications

10.1 Policy and guidelines

MNES are listed and protected under the following legislation and guidelines:

- *Environment protection and Biodiversity Conservation Act 1999*
- Environment Protection and Biodiversity Conservation Regulations 2000
- *Significant Impact Guidelines (No. 1.1): Matters of National Environmental Significance* (DEE 2013).

Other legislation and guidance documents relevant to studies conducted for and assessment of the Proposal are listed in Table 10.1.

Table 10.1: Legislation and guidance documents relevant to the Proposal

Reference source	Reliability
Aboriginal Heritage	
Aboriginal Heritage Act 1972	State
Environmental Factor Guideline Social Surroundings (EPA, 2016b)	State
Guidance for the Assessment of Environmental Factors, Assessment of Aboriginal Heritage No. 41 (EPA, 2004a)	State
Fauna	
Environment Protection and Biodiversity Conservation Act 1999	Commonwealth
Environment Protection and Biodiversity Conservation Regulations 2000	Commonwealth
Matters of National Environmental Significance: Significant Impact Guidelines 1.1 (DoE, 2013)	Commonwealth
Biodiversity Conservation Act 2016	State
Environmental Factor Guideline 'Terrestrial Fauna' (EPA, 2016a)	State
Technical Guidance 'Sampling Methods for Terrestrial Vertebrate Fauna' (EPA, 2016b)	State
Technical Guidance 'Terrestrial Fauna Surveys' (EPA, 2016c)	State
Vegetation and flora	
Environment Protection and Biodiversity Conservation Act 1999	Commonwealth
Environment Protection and Biodiversity Conservation Regulations 2000	Commonwealth
Matters of National Environmental Significance: Significant Impact Guidelines 1.1 (DoE 2013)	Commonwealth
Biodiversity Conservation Act 2016	State
Environmental Factor Guideline 'Flora and Vegetation' (EPA, 2016d)	State
Technical Guidance 'Flora and Vegetation Surveys for Environmental Impact Assessment' (EPA, 2016e)	State
Protection of Naturally Vegetated Areas Through Planning and Development, Environmental Protection Bulletin No. 20 (EPA, 2013)	State
Environmental Protection (Clearing of Native Vegetation) Regulations 2004 (Clearing Regulations)	State
Noise	
Environmental Factor Guideline Social Surroundings (EPA, 2016b)	State
State Planning Policy 5.4 (SPP 5.4) Road and Rail Noise (WAPC, 2019a)	State
Road and Rail Noise Guidelines (WAPC, 2019b)	State
Visual Impact Assessment	
Visual Landscape Planning in Western Australia: a manual for evaluation, assessment, siting and design (WAPC, 2007)	State
Guidelines for Landscape and Visual Impact Assessment, 3rd Edition (Landscape Institute and Institute of Environmental Management and Assessment, 2013)	State

10.1 Application of Recovery Plans and Threat Abatement Plans

The Proposed Action is not inconsistent with the relevant Recovery Plans and Conservation Advice relating to the MNES identified as occurring within the Development Envelope, as presented in Table 10.2.

Table 10.2: Assessment against Recovery/Threat Abatement Plans

Recovery / Threat Abatement Plan	Priority Actions	Assessment Against Plan
Clay Pans of the Swan Coastal Plain ecological community National Recovery Plan for the Clay Pans of the Swan Coastal Plain Ecological Community (DBCA & DoEE 2019)	The objective of this Recovery Plan is to maintain or improve the overall condition of the clay pan communities and reduce the level of threat. The Recovery Actions within the plan include: • Liaise with stakeholders to implement recovery • Monitor the extent and boundaries of occurrences, and implement monitoring with an adaptive management framework • Develop and implement fire management strategy, weed control, feral and grazing animal control, disease hygiene procedures • Investigate, monitor, and manage water quality and hydrology • Seek to minimise direct clearing, physical damage and hydrological change • Map habitat critical to survival and identify potential new occurrences • Ensure best practice land management in areas of competing interests • Seek long term protection for conservation • Develop management guidelines, and • Report on recovery plan implementation The plan states that on-ground works should demonstrate that they will not have a significant impact on clay pan communities by avoiding or mitigating: • Land clearing leading to loss of locations defined as 'core areas' of the clay pans • Clearing leading to significant increase in fragmentation of the communities • A significant increase in opportunity for introduction or increase in density of weeds or introduced/feral animals known to damage the communities	The Proposed Action is not inconsistent with the Recovery Plan, with this conclusion based on the following: • The Proposed Action has been designed to entirely avoid any direct clearing of the TEC and will therefore not reduce the extent of the TEC nor increase patch fragmentation. • The Proposed Action will not lead to an increased risk of damage from the spread of invasive weeds or dieback, increased risk of fire, or hydrological change through appropriate measures being implemented through the Action Management Plan (Appendix I). • The Proposed Action will not significantly alter hydrology, with groundwater abstraction to be temporary and to a maximum of 0.5 m below ground level to minimise potential impacts on the TEC.

Recovery / Threat Abatement Plan	Priority Actions	Assessment Against Plan
	• Proposals that will result in a significant increase in fire frequency • Proposals that will modify the hydrological regime of clay pans.	
***Corymbia calophylla – Kingia australis* woodlands on heavy soils of the Swan Coastal Plain ecological community** *Corymbia calophylla – Kingia australis* woodlands on heavy soil (Swan Coastal Plain Community type 3a – Gibson et al. 1994) Interim Recovery Plan (DBCA 2000a)	The objective of this interim Recovery Plan is to maintain or improve the overall condition of this plant community in the known locations and reduce the level of threat, with the aim of reclassifying it from Critically Endangered to Endangered. The recovery actions within the plan include: • Establish a recovery team to liaise with landholders/management t bodies/managers to disseminate information • Clarify and monitor boundaries of the TEC including the installation of markers and fencing where appropriate • Develop and implement a fire management strategy including fire management plans • Implement weed control (including monitoring of weed populations) and dieback hygiene management • Assess hydrological data • Increase the amount of the TEC reserved for conservation The interim recovery plan states the criteria for failure as being a significant loss of area or further modification of occurrences of the threatened ecological community.	The Proposed Action is not inconsistent with the Interim Recovery Plan based on the following: • Biological surveys undertaken in the area of the Proposed Action have resulted in clarification of the TEC patch boundaries, following consideration of DBCA mapping (Woodman 2020). • Re-design of the construction footprint and refinement of the Development Envelope has resulted in a substantial reduction in direct clearing of the TEC to maintain the maximum area possible and provision of an offset. • The Proposed Action will incorporate management measures to reduce the potential indirect impacts of fire, weeds, dieback, and hydrological changes through the preparation and implementation of an Action Management Plan (Appendix I). • The Proposed Action will not significantly alter hydrology in the area, and by avoiding groundwater abstraction beyond 0.5 m below ground level, the risk of damage to the TEC through altered hydrology will be minimised consistent with the Conservation Advice (DoEE 2017a).
***Corymbia calophylla – Xanthorrhoea preissii* woodlands and shrublands of the Swan Coastal Plain** Corymbia calophylla – Xanthorrhoea preissii woodlands and shrublands (Swan Coastal Plain Community type 3c – Gibson et al. 1994) Interim Recovery Plan (DBCA 2000b)	The objective of this interim Recovery Plan is to maintain or improve the overall condition of the plant community in the known locations and reduce the severity of threat, with the aim of reclassifying it from Critically Endangered to Endangered. The recovery actions within the plan include: • Establish a recovery team to liaise with landholders/management t bodies/managers to disseminate information • Clarify and monitor boundaries of the TEC including the installation of markers and fencing where appropriate • Develop and implement a fire management strategy including fire management plans	The Proposed Action is not inconsistent with the Interim Recovery Plan based on the following: • Biological surveys undertaken in the area of the Proposed Action have resulted in clarification of the TEC patch boundaries, following consideration of DBCA mapping (Woodman 2020). • Redesign of the construction footprint and refinement of the Development Envelope has resulted in a substantial reduction in direct clearing of the TEC to maintain the maximum area possible and provision of an offset. • The Proposed Action will incorporate management measures to reduce the potential indirect impacts of fire, weeds, dieback, and hydrological changes through the

Recovery / Threat Abatement Plan	Priority Actions	Assessment Against Plan
	• Implement weed control (including monitoring of weed populations) and dieback hygiene management • Assess hydrological data • Increase the amount of the TEC reserved for conservation The interim recovery plan states the criteria for failure as the significant loss of an area of further modification of occurrences of the threatened ecological community.	preparation and implementation of an Action Management Plan (Appendix I). • The Proposed Action will not significantly alter hydrology in the area, and by avoiding groundwater abstraction beyond 0.5 m below ground level, the risk of damage to the TEC through altered hydrology will be minimised consistent with the Conservation Advice (DoEE 2017b).
***Synaphea* sp. Serpentine** Serpentine Synaphea (*Synaphea* sp. Serpentine (G.R. Brand 103)) Interim Recovery Plan (DPaW 2017)	The objective of this plan is to abate the identified threats and maintain or enhance *in situ* populations to ensure the long-term conservation of the species in the wild. The plan identifies the following actions as potentially having a significant impact on the species: • Damage or destruction of occupied or potential habitat • Alteration of the local surface hydrology or drainage • Reduction in population size • A major increase in disturbance in the vicinity of a population. The recovery actions within the plan include: • Coordinate recovery actions • Monitor populations • Undertake weed control • Collect and store seed • Undertake surveys • Develop and implement a fire management strategy • Undertake regeneration trials • Identify and control insects • Determine susceptibility to *Phytophthora cinnamomi* • Maintain hygiene • Ensure long-term protection of habitat • Develop and implement translocations • Implement rabbit control • Liaise with land managers and Aboriginal communities • Obtain biological and ecological information • Map habitat critical to the survival of *Synaphea* sp. Serpentine (G.R.Brand 103)	The Proposed Action is not inconsistent with the Interim Recovery Plan, with this conclusion based on the following: • Targeted surveys undertaken in the area of the Proposed Action area and surrounds (Woodman 2020). • The design of the construction footprint and Development Envelope for the Proposed Action is such that the direct impact to *Synaphea* sp. Serpentine has been minimised as far as practicable. • The Proposed Action incorporates design and management measures to protect individuals adjacent to the area to be impacted by the Proposed Action as well as suitable habitat (Appendix I). • Inclusion of fire management and hygiene measures to limit potential indirect damage to the species through increased incidence of fire or the spread of weeds and dieback.

Recovery / Threat Abatement Plan	Priority Actions	Assessment Against Plan
	• Review this plan and assess the need for further recovery actions. Recovery will be unsuccessful is: • Populations have been lost which result in a reduction in the extent of occurrence; or • The number of mature plants has decreased by >10% from 1331 to 1198 or less; or • The area of occupancy has decreased by >10%, with a net loss of mature plants.	
Tetraria australiensis Approved Conservation Advice for *Tetraria australiensis* (Southern Tetraria)	There is no Recovery Plan available for *Tetraria australiensis*. The Conservation Advice lists the following as regional priority actions: • Monitor known populations to identify key threats, monitor recovery progress, and manage threats • Investigate formal conservation arrangements • Ensure road widening and maintenance activities in areas where the species occurs do not adversely impact on known populations • Ensure weed management (chemical) do not have a significant impact on the species • Develop and implement suitable fire management strategy for the species and provide maps of known occurrences to fire service personnel • Develop and implement a management plan for the control of weeds • Develop and implement suitable hygiene protocols to protect known sites from *Phytophthora* dieback • Raise awareness of the species within the local community • Investigate options for linking, enhancing or establishing additional populations • Undertake appropriate seed collection and storage for future planting • Implement appropriate translocation protocols if establishing additional populations is considered necessary and feasible	The Proposed Action is not inconsistent with the Conservation Advice for the species, with this conclusion based on: • Targeted surveys undertaken in the area of the Proposed Action area (Woodman 2020) and regional surveys to further define the population and habitat preferences of the species. Regional surveys have resulted in the estimated total population of *Tetraria australiensis* increasing from 17,00 to 21,500 individuals. Woodman (2020) surveys in the area of the Proposed Action improved the estimated population size of TPFL Population 10 from 1,054 to 1,214 individuals. • Redesign of the construction footprint and Development Envelope for the Proposed Action such that the direct impact to *Tetraria australiensis* has been minimised as far as practicable, in addition to the provision of an offset to counterbalance unavoidable significant residual impacts to the species. • Preparation of a fire management plan specific to the species (Appendix J) • Implementation of hygiene controls and management measures to limit the risk of damage to the retained population from the introduction or spread of weeds and dieback, and altered hydrology (Appendix I) • Implementation of an Environmental Offset Strategy involving translocation of individuals outside of the Proposed Action, and establishment of an additional population. The proposed Offset Strategy will increase

Recovery / Threat Abatement Plan	Priority Actions	Assessment Against Plan
		the area of *Tetraria australiensis* n the conservation estate resulting in a net ecological benefit.
Carnaby's Cockatoo Carnaby's Cockatoo (*Calyptorhynchus latirostris*) Recovery Plan (DPaW 2013)	The objective of this Recovery Plan is to halt further decline in the distribution and abundance of Carnaby's Cockatoo by protecting the species at each life stage and by enhancing habitat that is critical for survival throughout their breeding and non-breeding range, ensuring that the reproductive capacity of the species remains stable or increases. The recovery actions within the plan include: • Protect and manage breeding and associated feeding habitat • Protect and manage non-breeding habitat • Undertake regular monitoring • Conduct research to inform management • Manage other impacts • Engage the broader community • Undertake information and communication activities. The Recovery Plan specifies activities that will adversely affect Carnaby's Cockatoo should be avoided, and then minimised or mitigated where avoidance is not possible.	The Proposed Action is not inconsistent with the recommendations of the Recovery Plan, with this conclusion based on the following: • The Proposed Action has been subject to multiple targeted Carnaby's Cockatoo assessments, and DBCA habitat mapping has been considered. • The Proposed Action will not require the clearing of any known breeding trees or hollows. It will require the removal of two trees with potentially suitable hollows. To mitigate this, Main Roads proposes to install nine artificial hollows in replacement of the two natural hollows to be removed. • The Proposed Action will not remove any known roosting habitat. • The Proposed Action has been planned and designed to minimise the 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 within adjacent vegetation (Appendix I). • Planning and design of the Proposed Action has implemented the results of consultation with relevant stakeholders including the broader community • The proposed Offset Strategy will increase the foraging and breeding habitat in the conservation estate resulting in a net ecological benefit.
Baudin's Cockatoo and Forest Red-tailed Black Cockatoo Forest Black Cockatoo (Baudin's Cockatoo *Calyptorhynchus baudini*i and Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso*) Recovery Plan	The objective of this Recovery Plan is to prevent further decline in the breeding populations of Baudin's Cockatoo and Forest Red-tailed Black Cockatoo and to ensure their persistence throughout their current range in the south-west of Western Australia. Priority actions listed within the plan (from highest to lowest priority): • Seek the funding required to implement future recovery actions	The Proposed Action is not inconsistent with the recommendations of the Recovery Plan, with this conclusion based on the following: • The Proposed Action is not related to mining, orchards or forest management, nor is it expected to increase the prevalence of feral honeybees or the risk of illegal shooting. • As a component of urban development, the Proposed Action has been subject to surveys to identify Forest Red-tailed Black Cockatoo and Baudin's Cockatoo habitat (including the consideration of Black Cockatoo habitat

Recovery / Threat Abatement Plan	Priority Actions	Assessment Against Plan
	• 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 of important populations, and prepare management guidelines for these habitats • Monitor population numbers and distribution • Determine the patterns and significance of movement. • Maintain the Cockatoo Care program and other opportunities to promote the recovery of Forest Black Cockatoos With respect to urban development, the following recovery actions are specified: • Fauna survey to identify presence of Commonwealth listed threatened fauna species and referral of any proposed impacts to DoE • Wherever possible, retention of habitats known to be used for feeding, breeding and roosting by Forest Red-tailed Black Cockatoo Obtain advice from State Government and Western Australian Museum on protection of remaining habitat	mapped from DBCA and breeding records from the Western Australian museum) • The Proposed Action will not involve clearing of any known roosting trees. • The Development Envelope has been planned and designed to minimise clearing of Forest Red-tailed Black Cockatoo and Baudin's foraging and potential breeding habitat. • The proposed Offset Strategy will increase the foraging and breeding habitat in the conservation estate resulting in a net ecological benefit.
Dieback Threat Abatement Plan for Disease in Natural Ecosystems Caused by *Phytophthora cinnamomi* (DoEE 2015)	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.	The Proposed Action is not inconsistent with the goal or objectives of the Threat Abatement Plan. A Dieback assessment was undertaken for the Proposed Action, And the

Recovery / Threat Abatement Plan	Priority Actions	Assessment Against Plan
Relevant MNES: Clay Pans TEC *Corymbia-Kingia* TEC *Corymbia-Xanthorrhoea* TEC *Tetraria australiensis* Carnaby's Cockatoo Baudin's Cockatoo Forest Red-tailed Black Cockatoo	The plan has the three objectives: • Identify and prioritise for protection of 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.	entire Development Envelope is either excluded or unprotectable. The Proposed Action will incorporate Dieback hygiene during construction to protect adjacent vegetation that contains Threatened Flora and TECs to ensure that dieback does not spread further as a result of implementation of the project.
Introduced species (Cats) Threat Abatement Plan for Predation by Feral Cats (DotEE 2015)	This Threat Abatement Plan has the following objectives: • 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.	The Threat Abatement Plan is not directly relevant to this Proposed Action; however, the Proposed Action is not inconsistent with this plan. The Proposed Action will not increase the prevalence of feral cats in the area, as it will not increase food sources that may attract cats. The Development Envelope is not considered to be existing breeding habitat for Black Cockatoos, therefore predation of chicks from nesting is unlikely to occur.
Introduced species (Fox) Threat Abatement Plan for Predation by the European Red Fox (DEWHA 2008b)	This Threat Abatement Plan has the following objectives: • 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.	The Threat Abatement Plan is not directly relevant to the Proposed Action, however the Proposed Action is not inconsistent with the plan. The Proposed Action will not increase the prevalence of the Red Fox in the area, as it will not increase food sources that may attract the Red Fox. The Development Envelope is not considered to be existing breeding habitat for Black Cockatoos, therefore predation of chicks from nesting hollows is unlikely to occur.

11. Information Sources

11.1 Survey Limitations

The biological field surveys for ecological communities, flora species and fauna species/habitats were undertaken by suitably qualified and experienced personnel, within appropriate seasonal times, site access and resources. These biological surveys were guided by the instructions contained within relevant Commonwealth and State guidelines for the relevant listed communities and species expected to occur within the area of the Proposed Action.

There are nil constraints which are considered to have affected the accuracy or reliability of the biological survey outcomes that would affect the assessment of the Proposed Action contained within this Report.

A list of information sources used in the development of the Preliminary Document are supplied in Table 11.1.

Table 11.1: Scientific Literature and Information Sources

Reference source	Reliability	Uncertainties
Abbott, I. 1981, The avifauna of the Porongurup range, an isolated habitat in south-western Australia. Emu 81, 91-96	Reliable	Nil
Atlas of Living Australia (ALA) 2020, The Australasian Virtual Herbarium. Council of Heads of Australasian Herbaria, [Online], Available from: http://avh.chah.org.au, [January 2020]..	Reliable	Nil
ANZECC/ARMCANZ, 2000, *National Water Quality Management Strategy, Paper No. 4; Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Chapter 4.*	Reliable	Nil
Bamford Consulting Ecologists 2018, *Scoring system for the assessment of foraging value of vegetation for black cockatoos.*	Reliable	Nil
Bamford Consulting Ecologists 2019, Fauna Assessment Proposed Extension of Tonkin Highway, unpublished report prepared for Strategen Environmental, Bamford.	Reliable	Nil
Beard JS. 1990, *Plant Life of Western Australia.* Kangaroo Press, Kenthurst, New South Wales.	Reliable	Nil
Birdlife Australia 2018, The 2018 Great Cocky Count: a community based survey for Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*), Baudin's Black-Cockatoo (*Calyptorhynchus baudinii*) and Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*), Department of Biodiversity, Conservation and Attractions	Reliable	Nil
Davies, S.J. J. F. 1966, *The movements of the white-tailed black cockatoo (Calyptorhynchus baudinii) in south-western Australia. Western Australian Naturalist* **10,** 33-42.	Reliable	Nil
Department of Agriculture, Water and the Environment 2000a, *Corymbia calophylla - Kingia australis woodlands on heavy soils of the Swan Coastal Plain*. Listing Advice prepared the Environment Protection and Biodiversity Conservation Act 1999 (C'th) by the Endangered Species Scientific Sub-Committee of the Department of Agriculture, Water and the Environment (formerly as Environment Australia). July 2000.	Reliable	Nil
Department of Agriculture, Water and the Environment 2000b, *Corymbia calophylla - Xanthorrhoea preissii woodlands and shrublands of the Swan Coastal Plain*. Listing Advice under the Environment Protection and Biodiversity Conservation Act 1999 (C'th) by the Endangered Species Scientific Sub-Committee of the Department of Agriculture, Water and the Environment (formerly as Environment Australia). July 2000.	Reliable	Nil
Department of Agriculture, Water and the Environment 2012a, *Clay Pans of the Swan Coastal Plain: Advice to the Minister for Sustainability, Environment, Water, Population and Communities from the Threatened Species Scientific Committee (the Committee) on an Amendment to the list of Threatened Ecological Communities under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).* Listing Advice for the Clay Pans of the Swan Coastal Plain prepared by the Threatened Species Scientific Committee of the Department of Agriculture, Water	Reliable	Nil

Reference source	Reliability	Uncertainties
and the Environment (formerly as the Department of Sustainability, Environment, Water, Population and Communities). March 2012.		
Department of Agriculture, Water and the Environment 2012b, *Approved Conservation Advice for Clay Pans of the Swan Coastal Plain.* Conservation Advice prepared under s266B of the Environment Protection and Biodiversity Conservation Act 1999 (C'th) by the Threatened Species Scientific Committee of the Department of Agriculture, Water and the Environment (formerly as the Department of Sustainability, Environment, Water, Population and Communities). March 2012.	Reliable	Nil
Department of Agriculture, Water and the Environment 2012c, Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy. Prepared by the Department of Agriculture, Water and the Environment (formerly as the Department of Sustainability, Environment, Water, Population and Communities). October 2012.	Reliable	Nil
Department of Agriculture, Water and the Environment 2012d, Environment Protection and Biodiversity Conservation Act 1999 How to use the Offsets assessment guide. Prepared by the Department of Agriculture, Water and the Environment (formerly as the Department of Sustainability, Environment, Water, Population and Communities). October 2012.	Reliable	Nil
Department of Agriculture, Water and the Environment 2013, *Matters of National Environmental Significance: Significant Impact Guidelines 1.1*. Guideline report prepared by the Department of Agriculture, Water and the Environment (formerly as the Department of the Environment). October 2013.	Reliable	Nil
Department of Agriculture, Water and the Environment 2017a, *Approved Conservation Advice for Corymbia calophylla - Kingia australis woodlands on heavy soils of the Swan Coastal Plain*. Conservation Advice prepared under s266B of the Environment Protection and Biodiversity Conservation Act 1999 (C'th) by the Threatened Species Scientific Committee of the Department of Agriculture, Water and the Environment (formerly as the Department of the Environment and Energy). July 2017.	Reliable	Nil
Department of Agriculture, Water and the Environment 2017b, *Approved Conservation Advice for Corymbia calophylla - Xanthorrhoea preissii woodlands and shrublands of the Swan Coastal Plain*. Conservation Advice prepared under s266B of the Environment Protection and Biodiversity Conservation Act 1999 (C'th) by the Threatened Species Scientific Committee of the Department of Agriculture, Water and the Environment (formerly as the Department of the Environment and Energy). July 2017.	Reliable	Nil
Department of Agriculture, Water and the Environment 2020a, *Tonkin Highway Extension, Thomas Road to South Western Highway, WA, 2019/8608: Notification of Referral Decision and Designated Proponent – Controlled Action Decision on Assessment Approach*. Decision on assessment under s75 and s87 of the *Environment Protection and Biodiversity Conservation Act 1999* (C'th) by the Department of Agriculture, Water and the Environment to Main Roads Western Australia. April 2020.	Reliable	Nil
Department of Agriculture, Water and the Environment 2020b, *Tonkin Highway Extension, Thomas Road to South Western Highway, WA, 2019/8608: Additional Information Required for Preliminary Documentation. Request for additional assessment information* by the Department of Agriculture, Water and the Environment to Main Roads Western Australia. Reference EPBC 2019/8608. April 2020.	Reliable	Nil
Department of Agriculture, Water and the Environment 2020c, *Threatened Ecological* Communities. Department of Agriculture, Water and the Environment website. Accessed August 2020 at https://www.environment.gov.au/biodiversity/threatened/communities.	Reliable	Nil
Department of Agriculture, Water and the Environment (DAWE) 2020d, Interrogation of Species Profile and Threats (SPRAT) Database using Protected Matters Search Tool. Queried 13/1/20, report reference YTB32G, Available from: https://www.environment.gov.au/epbc/protected-matters-search-tool.	Reliable	Nil
Department of Biodiversity, Conservation and Attractions 2000a, Corymbia calophylla - Kingia australis woodlands on heavy soil (Swan Coastal Plain Community type 3a - Gibson et al. 1994) Interim Recovery Plan 2000-2003. Prepared by the Department of Biodiversity, Conservation and Attractions	Reliable	Nil

Reference source	Reliability	Uncertainties
(formerly as the Department of Conservation and Land Management). January 2000.		
Department of Biodiversity, Conservation and Attractions 2000b, Corymbia calophylla -Xanthorrhoea preissii woodlands and shrublands (Swan Coastal Plain Community type 3c - Gibson et al. 1994) Interim Recovery Plan 2000-2003. Prepared by the Department of Biodiversity, Conservation and Attractions (formerly as the Department of Conservation and Land Management). January 2000.	Reliable	Nil
Department of Biodiversity, Conservation and Attractions (DBCA) 2018, Threatened and Priority Flora List – December 2018, [Online], Government of Western Australia, Available from: https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants.	Reliable	Nil
Department of Biodiversity, Conservation and Attractions 2019a, Threatened and Priority Communities database search. Spatial data supplied by the Department of Biodiversity, Conservation and Attractions to Main Roads.	Reliable	Nil
Department of Biodiversity, Conservation and Attractions (DBCA) 2019b, Interrogation of the DBCA Western Australian Herbarium specimen database, Threatened and Priority Flora database and Threatened and Priority Flora List, search performed and data supplied by Main Roads.	Reliable	Nil
Department of Biodiversity, Conservation and Attractions & Department of Agriculture, Water and the Environment 2019c, *National Recovery Plan for the Clay Pans of the Swan Coastal Plain Ecological Community*. Prepared by the Department of Biodiversity, Conservation and Attractions and the Department of Agriculture, Water and the Environment (formerly as the Department of the Environment and Energy). February 2019.	Reliable	Nil
Department of Biodiversity, Conservation and Attractions 2020, *DBCA - Legislated Lands and Waters (DBCA-011)*. Spatial data set of lands and waters managed by the Department of Biodiversity, Conservation and Attractions. Accessed from data.wa.gov.au. September 2020.	Reliable	Nil
Department of Environment and Conservation (DEC) 2008, *Forest Black Cockatoo (Baudin's Cockatoo Calyptorhynchus baudinii and Forest Red-tailed Black Cockatoo Calyptorhynchus banksii naso) Recovery Plan.*	Reliable	Nil
Department of the Environment and Energy 2017a, Approved Conservation Advice for *Corymbia calophylla – Xanthorrhoea preissii* woodlands and shrublands of the Swan Coastal Plain. Canberra: Department of the Environment and Energy. Available from: http://www.environment.gov.au/biodiversity/threatened/communities/pubs/18-conservation-advice.pdf.	Reliable	Nil
Department of the Environment and Energy 2018, Threat abatement plan for disease in natural ecosystems caused by Phytophthora cinnamomi. Canberrs: Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/threat-abatement-plan-disease-natural-ecosystems-caused-phytophthora-cinnamomi-2018.	Reliable	Nil
Department of the Environment, Water, Heritage and the Arts 2008, Approved Conservation Advice for Tetraria australiensis (Southern Tetraria). Canberra: Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/10137-conservation-advice.pdf.	Reliable	Nil
Department of the Environment, Water, Heritage and the Arts 2009, Approved Conservation Advice for Calyptorhynchus banksii naso (Forest Red-tailed Black Cockatoo). Canberra: Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/67034-conservation-advice.pdf.	Reliable	Nil
Department of Parks and Wildlife 2016, *Synaphea* sp. Pinjarra Plain (A.S. George 17182) Interim Recovery Plan 2016–2021. Interim Recovery Plan No. 363. Department of Parks and Wildlife, Western Australia.	Reliable	Nil

Reference source	Reliability	Uncertainties
Department of Parks and Wildlife 2017, Serpentine *Synaphea* (*Synaphea* sp. Serpentine (G.R. Brand 103)) Interim Recovery Plan 2017–2022. Interim Recovery Plan No. 380. Department of Parks and Wildlife, Western Australia.	Reliable	Nil
Department of Parks and Wildlife (DPaW) 2013, *Carnaby's Cockatoo (Calyptorhynchus latirostris) Recovery Plan.* Australian Government, Canberra.	Reliable	Nil
Department of Primary Industries and Regional Development (DPIRD) 2017, *Current extent of native vegetation (remnant vegetation).* Online map layer, available via: https://walga.asn.au/Subscription-Services/Environmental-Planning-Tool.aspx.	Reliable	Nil
Department of Primary Industries and Regional Development (DPIRD) 2019, *Native vegetation extent – Western Australia* dataset layer, Available via: WALGA Environmental Planning Tool.	Reliable	Nil
Department of Primary Industries and Regional Development 2020, *Native Vegetation Extent (DPIRD-005)*. Data of native vegetation extent mapping polygons in Western Australia. Accessed from https://catalogue.data.wa.gov.au/dataset/native-vegetation-extent. May 2020.	Reliable	Nil
Department of Sustainability, Environment, Water, Population and Communities 2012, EPBC Act referral guidelines for three threatened black cockatoo species. Australian Government, Canberra.	Reliable	Nil
Eco Logical 2019, Mundijong Road Spring Flora Survey. Unpublished report prepared for Main Roads WA.	Reliable	Nil
Environmental Protection Authority 2002, Tonkin Highway Extension from Mills Road West Gosnells to South Western Highway Mundijong. Report and recommendations of the Environmental Protection Authority. Report 1043	Reliable	Nil
Environmental Protection Authority 2016, Technical Guidance Flora and Vegetation Surveys for Environmental Impact Assessment. Available at http://www.epa.wa.gov.au/policies-guidance/technical-guidance-flora-and-vegetation-surveys-environmental-impact-assessment. December 2016	Reliable	Nil
Ford, J. 1980, Morphological and ecological divergence and convergence in isolated populations of the Red-tailed Black-Cockatoo. Emu 80, 103-120.	Reliable	Nil
Glevan Consulting 2020, Main Roads Western Australia Tonkin Highway Extension Phytophthora Dieback occurrence assessment version 2.0, unpublished report completed for MRWA.	Reliable	Nil
Government of Western Australia (GoWA) 2019, 2018 South West Vegetation Complex Statistics. Current as of March 2019. WA Department of Biodiversity, Conservation and Attractions, Perth. http://catalogue.data.wa.gov.au/dataset/dbca.	Reliable	Nil
Heddle E.M., Loneragan O.W and Havel J.J. 1980, Vegetation of the Darling Scarp. IN DCE 1980 Atlas of Natural Resources, Darling System, Western Australia. Department of Conservation and Environment, Perth, Western Australia.	Reliable	Nil
Heron, S. J. 1970, The birds of Middle Swan, Western Australia. Emu 70, 155-158.	Reliable	Nil
International Union for Conservation of Nature 2012, IUCN Red List Categories and Criteria. Version 3.1. Second Edition. Gland, Switzerland and Cambridge, UK	Reliable	Nil
International Union for Conservation of Nature 2017, Guidelines for Using the IUCN Red List Categories and Criteria. Version 13. March 2017	Reliable	Nil
Johnstone, R. E. 1997, Current studies on three endemic Western Australian Cockatoos. Eclectus 3, 34-35.	Reliable	Nil
Johnstone, R.E. and Kirkby, T. 2009, Birds of the Wungong Dam Catchment, Bedfordale, Western Australia. West.Aust.Nat. 26 (4): 219-274.	Reliable	Nil
Johnstone RE & Storr GM 1998, Handbook of Western Australian Birds. Volume 1: Nonpasserines (Emu to Dollarbird). Western Australian Museum, Perth.	Reliable	Nil
Kirkby, T. 2019, Black Cockatoo breeding, feeding and roosting habitat assessment, Tonkin Highway extension, unpublished report prepared for Strategen-JBS&G.	Reliable	Nil
Kirkby, T. 2020, Assessment of potential Black Cockatoo *Calyptorhynchus spp)* breeding hollows, Tonkin Highway extension, unpublished report prepared for Strategen-JBS&G.	Reliable	Nil
Main Roads 2001, Tonkin Highway Extension Public Environmental Review. Environmental Impact Assessment report prepared by Main Roads and Western Infrastructure for the Environmental Protection Authority under s40 of the Environmental Protection Act 1986 (WA). August 2001	Reliable	Nil

Reference source	Reliability	Uncertainties
Main Roads 2019a, EPBC Act Referral: 2019/8608 - Tonkin Highway Extension – Thomas Road to South Western Highway. Referral under s68 of the Environment Protection and Biodiversity Conservation Act 1999 (C'th). December 2019	Reliable	Nil
Main Roads 2019b, Environmental Policy. May 2019	Reliable	Nil
Murdoch University (2015) Black Cockatoo Movement Data.	Reliable	
Peck A., Barrett G. and Williams M. 2019, The 2019 Great Cocky Count: a community based survey for Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*), Baudin's Black-Cockatoo (*Calyptorhynchus baudinii*) and Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*), Department of Biodiversity, Conservation and Attractions	Reliable	Nil
Purdie, B R, Tille, P J, and Schoknecht, N R. 2004, *Soil-landscape mapping in south-Western Australia: an overview of methodology and outputs*. Department of Agriculture and Food, Western Australia. Report 280, 160p	Reliable	Nil
Saunders DA 1974, The occurrence of the White-tailed Black Cockatoo, Calyptorhynchus baudinii, in Pinus plantations in Western Australia. Australian Wildlife Research 1, 45-54.	Reliable	Nil
Saunders DA 1979, Distribution and taxonomy of the White-tailed and Yellow-tailed Black Cockatoo Calyptorhynchus spp. Emu 79, 215-227.	Reliable	Nil
Saunders, D.A., Rowley, I. and Smith, G.T. 1985, The impacts of clearing for agriculture on the distribution of cockatoos in the southwest of Western Australia. In: *Birds of Eucalypt Forests and Woodlands: Ecology, Conservation, Management*. (Eds. A. Keast, H.F. Recher, H. Ford and D. Saunders) Pp. 309-321. Surrey Beatty & Sons, Chipping Norton.	Reliable	Nil
Sedgwick, E. H. 1940, Rockingham district. Emu 40, 237-245	Reliable	Nil
Sedgwick, L. E. 1964, Birds of the Stirling Ranges. Emu 64, 7-19	Reliable	Nil
Serventy, D. L. 1937, Migration in the Perth district. Emu 37, 90-94.	Reliable	Nil
Serventy, D. L. 1948, Birds of the Swan River district. Emu 47, 241-286	Reliable	Nil
Strategen-JBS&G 2019, Environmental Impact Assessment Report: Tonkin Highway Extension – Thomas Road to South Western Highway. Report prepared by Puglisi S and Sutherland E of Strategen-JBS&G (JBS&G Australia Pty Ltd) for Main Roads. Revision B. December 2019	Reliable	Nil
Threatened Species Scientific Committee (TSSC) 2018a, Conservation Advice *Synaphea* sp. Serpentine (G.R. Brand 103), [Online], Australian Government, Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/86879-conservation-advice-15022018.pdf, [4 September 2020].	Reliable	Nil
Threatened Species Scientific Committee 2018b, Conservation Advice Synaphea sp. Pinjarra Plain (A.S. George 17182). Canberra: Department of the Environment and Energy. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/86878-conservation-advice-15022018.pdf.	Reliable	Nil
Threatened Species Scientific Committee 2018c, Conservation Advice Calyptorhynchus baudinii Baudin's Cockatoo. Canberra: Department of the Environment and Energy. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/769-conservation-advice-15022018.pdf.	Reliable	Nil
Western Australian Herbarium 1998-, Florabase, [Online], Government of Western Australia, Available from: https://florabase.dpaw.wa.gov.au/, [January 2020].	Reliable	Nil
Western Australian Minister for Environment 2002, Construction and Use of the Tonkin Highway Extension from Mills Road West, Gosnells, to South Western Highway, Mundijong. Statement of approval of the Minister for Environment under s45(5) of the Environmental Protection Act 1986 (WA) granted to Main Roads Western Australia. Statement 595. June 2002.	Reliable	Nil
Western Australian Planning Commission (WAPC) 2017, Guidelines for Planning in Bushfire Prone Areas, Western Australian Planning Commission, Perth.	Reliable	Nil
Woodman Environmental Consulting Pty Ltd 2019, Tonkin Highway Extension (Thomas Road to South Western Highway) Reconnaissance Flora and Vegetation Survey. Report prepared by Woodman G and Firth L of Woodman Environmental Consulting Pty Ltd for Main Roads. Revision 0. December 2019	Reliable	Nil
Woodman Environmental Consulting Pty Ltd 2020, *Tonkin Highway Extension (Thomas Road to South Western Highway) Flora and Vegetation* Assessment.	Reliable	Nil

Reference source	Reliability	Uncertainties
Report prepared by Saligari A, Firth L and Coultas D of Woodman Environmental Consulting Pty Ltd for Main Roads. Revision 0. May 2020		

12. Environmental Approvals, Compliance and Policy

12.1 Environmental Approvals and Compliance

There are no proceedings under a Commonwealth, State or Territory law for the protection of the environment, or the conservation and sustainable use of natural resources against Main Roads or it's executive officers.

12.2 Ministerial Statement Management and Mitigation Requirements

The Proposed Action forms the second portion of the project '*Construction and use of the Tonkin Highway Extension from Mills Road West, Gosnells to South Western Highway, Mundijong*', which was approved under Ministerial Statement 595 in June 2002 under the State *Environmental Protection Act 1986* (WA) following assessment by the State Environmental Protection Authority (EPA). As part of the approval under Ministerial Statement 595, Main Roads is required to prepare and implement a a Landscape and Revegetation Strategy and Plan and a Vegetation Mitigation Strategy, the requirements of which are outlined in Section 7.

12.3 Environmental Record of Main Roads

Main Roads is a State Government agency with an assured record of responsible environmental management and performance. Main Roads has a strong environmental compliance record, with Main Roads remaining in compliance with all conditions of environmental approvals granted under the EPBC Act.

Main Roads' operations are undertaken in accordance with an Environmental Policy (Main Roads 2019b), which outlines Main Roads' overarching objectives for environmental protection, sustainability and continual improvement in environmental performance. This policy is available to be viewed at the following address: https://www.mainroads.wa.gov.au/globalassets/community-environment/environment/environmental-policy.pdf.

The Environmental Policy is implemented through Main Roads' international standard AS/NZS ISO 14001:2015-certified Environmental Management System (EMS). Main Roads' EMS provides a formalised systematic approach to environmental management for all aspects of the operations (road planning, construction and maintenance).

Main Roads' EMS comprises a series of Environmental Management Plans (EMPs) and Principal Environmental Management Requirements (PEMRs) to ensure the potential environmental impacts of its operations are controlled and monitored to an acceptable standard. These EMPs and PEMRs address the management of a range of operational environmental aspects, including the impact to ecological communities.

Compliance with the Main Roads' EMS is regularly audited both internally and by independent third parties in order to ensure compliance and identify any changes which may improve the environmental outcomes. The regular auditing of the EMS is consistent with Main Roads' Environmental Policy to implement and maintain an effective EMS so as to ensure operations are managed in compliance with all environmental requirements.

13. Ecologically Sustainable Development

13.1 Principles of Ecologically Sustainable Development (EPBC Act s3A)

As defined in Section 3A of the EPBC Act, the following provides an assessment of how the Proposed Action meets the principles of ecologically sustainable development:

- *Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations*

A holistic decision-making process has been established for the Proposal with the aim to provide an integrated and transparent approach. A comprehensive decision-making tool was used to assist in making a range of significant decisions, through consideration of the triple bottom line (environment, social, local economic). The tool allows some flexibility in the weightings appointed to each sustainability aspect while maintaining a holistic balance. Where the tool has been used to inform and document significant design decisions, the inputs, selection criteria and outcomes have been documented in design reports. The Proposed Action provides long term economic, social and equity benefits for the metropolitan region. This includes improved road safety, reduced travel time, economic growth and employment generation.

The Proposed Action is consistent with the Regional Road Reserve within the Metropolitan Region Scheme.

The Proposed Action has been planned and designed to reduce impacts to native vegetation and registered Aboriginal sites where possible while meeting community and stakeholder objectives.

- *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*

The Proposed Action has been subject to comprehensive studies to assess the environmental values and potential impacts of the Proposed Action, including a range of biological surveys (Ecological 2019; Woodman 2019, 2020; Kirkby 2020; Strategen-JBS&G 2020) to inform the design and potential impacts of the Proposed Action and to provide improved scientific certainty to the environmental assessment.

Information gathered during these studies was used to inform the environmental impact assessment and has reduced the uncertainty surrounding the prediction of impacts for the assessment.

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.

- *The principle of inter-generational 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*

The Proposed Action will ensure the health, diversity and productivity of the environment is maintained through retaining as much habitat as possible, establishing noise walls to reduce noise related impacts and maintaining access for property owners.

- *The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision making*

Main Roads recognises the significance of biological diversity and includes this in the decision-making process. Main Roads has sought to preserve as much of the remnant biodiversity as possible

by avoiding areas of native vegetation where practical. Main Roads will continue to implement minimisation measures through the detailed design phase.

Main Roads recognises the need for mitigation and management measures and have incorporated this into their overall costs.

- *Improved valuation, pricing and incentive mechanisms should be promoted.*

Main Roads acknowledges the need for improved valuation, pricing and incentive mechanisms and endeavours to pursue these principles when appropriate. For example, environmental factors will greatly determine the location of road corridors, with the project having a strong focus on reducing its direct and indirect clearing footprint.

Impacts on flora, vegetation and terrestrial fauna have been assessed and mitigation and management measures proposed.

Main Roads accepts that the cost of the Proposal must include environmental impact mitigation, management and maintenance activities. These requirements will be incorporated into the overall cost.

This Proposed Action will be subject to obtaining a sustainability rating. This includes consideration of environmental, social and economic impacts of the Proposed Action. The Proposed Action will be required to obtain a rating under the Infrastructure Sustainability Council of Australian (ISCA) rating scheme.

Document Distribution

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E	Electronic	Main Roads Western Australia	15/01/2021
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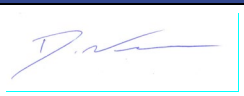
Document Status

Rev No.	Author	Reviewer	Approved for Issue		
		Name	Name	Signature	Date
A	E. Sutherland, R. Chesney, J. Hyatt, S. Hawkins	D. Newsome	D. Newsome		21/10/2020
B	S. Hawkins	D. Newsome	D. Newsome		06/11/2020
C	D. Newsome J. Hyatt, S. Hawkins	D. Newsome	D. Newsome		9/12/2020
D	D. Newsome J. Hyatt, S. Hawkins	D. Newsome	D. Newsome		17/12/2020
E	D. Newsome J. Hyatt S. Hawkins	D Newsome	D. Newsome		15/01/2021
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