

Source & Notes
Black cockatoo and tree mapping from Coffey (2015).
Aerial imagery from Landgate (August 2014).

NorthLinkWA

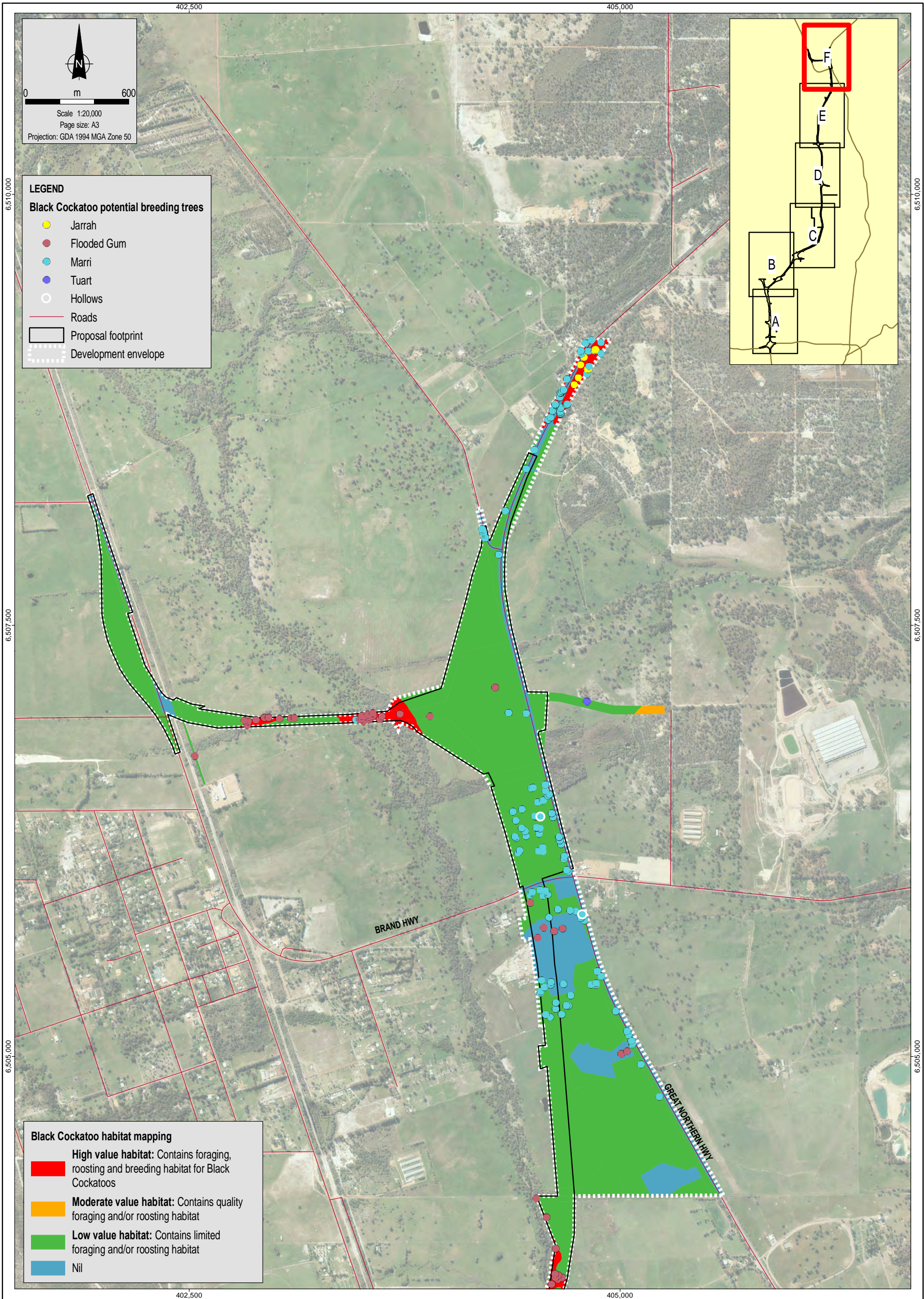
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Main Roads WA
Public Environmental Review
Perth-Darwin National Highway

Black Cockatoo habitat mapping
Map 5 of 6

Figure No:
9.2E





9.2.3.1 Foraging Assessment

The two species of Black Cockatoo from the vicinity of the proposal footprint have different foraging requirements. Carnaby's Cockatoo can be described as a generalist, foraging on a wide range of plant species, including *Eucalyptus* sp., *Corymbia* sp., *Allocasuarina* sp., *Banksia* sp. and other proteaceous trees and shrubs (DSEWPAC, 2012c). Forest Red-tailed Black Cockatoos have a more specific diet consisting of *Eucalypt* sp., *Corymbia* sp. and *Allocasuarina fraseri*. Habitats where these plant species are dominant were classified as providing foraging habitat for each species. Areas of High and Moderate value Black Cockatoo habitat have been classified as quality foraging habitat for Carnaby's Cockatoos, whereas areas of High value Black Cockatoo habitat have been classified as quality foraging habitat for Forest Red-tailed Black Cockatoos. As such, 201.8 ha of quality Carnaby's Cockatoo foraging habitat (classified as providing High and Moderate value Black Cockatoo habitat) and 120.1 ha of quality Forest Red-tailed Black Cockatoo foraging habitat (classified as High value Black Cockatoo habitat) was recorded in the proposal footprint (Figure 9.2).

There were 21 species of foraging resources and eight records of Black Cockatoo foraging evidence observed in the proposal footprint (upon Marri nuts and Banksia cones) (Coffey, 2015b).

9.2.3.2 Roosting Assessment

The Eucalypt/Corymbia Woodlands and Wetland habitats with stands of tall trees provide potential roosting habitat for Black Cockatoos (58.6 ha) (see Figure 9.2).

A desktop search for known roost sites was completed for the proposal footprint using data from the Great Cocky Count (Burnham et al., 2010). No known roost sites occur in the proposal footprint and none were recorded during the survey. Three major roost site locations have been recorded in the Pine Plantations to the west of the proposal footprint in the Gngangara region. All sites are within 10 km of the proposal footprint and have between 64 and 542 Carnaby's Cockatoos using these roost locations (Burnham et al., 2010).


9.2.3.3 Breeding Assessment

The proposal footprint contains 737 trees that have a DBH over 500 mm. The majority of these trees are Marri (574), followed by Flooded Gum (90), Jarrah (68) and Tuarts (5). The EPBC Act Referral Guidelines for the Three Threatened Black Cockatoo Species (DSEWPAC, 2012c) states, "in a woodland stand with trees of suitable diameter at breast height, all trees of all ages and size are potentially important for maintaining breeding in the long term" and, as such, the Eucalypt/Corymbia Woodland, Modified Vegetation and Wetland habitats with stands of suitably sized trees and species are classified as potential breeding habitat and mapped as High value (120.1 ha) (see Figure 9.2).

For hollows to be of use to Black Cockatoos they should have dimensions of at least 12 cm entrance size (Groom, 2011; Johnstone et al., 2013). A total of 13 trees that contained suitable sized hollows were recorded within the proposal footprint (see Figure 9.2). There are no known breeding records for Black Cockatoos in the proposal footprint or its vicinity.

9.2.4 Fauna Assemblage

A desktop assessment of database searches and relevant surveys identified 360 species of fauna that have been previously recorded in the vicinity of the proposal footprint (Appendix G). This includes four invertebrate, five fish, 14 amphibian, 64 reptile, 232 bird and 41 mammal species. It should be noted that the species list from the desktop assessment includes historic records of species that have since become locally extinct and species that have been recorded in the general region, but are vagrants and are generally not found in the area because of a lack of suitable habitat.



A more recent assessment of the fauna assemblage of the Gnamptogaea Sustainability Strategy (GSS) study area suggests that there is a total of 304 species of fauna currently existing in the vicinity of the proposal footprint. This includes 13 amphibians, 64 reptiles, 217 birds and 10 mammals (native non-bat mammals) (Wilson and Valentine, 2009). The reduction in the number of birds and mammals in recent data compared with the historical data corresponds with findings that these two faunal groups have been impacted to a greater extent by urban development (How and Dell, 2000; Wilson and Valentine, 2009; Government of Western Australia, 2000b). There is no data to suggest any historical changes to distribution and abundance of amphibians and reptiles (How and Dell, 2000).

The changes to fauna assemblage are caused by the impact of European settlement such as the loss of habitat, fragmentation of habitat, feral predators, changed fire regimes, climate change and the spread of *Phytophthora* dieback. However, there is a lack of the quantitative data on the level of impact these threats currently pose (Wilson and Valentine, 2009). Despite these impacts, the persistence of the majority of the original reptile assemblage in Perth's remnant bushlands suggests that many of the ecosystem processes remain intact (How and Dell, 2000).

The objective of the field surveys was to sample terrestrial vertebrate fauna. As such, a systematic survey for the invertebrates and fish of the fauna study area was not conducted. Conservation significant invertebrates and fish species identified in the desktop assessment were assessed on their likelihood of occurrence in the fauna study area based on the habitats present, current distribution and relevance of previous records. The DEC conducted a terrestrial invertebrate biodiversity assessment for the GSS, which identified three conservation significant invertebrates as currently occurring on the northern SCP (Wilson and Valentine, 2009). Of these, only the Priority 4 listed Graceful Sun Moth (*Synemon gratiosa*) occurs in close proximity (within 10 km) of the proposal footprint.

A total of four conservation significant invertebrate species and one conservation significant fish species were identified in the desktop assessment; however, none of them were considered likely to occur in the fauna study area (Appendix G).

Short range endemics (SRE) are species of animal (predominantly Invertebrates) that have a restricted distribution of less than 10,000 km² (Harvey, 2002). The desktop review did not identify any conservation significant SREs in the vicinity of the proposal footprint. The Mound Springs SCP TEC located adjacent to the proposal footprint was identified as a location of potential SRE habitat (Wilson and Valentine, 2009). However, the proposal avoided this site during earlier planning studies and will not impact this site. The lack of restricted landforms or habitats and the presence of vegetation units that are contiguous and widespread outside of the proposal footprint limits the likelihood of SREs being confined to the development area (EPA, 2009). Survey methodology focusing on terrestrial vertebrate fauna was reviewed and endorsed by the OEPA. As such, no specific SRE survey was required to comply with the ESD.

A total of 97 species were recorded during both the Level 1 opportunistic survey and Level 2 trapping survey, including one fish, six amphibian, 19 reptile, 62 bird and nine mammal species (Table 9.3) (Appendix G). Of the 97 species recorded during the survey, nine species were introduced.

Table 9.3 Summary of fauna assemblage

Fauna group	Species identified in desktop review	Species recorded in proposal footprint during 2014 survey
Invertebrates	4	0
Fish	5	1
Amphibians	14	6
Reptiles	64	19
Birds	232	62
Mammals	41	9
Total	360	97

9.2.5 Conservation Significant Fauna

From the database searches a total of 67 conservation significant fauna species listed under the EPBC Act, WC Act or DPAW's Priority listing, have been recorded in the vicinity of the proposal footprint. These include four invertebrate, one fish, four reptile, 47 bird and 11 mammal species. These species were assessed for their likelihood to occur, reviewing each species' current distribution, habitat requirements/relevance and location and age of previous records in the vicinity of the proposal footprint.

Four conservation significant fauna were recorded in the proposal footprint during the survey (Appendix G) (see Figure 9.1):

- Carnaby's Cockatoo (*Calyptorhynchus latirostris*) listed as Endangered (EPBC Act) and Schedule 1 (WC Act).
- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) listed as Vulnerable (EPBC Act) and Schedule 1 (WC Act).
- Australian Bustard (*Ardeotis australis*) listed as Priority 4 (DPAW Priority list).
- Southern Brown Bandicoot (*Isodon obesulus fusciventer*) listed as Priority 5 (DPAW Priority list).

A further seven species of conservation significance are considered likely to occur in the proposal footprint:

- Great Egret (*Ardea alba*) listed as Migratory (EPBC Act) and Schedule 3 (WC Act).
- Cattle Egret (*Ardea ibis*) listed as Migratory (EPBC Act) and Schedule 3 (WC Act).
- Rainbow Bee-eater (*Merops ornatus*) listed as Migratory (EPBC Act) and Schedule 3 (WC Act).
- Western Carpet Python (*Morelia spilota imbricata*) listed as Schedule 4 (WC Act).
- Jewelled Sandplain Ctenotus (*Ctenotus gemmula*) listed as Priority 3 (DPAW Priority list).
- Black-striped Snake (*Neelaps calonotos*) listed as Priority 3 (DPAW Priority list).
- Western Brush Wallaby (*Macropus irma*) listed as Priority 4 (DPAW Priority list).



9.2.6 Locally and Regionally Significant Fauna

Fauna of local and regional significance for the proposal are defined as species that have distributions restricted to the SCP or species whose populations/distributions have declined on the SCP since European settlement (Government of Western Australia, 2000b; Wilson and Valentine, 2009). Locally or regionally significant species are not listed under Commonwealth or State legislation or under DPAW's Priority species list.

A total of 22 species considered to be locally or regionally significant were recorded within the proposal footprint during the survey. These include:

- Common species with distributions restricted to the SCP (as defined in Wilson and Valentine, 2009): One amphibian *Crinia insignifera* and two reptiles *Ctenophorus adelaidensis* and *Hemiergis quadrilineata*.
- Species that are rare on the SCP but common elsewhere (as defined in Government of Western Australia, 2000b): Two reptiles *Varanus tristis* and *Parasuta gouldii*.
- Species that are habitat specialists with a reduced distribution on the SCP (as defined in Government of Western Australia, 2000b): Nine birds including the Common Bronzewing, Splendid Fairy-wren, White-browed Scrubwren, Weebill, Western Thornbill, Yellow-rumped Thornbill, Scarlett Robin, Hooded Robin and Grey Shrike-thrush.
- Wide-ranging species with reduced populations on the SCP (as defined in Government of Western Australia, 2000b): Eight birds including the Emu, Brown Goshawk, Little Eagle, Wedge-tailed Eagle, Brown Falcon, New Holland Honeyeater, Western Little Wattlebird and Black-faced Woodswallow.

9.2.7 Fauna Movement Survey

A specific fauna movement survey (see Appendix G) conducted on the vehicle tracks directly adjacent to the Maralla Road Bushland (approximately 500 m in length) and Whiteman Park/Cullacabardee Bushland (approximately 1,800 m in length) was used to identify areas of high fauna traffic (Figure 9.3). This survey identified fresh animal tracks and sorted them into fauna class and frequency of movement. This data will be used to recommend the appropriate locations and types of fauna movement corridors or mechanisms. Only ground dwelling native species were recorded during the fauna movement survey as these are the target species for any potential fauna movement corridors.

A total of 255 fauna crossings were recorded at the Whiteman Park/Cullacabardee Bushland during the survey with the vast majority of records belonging to Western Grey Kangaroos (83%) followed by Bobtail Skinks (12%). Smaller skinks (3%), snakes (1.5%) and a Goanna (0.5%) were also recorded crossing the track at this location, but in much lower numbers. Analysis of the Whiteman Park/Cullacabardee site indicated a total of nine hotspots (99% confidence interval), two located north of Baal Road and seven concentrated towards the southern section of the track (see Figure 9.3).

A total of 99 fauna crossings were recorded at the Maralla Road Bushland during the survey with the vast majority of records belonging to Western Grey Kangaroos (70%) followed by Bobtail Skinks (26%), smaller Skinks (2%), an Emu (1%) and a Goanna (1%). Analysis of the Maralla Road site had shown that two hotspots (99% confidence interval) were recorded along the track. One hotspot was located adjacent to the Dampland habitat and the other halfway along the track towards Maralla Road (see Figure 9.3).



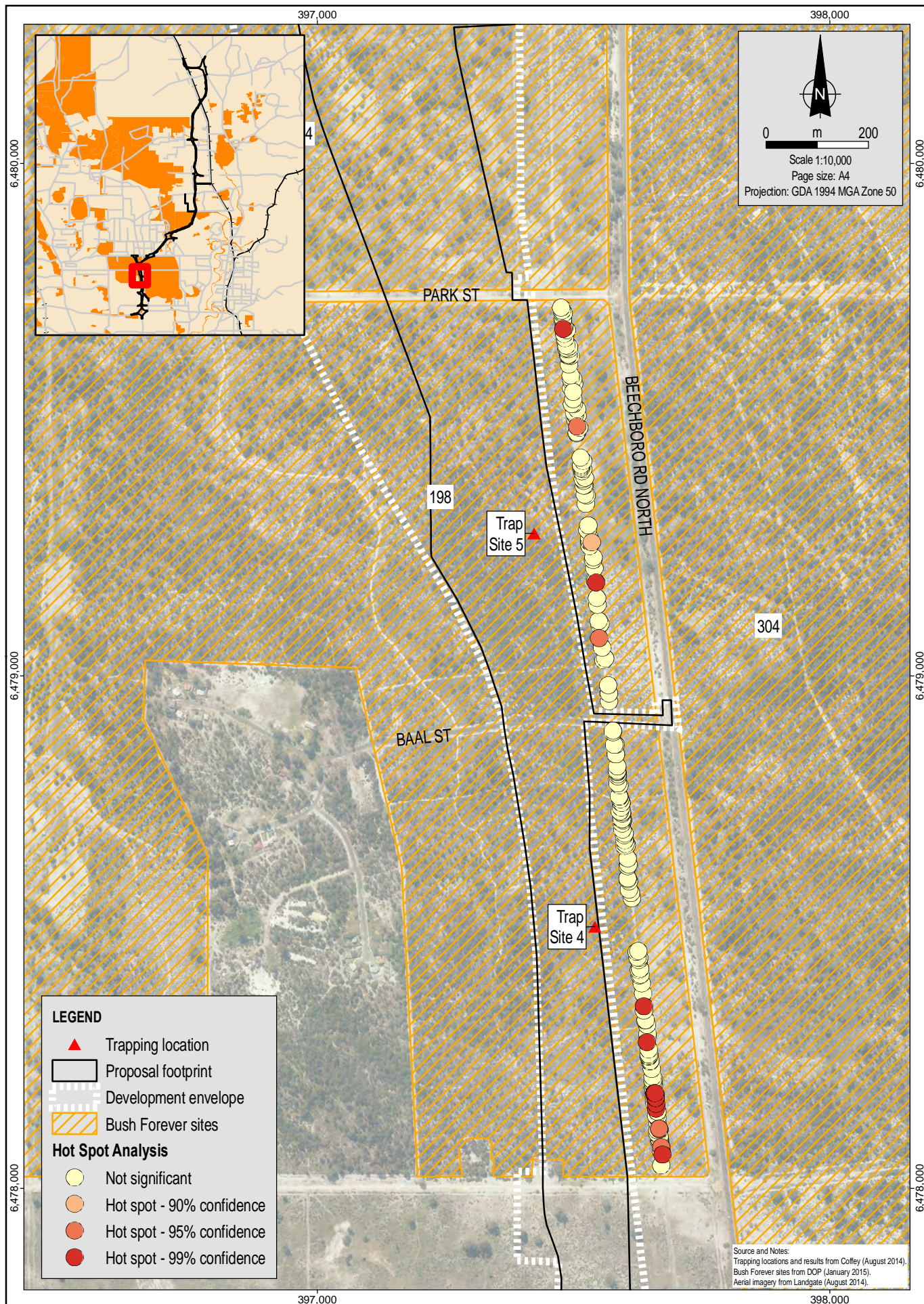
9.2.8 Ecological Connectivity

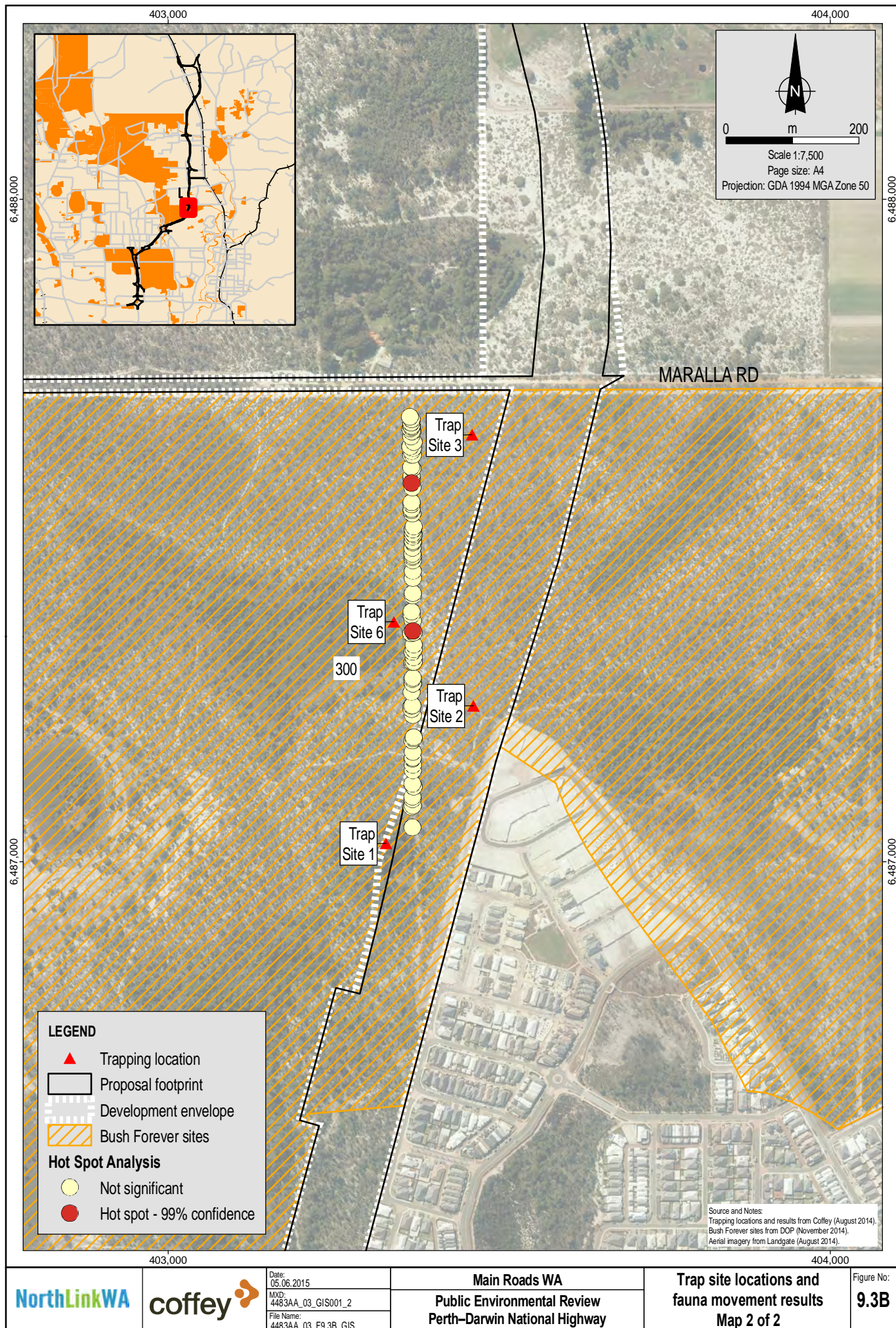
A combination of aerial photographs, ground-truthing, assessment of the Perth regional ecological linkages report (Brown et al., 2009) and consultation with the OEPA was used to identify areas of importance in regards to ecological linkages. The main areas of focus included Maralla Road Bushland and Whiteman Park/Cullacabardee Bushland, which have been previously identified as an “existing or potential bushland/wetland linkage” (Government of Western Australia, 2000). A number of priority listed ground dwelling fauna have previously been recorded in the surrounding area, namely the Jewelled Sandplain Ctenotus, Southern Brown Bandicoot and Western Brush Wallaby. These sites were surveyed for their potential to provide ecological linkages and encourage safe fauna movement.

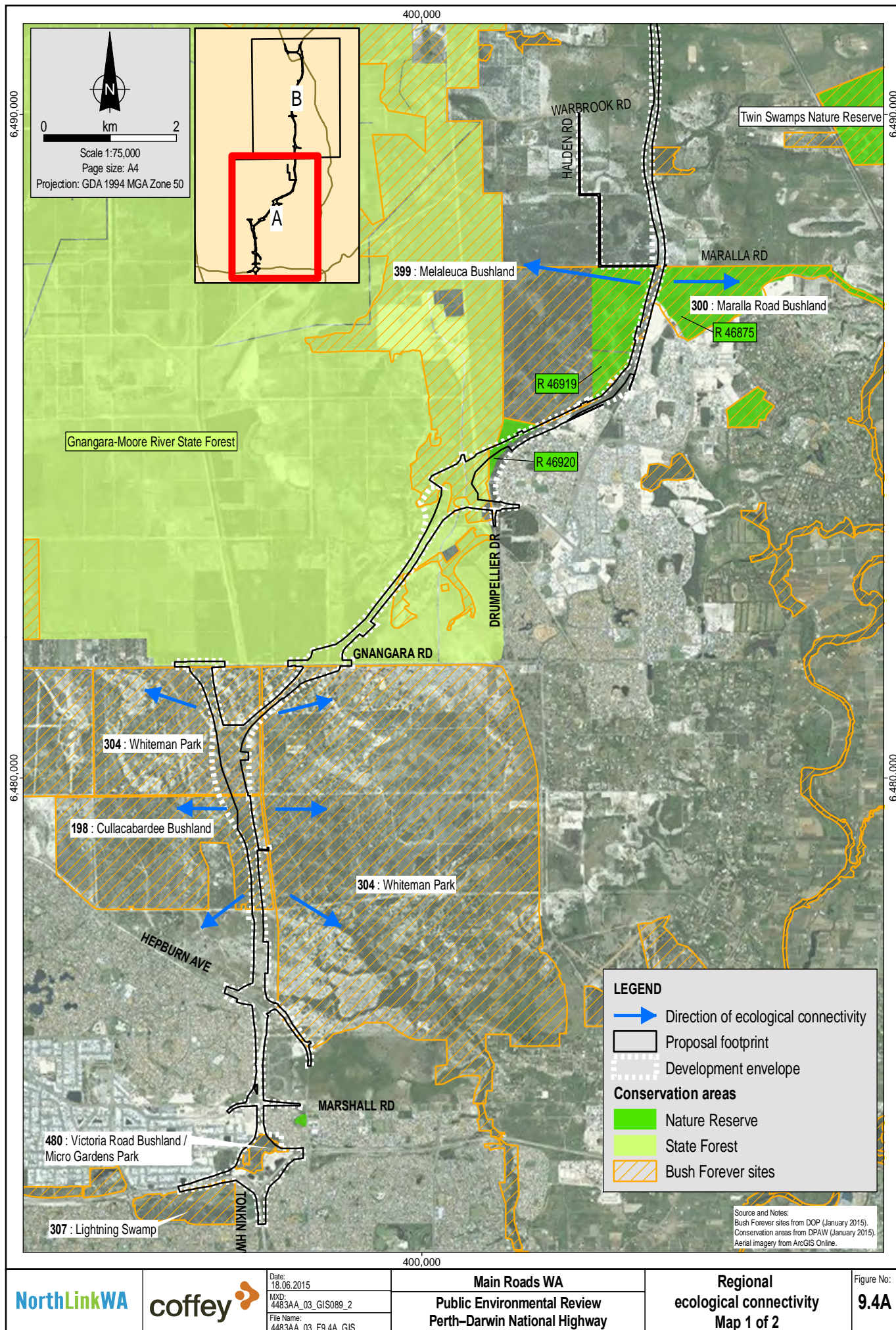
The proposal is located within an existing road reserve at Maralla Road Bushland (Government of Western Australia, 2000b). This site provides an ecological linkage to Bush forever sites 300 and 301 in the east and 300 and 399 to the west (Government of Western Australia, 2000b). The section of vegetation that exists between the Ellenbrook Estate and Maralla Road acts as a bottleneck that restricts access to large areas of native vegetation in both an eastern and western direction, including Melaleuca Park Bushland, Ellenbrook Nature Reserve and Walyunga National Park (Figure 9.4).

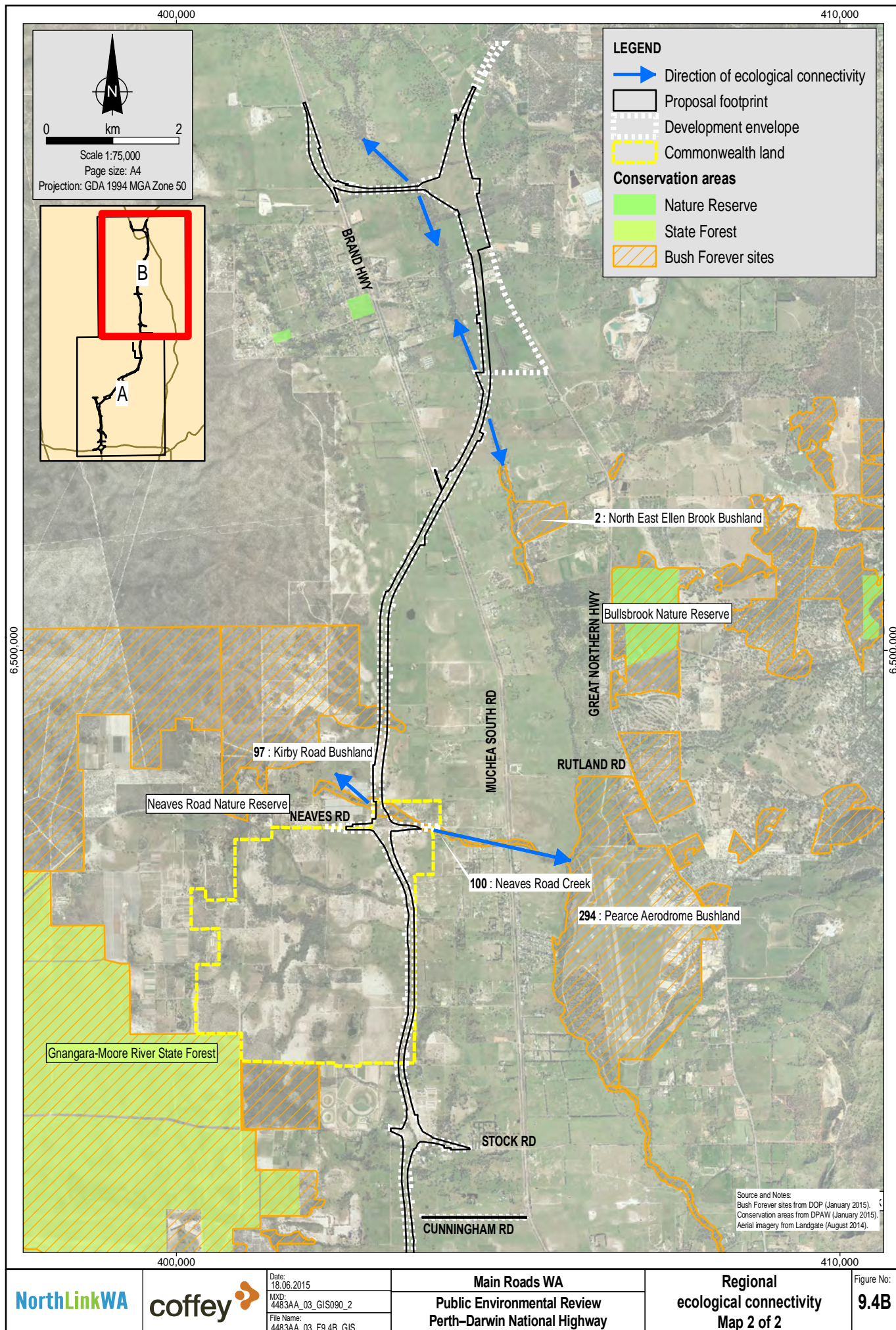
The Cullacabardee Bushland forms part of an ecological linkage with the greater Whiteman Park Nature Reserve (Government of Western Australia, 2000b), which extends both east and west of the proposal (see Figure 9.4).

The Dampland and Eucalypt/Corymbia Woodland at the Tonkin Highway/Reid Highway intersection (Micro Gardens Park) maintains a level of ecological connectivity between Lightning Swamp Bushland, Malaga Regional Space and Koondoola Regional Bushland to the west, and Point Reserve to the east. This site has been identified as being part of a “regionally significant fragmented bushland/wetland linkage” (Government of Western Australia, 2000b). Diggings attributed to the conservation significant Southern Brown Bandicoot (P5) were recorded in the Micro Gardens Park and the road reserve near the Reid Highway/Altone Road intersection (see Figure 9.1). Although heavily degraded, the vegetation of the road reserve provides an ecological linkage between areas of suitable habitat.











9.3 Potential Impacts

The proposal has the potential to impact a number of fauna habitats, fauna assemblages and conservation significant fauna during the construction and operation phases.

The following impacts are anticipated during the construction phase:

- Habitat loss due to vegetation clearing.
- Habitat fragmentation due to vegetation clearing.
- Disturbance to waterbirds (including migratory species) from impacts to wetlands.
- Fauna mortalities primarily due to clearing activities.
- Feral predation of displaced fauna by Red Foxes and Cats.
- Accidental fire during construction activities.
- Light and noise as a result of machinery and construction activities.

The following impacts are anticipated during the operation phase:

- Habitat fragmentation.
- Severing of ecological connectivity.
- Fauna mortalities from fauna/vehicle interactions.
- Feral predation by Red Foxes and Cats.
- Habitat degradation, edge effects, weeds, dieback, rubbish and vehicle tracks.
- Increased risk of bushfires due to greater human access to areas of vegetation.
- Light and noise as a result of vehicles along the PDNH.
- Altered surface and groundwater hydrology resulting in habitat degradation.

9.4 Assessment of Potential Impacts

9.4.1 Habitat Loss and Habitat Fragmentation

Due to the localised impact of vegetation clearing and the cumulative impact of the urbanisation of the SCP, habitat loss during construction is considered a major threatening process expected from the proposal. The impact of habitat loss on conservation significant fauna at a local and regional scale is provided in Table 9.4.


As a result of the extended, linear nature of the proposal, habitat fragmentation and the related loss of ecological connectivity is considered a potential significant impact that requires mitigation. Fragmented habitats have an increased risk of loss of genetic diversity and ecological diversity (QDMR, 2000). Along with an increased risk of vehicle collisions and a higher susceptibility to impacts such as fire, disease and predation this could lead to localised extinction (QDMR, 2000). Due to their restricted dispersal abilities, ground dwelling fauna are more likely to be impacted by habitat fragmentation and the loss of ecological connectivity.

Table 9.4 Local and regional context of habitat loss for conservation significant fauna

Species	EPBC Act Conservation significance	State Conservation Significance	Habitat loss due to the proposal	Proportion of habitat loss at a local scale ¹	Proportion of habitat loss at a regional scale ²
Carnaby's Cockatoo	Endangered	Schedule 1	201.8 ha foraging habitat	2.6%	0.2% at a regional scale 0.04% at a bioregional scale ³
			58.6 ha roosting habitat	Cannot be calculated	Cannot be calculated
			120.1 ha potential breeding habitat	Cannot be calculated	Cannot be calculated
Forest Red-tailed Black Cockatoo	Vulnerable	Schedule 1	120.1 ha foraging habitat	1.6%	0.1% at a regional scale 0.03% at a bioregional scale ³
			58.6 ha roosting habitat	Cannot be calculated	Cannot be calculated
			120.1 ha potential breeding habitat	Cannot be calculated	Cannot be calculated
Great Egret	Migratory	Schedule 3	15.5 ha of potential habitat	Cannot be calculated	Cannot be calculated
Cattle Egret	Migratory	Schedule 3	271.2 ha of potential habitat	Cannot be calculated	Cannot be calculated
Rainbow Bee-eater	Migratory	Schedule 3	367.5 ha of potential habitat	4.8%	0.4%
Western Carpet Python		Schedule 4	124.8 ha of potential habitat	1.6%	0.1%
Jewelled Sandplain Ctenotus		Priority 3	81.7 ha of potential habitat	1.1%	0.1%
Black-striped Snake		Priority 3	124.8 ha of potential habitat	1.6%	0.1%
Western Brush Wallaby		Priority 4	124.8 ha of potential habitat	1.6%	0.1%
Southern Brown Bandicoot		Priority 5	19.0 ha of potential habitat	Cannot be calculated	Cannot be calculated

Note: Values that cannot be calculated are due to the lack of information pertaining to the local or regional scale of the specific habitat requirements of that species.

1. Local scale represents the extent of all Bush Forever sites within 1 km of the proposal footprint.
2. Regional scale represents the extent of all Bush Forever sites within 10 km of the proposal footprint.
3. Bioregional scale represents the amount of Black Cockatoo habitat on the SCP.



A total of 159.3 ha of natural fauna habitats will be impacted by the proposal (21.4% of the proposal footprint). The majority of the proposal footprint occurs on secondary fauna habitats and areas classified as infrastructure/cleared. As such, the remaining 586.4 ha (78.6%) of the proposal footprint offers limited/no habitat to fauna. It is expected that the entire proposal footprint will be cleared of vegetation and hence all fauna habitats identified in the proposal footprint (see Table 9.1) will be removed.

The 159.3 ha of natural vegetation expected to be cleared is distributed over the majority of the proposal footprint thus dispersing the expected impacts. The proposal will result in a loss of habitat at a local scale, but due to its linear nature, similar surrounding habitat will remain. There are 13 Bush Forever sites located within 1 km of the proposal footprint that collectively contain approximately 7,649 ha of native vegetation (Government of Western Australia, 2000b). The clearing of 159.3 ha of natural vegetation equates to a 2.1% loss at a local scale.

At a regional scale the fauna habitats present in the proposal footprint are common and widespread in the SCP. Approximately 101,000 ha of remnant native vegetation occurs in the GSS (Brown et al., 2009), a 2,200 km² section of the northern SCP that includes the proposal and its regional surrounds. The remnant native vegetation of the GSS contains habitats similar to those found in the proposal footprint (Banksia Woodland, Eucalypt/Corymbia Woodland, Dampland and Wetland habitats) and additional habitats that are not represented in the proposal footprint (Wilson and Valentine, 2009). The 159.3 ha of native vegetation to be cleared in the proposal footprint represents approximately 0.2% of the remnant native vegetation in a regional context.

9.4.1.1 Impact on Carnaby's Cockatoo (*Calyptorhynchus latirostris*) and Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*)

The total population of Carnaby's Cockatoo is approximately 40,000 individuals (Garnett et al., 2011) with approximately 8,000 to 10,000 birds on the northern SCP (Johnstone and Kirkby, 2011). Habitat loss is a known threatening process for this species (DOTE, 2015).


The proposal footprint is situated at the northern extent of the Forest Red-tailed Black Cockatoo's current range (DSEWPAC, 2012c). The total estimated population for this species is approximately 10,000 to 15,000 birds, with the breeding population being as low as 10 to 20% (Johnstone and Kirkby, 2011).

9.4.1.2 Impact on Black Cockatoo Foraging Habitat

The proposal will result in the loss of approximately 201.8 ha (excluding Pine Plantation) of quality foraging habitat for Carnaby's Cockatoos and 120.1 ha of quality foraging habitat for Forest Red-tailed Black Cockatoos (excluding Pine Plantation). Areas adjacent to the proposal footprint such as East Wanneroo, Gngangara and Whiteman Park have been identified as important sites for Carnaby's Cockatoo on the SCP (Johnstone and Kirkby, 2011).

The clearing of foraging habitat in the proposal footprint equates to a loss of approximately 2.6% of the local Carnaby's Cockatoo habitat available within 1 km of the proposal footprint and 0.2% of the regional habitat available within 10 km of the proposal footprint (based upon habitat within Bush Forever sites). There are approximately 474,000 ha of suitable Carnaby's Cockatoo habitat on the SCP (Johnston, 2013). The clearing of 201.8 ha of Carnaby's Cockatoo foraging habitat through the proposal represents 0.04% of the available habitat in a bioregional context.

The clearing of foraging habitat in the proposal footprint equates to a loss of approximately 1.5% of the local Forest Red-tailed Black Cockatoo habitat available within 1 km of the proposal footprint and 0.1% of the regional habitat available within 10 km of the proposal footprint (based upon habitat within Bush Forever sites). The clearing of 120.1 ha of Forest Red-tailed Black Cockatoo foraging habitat through the proposal represents 0.03% of the available habitat in a bioregional context.



The impact on both Black Cockatoo species from the proposal was assessed against the Significant Impact Guidelines 1.1 (DOTE, 2013) in Chapter 16. The proposal will impact critical habitat for the Carnaby's Cockatoo and the Forest Red-tailed Black Cockatoo, which constitutes a significant impact (DPAW, 2013a; Chapman, 2007).

9.4.1.3 Impact on Black Cockatoo Roosting Habitat

The Eucalypt/Corymbia Woodlands and Wetland habitats with stands of tall trees are classified as potential roosting habitat for Black Cockatoos. Black Cockatoos show roost site fidelity and will revisit suitable roost sites (DSEWPAC, 2012c). Due to the absence of significant roost sites in the proposal footprint, limited impacts to roosting habitats are expected. Approximately 58.6 ha of potential roosting habitat is expected to be cleared for the proposal.

9.4.1.4 Impact on Black Cockatoo Breeding Habitat

The Eucalypt/Corymbia Woodland, Modified Vegetation and Wetland habitats with stands of suitably sized trees (118.2 ha) are classified as potential breeding habitat and are mapped as high value. In total 120.1 ha of potential breeding habitat for Black Cockatoos is expected to be cleared for the proposal.

The proposal footprint contains 737 trees that have a DBH over 500 mm. A total of 13 trees that contained suitably sized hollows were located throughout the proposal footprint. All 737 trees of suitable size, including the 13 trees with suitable sized hollows, are expected to be cleared for the proposal.

As the proposal footprint is not known as a current breeding site, the impact on Black Cockatoo breeding is not immediate.

9.4.1.5 Impact on the Great Egret (*Ardea alba*)

The Great Egret has been previously recorded at Lightning Swamp, Whiteman Park, Bennett Brook, Waltham Reserve and Malaga Regional Open Space, which are all directly adjacent to the proposal footprint (DPAW, 2014c).

The Great Egret occurs throughout Australia with Western Australian populations occurring across the greater part of the state, except the arid eastern interior (Johnstone and Storr, 1998). The Great Egret inhabits mostly shallow fresh lakes, pools in rivers, lagoons, lignum swamps, clay pans and samphire flats, large dams and sewage ponds (Johnstone and Storr, 1998). The Wetland habitats of the proposal footprint provide suitable habitat for this species. As such, approximately 15.5 ha of suitable habitat for this species will be cleared by the proposal.


This species is not considered susceptible to habitat fragmentation effects as it is highly mobile (DOTE, 2014d) and no significant nesting sites are known from the SCP. As such, impacts to this species are likely to be limited to local scale habitat loss.

Based upon the Significant Impact Guidelines 1.1 (DOTE, 2013), the proposal footprint does not support an ecologically significant proportion of this species, contain critical habitat, occur at the limit of this species' range or occur within an area where this species is declining. As such, the proposal will not create a significant impact to this relatively common and widespread species.

9.4.1.6 Impact on the Cattle Egret (*Ardea ibis*)

The Cattle Egret has been previously recorded from the Lake Joondalup area, which is approximately 10 km west of the proposal footprint (DPAW, 2014d).

A Cattle Egret was recorded foraging in pastures adjacent to the proposal footprint during the survey period. The Cattle Egret inhabits pastures, garbage tips, crops, wetlands, tidal flats and drains (Pizzey and Knight, 2007). The Wetland and Paddock habitat types provide suitable habitat for this species. As such, approximately 271.2 ha of suitable habitat for this species is expected to be cleared by the proposal.



The Cattle Egret occurs in the wetter parts of WA and also in Northern and Eastern Australia, New Zealand and Southeast Asia (Johnstone and Storr, 1998). Due to its cosmopolitan distribution and mobile nature, this species will not be impacted as a result of loss of habitat.

Based upon the Significant Impact Guidelines 1.1 (DOTE, 2013), the proposal footprint does not support an ecologically significant proportion of this species, contain critical habitat, occur at the limit of this species' range or occur within an area where this species is declining. As such, the proposal will not create a significant impact to this relatively common and widespread species.

9.4.1.7 Impact on the Rainbow Bee-eater (*Merops ornatus*)

The Rainbow Bee-eater is one of the most widespread bird species in Australia (Barrett et al., 2003) occurring across the country in a range of habitats. This species has previously been recorded on numerous occasions in the vicinity of the proposal footprint (DPAW, 2014c, d).

The Rainbow Bee-eater is considered likely to occur in the proposal footprint across all fauna habitat types including the secondary habitat type of Modified Vegetation. A total of 367.5 ha of suitable habitat for this species will be impacted by the proposal. This equates to a loss of approximately 4.8% of the local habitat available within 1 km of the proposal footprint and 0.4% of the regional habitat available within 10 km of the proposal footprint (based upon habitat within Bush Forever sites).

Due to the common occurrence, widespread distribution and mobile nature of this species, the impact due to loss of suitable habitat in the proposal footprint is expected to be negligible.

Based upon the Significant Impact Guidelines 1.1 (DOTE, 2013), the proposal footprint does not support an ecologically significant proportion of this species, contain critical habitat, occur at the limit of this species' range or occur within an area where this species is declining. As such, the proposal will not create a significant impact to this relatively common and widespread species.

9.4.1.8 Impact on the Western Carpet Python (*Morelia spilota imbricata*)

The Western Carpet Python has previously been recorded (from only one record) approximately 15 km west of the proposal footprint (GHD, 2013c). Habitat destruction is a known threatening process for the Western Carpet Python (Pearson, 2005; DEC, 2012b).


It is a widespread subspecies that occurs across the southern portion of Western Australia (Bush et al., 2010). As such, the loss of suitable habitat from the proposal is expected to be negligible at a regional scale.

This species requires large areas of undisturbed bushland (Bush et al., 2007) and as such the most likely location for it to occur in the proposal footprint is the Banksia Woodland and Eucalypt/Corymbia Woodland of the Maralla Road Bushland. A total of 124.8 ha of suitable habitat for this species will be impacted by the proposal. This equates to a loss of approximately 1.6% of the local habitat available within 1 km of the proposal footprint and 0.1% of the regional habitat available within 10 km of the proposal footprint (based upon habitat within Bush Forever sites).

Only one record of this species has occurred in the vicinity of the proposal footprint (GHD, 2013a). This is an isolated record with no additional records in the vicinity (DPAW, 2014d). As such, the loss of ecological connectivity, habitat loss and fragmentation from the proposal is unlikely to significantly impact this species.

9.4.1.9 Impact on the Jewelled Sandplain Ctenotus (*Ctenotus gemmula*)

There have been recent records of the Jewelled Sandplain Ctenotus occurring in bush associated with the proposal footprint such as Whiteman Park and Maralla Road Bushland (Bush et al., 2010).



This species is scarce on the SCP as it is the northern extent of its range (Bush et al., 2010). Populations also occur along the south coast of WA from Rocky Lake to Toolina Cove (Storr et al., 1999). Even though the occurrence of this species is scarce on the SCP the proposal is unlikely to impact this species at a regional level due to its extended distribution.

The Jewelled Sandplain Ctenotus is considered likely to occur in the Banksia Woodland of the proposal footprint. A total of 81.7 ha of suitable habitat for this species will be cleared by the development of the proposal. This equates to a loss of approximately 1.1% of the local habitat available within 1 km of the proposal footprint and 0.1% of the regional habitat available within 10 km of the proposal footprint (based upon habitat within Bush Forever sites). Impacts to this species from the loss of habitat, loss of ecological connectivity and habitat fragmentation are expected to be restricted to a local scale.

9.4.1.10 Impact on the Black-striped Snake (*Neelaps calonotos*)

The Black-striped Snake occurs only along the SCP with the bulk of this species' known distribution occurring in the Perth region. However, there have been recent records of this species further north near Dongara and Eneabba, suggesting it has a broader distribution (Bush et al., 2010). This species inhabits coastal dunes and Eucalypt/Banksia Woodlands (Bush et al., 2010) and it has been recorded directly adjacent to the proposal footprint in Ellenbrook and Muchea (DPAW, 2014d).

Even though this species has a limited distribution, the loss of suitable habitat in the proposal footprint is expected to be negligible at a regional scale due to the widespread occurrence of suitable habitat.

A total of 124.8 ha of suitable habitat for this species (Banksia Woodland and Eucalypt/Corymbia Woodland of the proposal footprint) will be cleared by the development of the proposal. This equates to a loss of approximately 1.6% of the local habitat available within 1 km of the proposal footprint and 0.1% of the regional habitat available within 10 km of the proposal footprint (based upon habitat within Bush Forever sites).

As this species is a ground dwelling reptile with limited dispersal abilities, cumulative habitat fragmentation is a risk to the local populations of this species. Impacts to this species from the loss of habitat, loss of ecological connectivity and habitat fragmentation are expected to occur at a local scale.

9.4.1.11 Impact on the Australian Bustard (*Ardeotis australis*)

This species was recorded on a road reserve adjacent to the proposal footprint in Bullsbrook (see Figure 9.1) and has also previously been recorded at Whiteman Park (Coffey, 2015c).


The Australian Bustard is a wide-ranging species that occurs over the majority of Australia apart from the southwest and southeastern areas. It inhabits open grass plains, low shrublands and grassy open woodlands (Ziembicki, 2010).

The Australian Bustard is a highly nomadic species and the records are of vagrant individuals rather than populations occurring in the vicinity of the proposal footprint. As such, significant impacts to this species from the proposal will not occur.

9.4.1.12 Impact on the Western Brush Wallaby (*Macropus irma*)

The Western Brush Wallaby has previously been recorded in Whiteman Park, Cullacabardee and Ellenbrook, all of which are adjacent to the proposal footprint (DPAW, 2014c).

This species occurs in southwestern Australia from Kalbarri in the north to Cape Arid in the south (Woinarski et al., 2014). As such, the loss/impact upon suitable habitat in the proposal footprint is expected to be negligible at a regional scale. The Banksia Woodland and the Eucalypt/Corymbia Woodland around Cullacabardee and Maralla Road Bushlands provide suitable habitat for this species. As such, approximately 124.8 ha of potential habitat will be impacted by the proposal. This equates to a loss of approximately 1.6%



of the local habitat available within 1 km of the proposal footprint and 0.1% of the regional habitat available within 10 km of the proposal footprint (based upon habitat within Bush Forever sites).

Impacts to this species from the loss of habitat, loss of ecological connectivity and habitat fragmentation are not expected to be significant and only occur at a local scale.

9.4.1.13 Impact on the Southern Brown Bandicoot (*Isodon obesulus fusciventer*)

This species has previously been recorded in Aveley, Beechboro, Bullsbrook, Whiteman, Caversham and Ellenbrook, all of which are all adjacent to the proposal footprint (DPAW, 2014c). Three individuals were captured at trap site 6 (next to the proposal footprint) during the trapping program and diggings were recorded at Micro Gardens Park and in the road reserve alongside Reid Highway (see Figure 9.1).

The West Australian subspecies is distributed along the coast from Guilderton to Esperance (DPAW, 2014d). As such, the impacts to this species at a regional level from the proposal are not considered significant and are unlikely to alter the conservation significance of this species.

A total of 19 ha of suitable habitat (classified as Dampland habitat) will be impacted by the development of the proposal. Local populations of this species are likely to be impacted by this development, as they are a ground dwelling species with poor dispersal abilities and are predominantly found in the restricted environs of the Dampland habitats. In particular the population recorded at Micro Gardens Park may be affected as there are restricted dispersal opportunities in the area and the majority of the vegetation in this area will be cleared. The population size in the Dampland habitat in the Maralla Road Bushland is unknown; however, due to this habitat occurring adjacent to the proposal footprint the species will potentially be affected by habitat fragmentation.

9.4.1.14 Impact on Locally and Regionally Significant Fauna

All of the locally and regionally significant fauna recorded in the proposal area are considered common either on the SCP or within other portions of their distributions. As such, the proposal will not increase the level of significance of these species. Impacts to these species due to the loss of habitat in the proposal footprint are expected to be negligible at a regional scale due to the widespread occurrence of suitable habitat for these species.


Impacts to these species from the loss of habitat, loss of ecological connectivity and habitat fragmentation caused by the proposal are restricted to the local scale and not expected to be significant.

9.4.2 Fauna Mortalities

The proposal will bisect areas of intact vegetation in particular around the Whiteman Park/Cullacabardee Bushland and Maralla Road Bushland. There is considerable potential for an increase in vehicle/fauna interactions during the operation phase of this proposal.

For common animals, particularly smaller species, road mortalities do not exert a significant pressure on population dynamics or conservations status (QDMR, 2000). However, for large fauna, particularly those with restricted and declining distributions and those that have repeated and regular contact with roads, there is evidence that road mortalities can significantly impact populations (QDMR, 2000). As such, populations of the Western Brush Wallaby and the Southern Brown Bandicoot are more susceptible to the effects of road mortalities during the operation phase of the proposal than the more common species. Birds of prey and other scavenging fauna will be attracted to road kill and may themselves fall victim to vehicle collisions.

Black Cockatoo species often forage on roadside vegetation and due to their large size have a tendency to fly low, particularly after take-off. This characteristic means these species are susceptible to vehicle collisions (Saunders et al., 2011).



Fauna mortalities are expected to occur during the construction phase as machinery clears trees and vegetation. This may particularly include species that reside in trees and hollows. Ground dwelling fauna are at higher risk of mortality during the construction phase due to their limited ability to disperse away from habitats as they are being cleared.

9.4.3 Feral Predation

During both the construction and operation phases the clearing of native vegetation, habitat degradation and fencing along the perimeter may lead to increased predation from Red Foxes and Cats. The movement of introduced predators is often facilitated through the clearing of natural vegetation (QDMR, 2000). Both the Red Fox and Cat were regularly recorded in the fauna survey (Coffey, 2015b). Ground dwelling native fauna are most at risk of increased predation as the level of protection provided by current fauna habitats will be decreased through vegetation clearing.

9.4.4 Habitat Degradation

During its operation phase the proposal will potentially increase degradation to the surrounding fauna habitats, including creating new areas of edge effects. Edge effects occur when fragmented habitats are further degraded by indirect impacts. By creating greater human access to fauna habitats the proposal may lead to an increase in anthropogenic factors such as rubbish, the spread of weeds and dieback, off-road vehicle access and chemical pollution. These impacts can be cumulative and result in the degrading of fauna habitats and their ability to support the resident fauna populations.

Habitat degradation is a known threatening process for both the Carnaby's Cockatoo and the Forest Red-tailed Black Cockatoo (DOTE, 2014e, 2015).

Factors involved in habitat degradation are already prevalent in the vicinity of the proposal footprint with rubbish, weeds, dieback, off road vehicle access all being recorded in the proposal footprint during the survey (Coffey, 2015b). As the proposal will not be the sole source of the factors creating habitat degradation, the extent and significance of impacts from the proposal on fauna habitats and the fauna assemblage they support is difficult to assess. However, the proposal is likely to constitute a small negative cumulative effect in degrading fauna habitats.

Edge effects will potentially be increased along areas of significant habitat such as Maralla Road Bushland and Whiteman Park/Cullacabardee Bushland, adding to the impacts already present. The proposal is likely to create a small negative cumulative effect in these areas by degrading the surrounding fauna habitats.


9.4.5 Altered Fire Regimes

Fires are a natural part of many ecosystems in Australia; however, the increased frequency, intensity and duration of manmade fires can cause impacts through habitat loss or fragmentation (temporary) or direct fauna mortalities. The proposal may increase the risk of accidental and deliberately lit fires (during the operation phase) as the proposal allows greater access into areas of native vegetation, including areas of significant habitat such as Maralla Road Bushland and Whiteman Park/Cullacabardee Bushland.

Fire and its associated habitat loss, including the destruction of suitable breeding hollows, is listed as a threat to Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo (Cale, 2003; DOTE, 2014e).

9.4.6 Impact from Light and Noise

The artificial lighting, mechanical noise and road noise caused during the construction and operation phases of the proposal may impact fauna in the vicinity of the proposal. The extent of effect of these impacts is difficult to assess as the impact from these is relatively unknown (QDMR, 2000). These impacts may disrupt the natural behaviour of fauna in the close vicinity to the proposal. Impacts to fauna behaviour can include the disorientation of migratory or nocturnal fauna, increased levels of physiological stress, the avoidance of habitats close to the proposal and the abandoning of previously used roost or nest sites. The



impacts to fauna, including those to populations in the Maralla Road Bushland and Whiteman Park/Cullacabardee Bushland, from light and noise are considered to be minimal considering the prevalence of similar impacts surrounding the proposal footprint.

9.4.7 Impacts from Changes to Hydrological Conditions

The proposal may disrupt the surface flow of water or lower local ground water levels. This could affect groundwater-dependent vegetation particularly around Wetland and Dampland habitats, in turn causing habitat degradation and reducing the ability of these habitats to support fauna such as the Great Egret, Cattle Egret and Southern Brown Bandicoot.

Seven groundwater dependent plant species that are known foraging and breeding resources for Black Cockatoos were recorded in the proposal footprint:

- *Banksia attenuata* – groundwater dependent facultative).
- *Banksia ilicifolia* – groundwater dependent (obligate).
- *Banksia littoralis* – groundwater dependent (obligate).
- *Banksia menziesii* – groundwater dependent (facultative).
- *Corymbia calophylla* – groundwater dependent (facultative).
- *Eucalyptus rudis* – groundwater dependent (obligate).
- *Eucalyptus tottiana* – groundwater dependent (facultative).

Disruption to the hydrological regime due to the development is unlikely to significantly impact the productivity and survival of these plant species, and is therefore unlikely to reduce the amount or quality of Black Cockatoo foraging and breeding resources in the local area. Impacts to the hydrological regime will be temporary in nature during construction, and the extent of the hydrological change is unlikely to impact these deep rooted groundwater dependent species.

The critically endangered Western Swamp Tortoise occurs at only four locations. Two of these (Ellen Brook Nature Reserve and Twin Swamps Nature Reserve) are within 6 km of the proposal footprint.

Due to the close proximity of the proposal footprint to sensitive habitat (the Twin Swamps Nature Reserve and Ellen Brook Nature Reserve) and the conservation significance of this species, an analysis on the potential impact to these habitats from changes to hydrological conditions was undertaken. The potential impacts to Western Swamp Tortoise habitat and groundwater dependent vegetation are addressed further in Chapter 10.

9.4.8 Impact on Ecological Connectivity

As the proposal is an extended linear development, the loss of ecological connectivity is a major potential impact affecting the fauna values of areas surrounding the alignment. The proposal predominantly extends north-south, potentially limiting the ecological connectivity in an east/west direction. For the majority of the proposal footprint, the loss of ecological connectivity is not an issue as the final preferred alignment occupies already highly impacted areas (modified vegetation, cleared areas, paddocks etc.) or abuts existing infrastructure (Ellenbrook and Malaga housing estates). Whiteman Park/Cullacabardee Bushland, Maralla Road Bushland and the areas surrounding Micro Gardens Park were identified as being at risk of loss of ecological connectivity.

Impacts created by fragmented ecosystems include:

- Restricted dispersal – Potential loss of territory and inability to find a mate, due to the increased size of roads and volume of traffic in the area.

- Loss of genetic diversity – Potential for the limiting of gene flow between populations, which can lead to an increased risk of inbreeding and a higher susceptibility to impacts such as disease, droughts and fires.
- Loss of ecological diversity – Local extinctions of specific species could reduce the faunal assemblage of the remnant vegetation in the area, which can lead to a reduction in functionality within an ecosystem.
- Increased risk of vehicle collision – Higher levels of traffic on surrounding roads and wider stretches of roads can lead to increased fauna mortalities.
- Higher susceptibility to impacts – Impacts such as fire, disease and feral predation can lead to localised extinction.

Impact on Maralla Road Ecological Connectivity

The Maralla Road Bushland forms part of an ecological linkage in an east-west direction including Bush Forever sites 300, 301 and 399, Ellenbrook Nature Reserve and Walyunga National Park. The maintenance of ecological connectivity at the Maralla Road site is important due to the bottleneck that occurs between Ellenbrook Estate and Maralla Road, which is only 500 m wide (see Figure 9.3). This ecological linkage is one of the few existing on the eastern side of the SCP that connects to the Darling Range and is seen as a linkage of high importance (Brown et al., 2009).

Almeria Parade, Maralla Road, cleared agricultural land and the Ellenbrook housing estate are the existing causes of the restriction in ecological connectivity at a local level. The proposal will create a further barrier to ecological connectivity, primarily in an east-west direction.

The proposal intersects a portion of approximately 500 m of native vegetation at this site (Banksia Woodland and Eucalypt Woodland) (see Figure 9.3). A number of priority listed ground dwelling fauna have previously been recorded in the surrounding area, namely the Jewelled Sandplain Ctenotus, Southern Brown Bandicoot and Western Brush Wallaby. The populations of these species and the faunal assemblage of the surrounding areas will potentially be impacted by the development unless connectivity can be maintained.

Impact on Whiteman Park/Cullacabardee Bushland Ecological Connectivity

The Cullacabardee Bushland forms part of an ecological linkage with the greater Whiteman Park Nature Reserve, which extends both east and west of the proposal and has previously been identified as an “existing or potential bushland/wetland linkage” (Government of Western Australia, 2000b).

The native vegetation occurring through the core areas of Whiteman Park (including Cullacabardee Bushland) has been identified as providing connectivity between the coast and the hills (east-west) and north-south directions (Brown et al., 2009). The proposal will create a barrier, cutting ecological connectivity in an east-west direction and to a lesser degree the north-south direction. Beechboro Road North, Gnangara Road, degraded vegetation, vehicle tracks and the fences either side of the road already create barriers to ecological connectivity at a local level, particularly for ground dwelling fauna.

The proposal intersects a portion of a strip of approximately 1,800 m of native vegetation at this site (Banksia Woodland and Eucalypt Woodland) (see Figure 9.3). A number of priority listed ground dwelling fauna have been previously recorded in the surrounding area, namely the Jewelled Sandplain Ctenotus, Southern Brown Bandicoot and Western Brush Wallaby. The populations of these species and the faunal assemblage of the surrounding areas will potentially be impacted by the development.



Impact on Micro Gardens Park Ecological Connectivity

The Dampland and Eucalypt/Corymbia Woodland at the Tonkin Highway/Reid Highway intersection (Micro Gardens Park) maintains a level of ecological connectivity between Lightning Swamp Bushland, Malaga Regional Space and Koondoola Regional Bushland to the west and Point Reserve to the east (see Figure 9.3). This site has been identified as being part of a “regionally significant fragmented bushland/wetland linkage” (Government of Western Australia, 2000b). Diggings attributed to the Southern Brown Bandicoot were recorded in the Micro Gardens Park and the road reserve near the Reid Highway/Altone Road intersection (see Figure 9.3). Although heavily degraded, the vegetation of the road reserve provides an ecological linkage between areas of suitable habitat.

The proposal will require the clearing of some of the roadside vegetation along Tonkin Highway and Reid Highway. This will impact the resident fauna in this area by restricting/cutting the ecological linkage along approximately 4.5 km of the existing roadside vegetation that occurs between the remnant bushland in the area. The ecological linkages present are already limited due to the presence of numerous roads and the degraded nature of roadside vegetation. The level of ecological linkage still maintained is unknown; however, the presence of Southern Brown Bandicoot diggings (see Figure 9.1) and other fauna recorded using the roadside vegetation suggests that it provides some level of ecological linkage.

9.5 Mitigation and Management

To reduce the proposal’s impacts to existing fauna values, the mitigation hierarchy (i.e. avoid, minimise, rehabilitate and offset) discussed in Chapter 7 has been applied during proposal design and in the development of appropriate mitigation and management strategies and offsets.

To avoid ecologically sensitive areas, the road alignment and design has been altered throughout the planning of the proposal (for further information also refer to Chapters 3 and 4).

To avoid impacts to habitat for the Critically Endangered Western Swamp Tortoise at Twin Swamps Nature Reserve, the interchange at Warbrook Road was relocated to Stock Road.

To avoid an area containing a high concentration of Black Cockatoo breeding trees, the width of the proposal footprint was reduced between Baal Street and Gngangara Road (see Figure 4.3). The updated proposal footprint design reduced the number of breeding trees cleared from 410 to 342 (a reduction of 68 breeding trees).

The proposal alignment predominantly follows existing infrastructure, cleared areas or secondary habitats, which reduces impacts to existing fauna habitats. A total of 586.4 ha or 78.6% of the proposal footprint occurs on these disturbed areas that offer little or no habitat for fauna.

Through design efficiencies the proposal design has been reduced from 1,028.4 ha (fauna study area/development envelope) to about 745.7 ha in size (proposal footprint), which equates to a 282.7 ha reduction. The smaller design footprint reduces impacts to natural fauna habitats by a total of 49.6 ha across the alignment (Table 9.5).

Table 9.5 Reduction of impacts per habitat type

Habitat type	Area in study area (ha)	Area in proposal footprint (ha)	Impact reduction (%)
Natural fauna habitats			
Banksia Woodland	96.3	81.7	15.2%
Eucalypt/Corymbia Woodland	63.7	43.1	32.3%
Dampland	27.1	19.0	29.9%
Wetland	21.8	15.5	28.9%
Secondary habitats			
Modified Vegetation	303.0	208.2	31.3%
Paddock	331.6	255.7	22.9%
Pine Plantation	69.9	51.0	27.0%
Infrastructure/cleared	115.0	71.5	37.8%
Total	1,028.4	745.7	27.5%

To ensure that impacts to the remaining fauna values present within and in close proximity to the proposal footprint are minimised and that the relevant EPA objectives can be met, MRWA commits to the following outcomes:

- A maximum of 201.8 ha of Carnaby's Cockatoo foraging habitat; 120.1 ha of Forest Red-tailed Black Cockatoo foraging habitat; and 120.1 ha of breeding habitat (inclusive of 737 potential breeding trees) and 58.6 ha of roosting habitat for both Black Cockatoo species will be removed.
- A maximum of 159.3 ha of natural fauna habitat will be removed.
- Ecological connectivity will be maintained across the PDNH alignment.
- The occurrence of fauna mortality, associated with vegetation clearing, vehicle interaction will be minimised during construction and operation.

While various management measures are proposed in this PER to achieve these desired outcomes, alternative management strategies may arise with further design, investigations and project planning. MRWA is committed to achieving environmental outcomes through appropriate management measures that are relevant to specific conditions on-site and which may vary from those described in this document.

This approach is consistent with the Environmental Assessment Guideline for Recommending Environmental Conditions (EPA, 2013a).

An EMP will be developed and implemented prior to construction and will include measures for mitigating and managing impacts to fauna values particularly in regard to the clearing of vegetation, use of fauna spotters, risk of fire, spread of weeds and dieback, light and noise impacts and the use of fauna fencing.

The mitigation and management strategies summarised below can be applied to achieve the above environmental commitments for fauna values.

9.5.1 Habitat Loss and Habitat Fragmentation

The following mitigation/management measures will reduce the impacts of habitat loss and habitat fragmentation:

- A total of 21 fauna underpasses and two bridges are planned to be constructed in key locations along the alignment. Refer to Section 9.5.8 for details.
- During construction, boundary fencing or flagging will be used to delineate extent of clearing so clearing outside of the specified boundary will not occur.
- Clearing to occur only within construction footprint in Maralla Road Bushland and Whiteman Park/Cullacabardee Bushland where ecological connectivity is paramount.
- An offset site in Chittering has been purchased to offset the impacts of habitat loss from the proposal and includes 673.5 ha of Black Cockatoo habitat. A summary of the fauna values of the offset site is contained in Chapter 17.
- Retain or rehabilitate roadside vegetation, especially along the Reid Highway section of the proposal footprint to help facilitate fauna movement between local habitats.

9.5.2 Habitat Degradation

The following mitigation/management measures will reduce the impacts of habitat degradation:

- Implement an EMP (Appendix F) to limit the risk of fire, spread of weeds and dieback, rubbish and vehicle tracks caused during construction.
- Retain and translocate hollow logs to surrounding habitats. Logs are an important refuge site for many animal species and take a long time to be created.

9.5.3 Feral Predation

The following mitigation/management measures will reduce the impacts of feral animal predation:

- Retain and translocate hollow logs to surrounding habitats. Logs are an important refuge site for many animal species and provide shelter against predation.
- The use of furniture (objects to provide shelter) in fauna underpasses to reduce risk of predation.
- Revegetation as close to fauna underpasses as possible to reduce risk of predation.
- The use of multiple fauna underpasses close to each other to reduce the risk of predators taking advantage of the funnelling effect of underpasses on fauna.

9.5.4 Fauna Mortalities

The following mitigation/management measures will reduce the impacts of fauna mortalities during the construction and operation phases of the proposal:

- A total of 21 fauna underpasses and two bridges are planned to be constructed in key locations along the alignment. Details on these are covered in Section 9.5.8.
- The use of Banksia and other Black Cockatoo foraging resources will be limited as part of revegetation activities within 10 m of the road. Having foraging resources close to the road will create a higher chance of vehicle impact on these species.
- Clearing to occur outside of spring wherever possible, to minimise impacts to the breeding cycle of resident fauna e.g. nesting birds. If clearing is conducted during spring fauna spotters must be present.
- A trapping and translocation program will be conducted for ground dwelling fauna in areas of native vegetation prior to clearing. Fauna will be released in comparable habitat outside of the construction footprint.

- Fauna spotters will be present during the clearing of native vegetation to help translocate any fauna to adjacent suitable habitat and minimise any mortalities.
- Fauna fencing will be installed on both sides of the road in areas north of Hepburn Avenue along the alignment to a minimum of 100 m north of Maralla Road (Figure 9.5) to restrict fauna access to the road. The fauna fence design will be consistent with MRWA Drawing No. 200331-110 (1,800 mm high and dug into the ground 500 mm). The design of fauna fencing restricts medium to large ground dwelling fauna from obtaining access to the road and guides them to safe crossing points at the fauna underpass locations.
- Fauna escape ramps will be installed a minimum of every 200 m in sections containing fauna fencing. Fauna escape ramps are one-way devices that allow trapped animals safe egress from the road reserve. The ramps are required to be a 1,500 mm high to prevent fauna access in the wrong direction.
- A 40 km/h speed limit will be enforced within the construction zone to mitigate against animal strikes.
- All fauna injured during the construction period will be taken to an authorised veterinarian or wildlife carer.
- Fauna warning signs will be installed in areas where native vegetation occurs next to the roadside.

9.5.5 Altered Fire Regimes

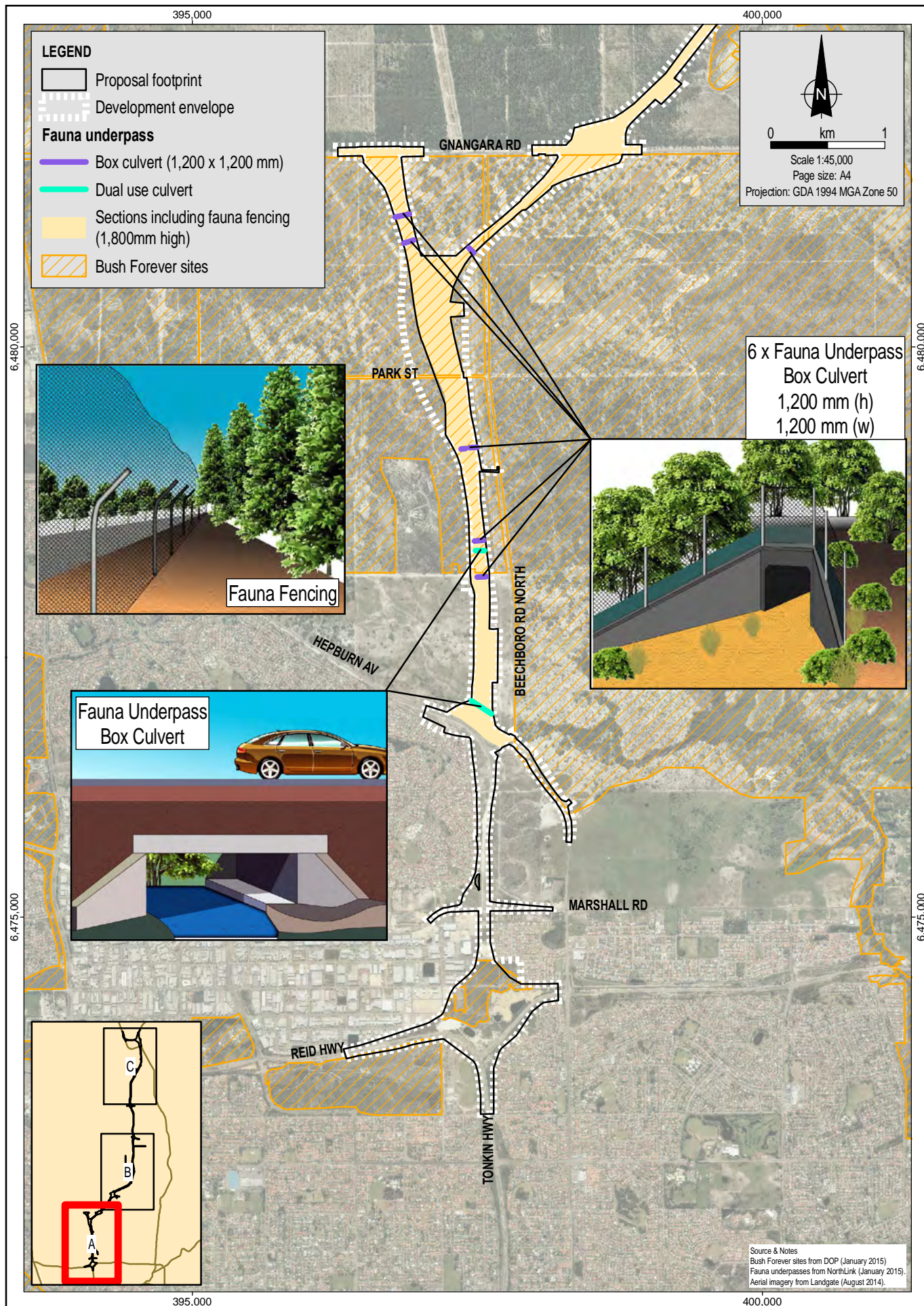
The following mitigation/management measures will reduce the impacts of altered fire regimes:

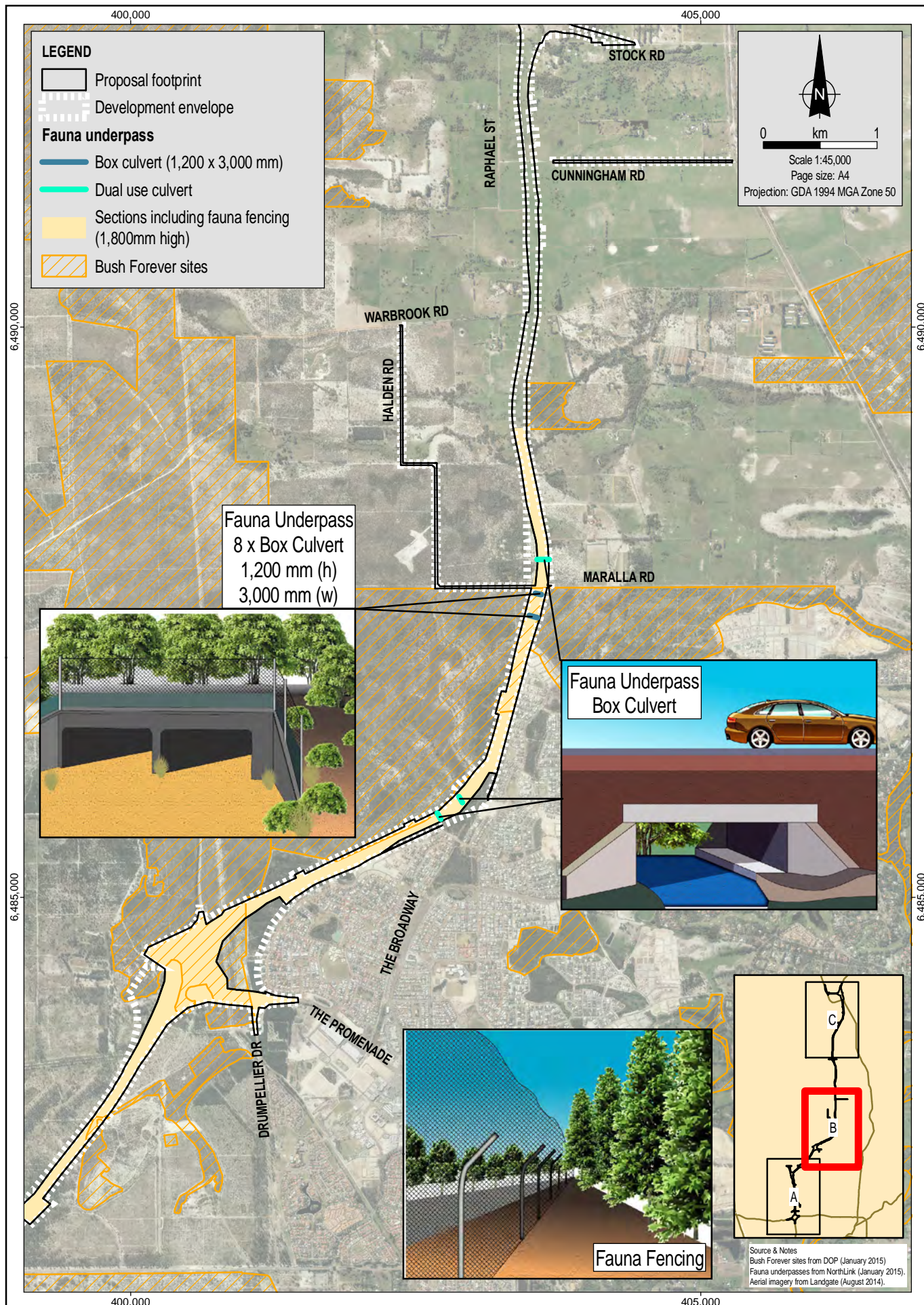
- The risk of fire will be managed by minimising fuel load and controlling ignition sources through the implementation of an EMP and an emergency response procedure.
- Impacts from fire during the operation phase of the proposal will be managed by the inclusion and maintenance of firebreaks.
- The proposal will act as a firebreak and the footpaths and access tracks will allow greater access for fire fighters.

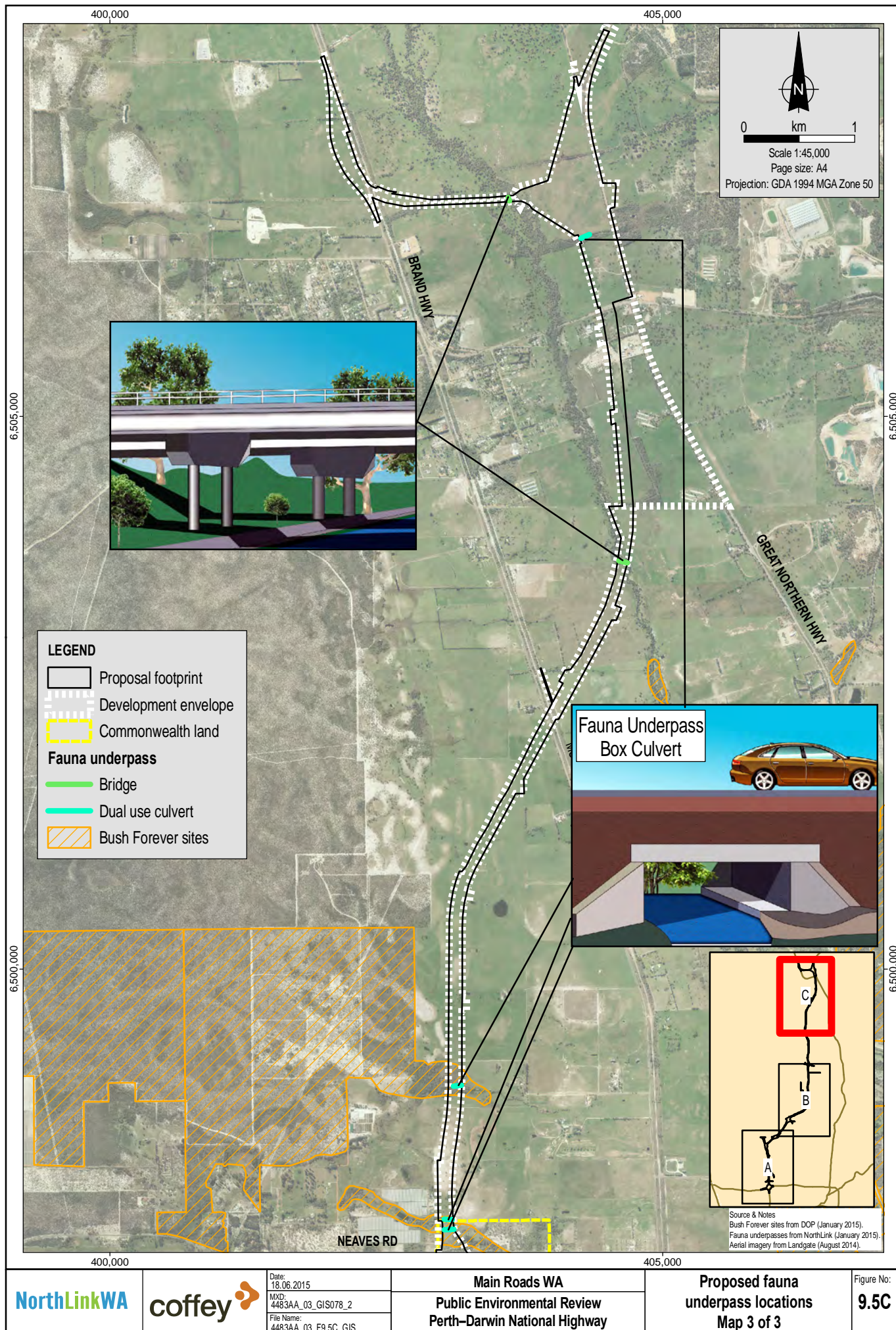
9.5.6 Light and Noise

Impacts to fauna from light and noise are difficult to quantify. The following precautionary measures will minimise the level of impact from light and noise:

- Lights will be directed towards construction activities to limit the amount of light spill to surrounding habitats.
- Where possible low level lighting will be used during the construction phase of the proposal. Artificial screening will be employed along areas adjacent to native vegetation.
- The road lighting will consider AS 4282 'Control of the Obtrusive Effects of Outdoor Lighting' and road lighting will comply with AS 1158 'Road Lighting' to reduce impacts from light pollution.







9.5.7 Changes to Hydrological Conditions

Hydrological impacts and the associated management measures for hydrological conditions are discussed in Chapter 10. There is no significant impact expected for the Western Swamp Tortoise or habitats at Twin Swamp Nature Reserve and Ellen Brook Nature Reserve from alteration of hydrology.

9.5.8 Underpass Design

The underpass locations, sizes and designs have been selected based upon a combination of the following factors:

- The hotspot data obtained from the fauna movement survey.
- Topography – fauna underpasses are not effective unless they are at or slightly below ground level and do not contain a high gradient.
- Information gathered from relevant studies and reports (Bamford, 2011; MRWA, 2010; QDMR, 2000).
- Design that is consistent with MRWA Design of Fauna Underpass document (MRWA, 2010).
- Advice from fauna underpass expert for Western Australia (Chambers, pers. comm.).


Underpass dimensions differ at each location based upon the fauna recorded or expected to occur in the vicinity, as well as the need to limit human interaction, in particular access by four wheel drive vehicles and motorbikes (Table 9.6 and Figure 9.5). Human interference has been identified as a key factor in the reduction of use of fauna underpasses (Bamford, 2011). Fauna underpasses with a height of 1,200 mm are of sufficient size that large animals such as an adult Western Grey kangaroos will readily use the structure, while limiting human access (Chambers, pers. comm.). As such, both the Whiteman Park/Cullacabardee and Maralla Road Bushland sites will have 1,200 mm high underpasses installed, due to the abundance of Western Grey Kangaroo records in the fauna movement survey. Multiple underpass locations are proposed at each site to help facilitate populations on either side of the proposal and to facilitate escape routes in case of fire, flooding or other impacts at one location (QDMR, 2000). Multiple locations ensure that even if an impact occurs on one location, ecological connectivity will still be maintained.

Table 9.6 Summary of fauna underpass design and locations

Location	Underpass design	Dimensions (height x width) (mm)	Length (from opening to opening)	Comments
Hepburn Ave	Dual Purpose Drainage/fauna culvert	Minimum of 300 x 300	Sections of 80 m, 20 and 15 m	Under the PDNH alignment
Cullacabardee Bushland	Box Culvert	1,200 x 1,200	82 m	Under the PDNH alignment
Cullacabardee Bushland	Dual Purpose Drainage/fauna culvert	Minimum of 300 x 300	80 m	Under the PDNH alignment
Cullacabardee Bushland	Box Culvert	1,200 x 1,200	80 m	Under the PDNH alignment
Cullacabardee Bushland	Box Culvert	1,200 x 1,200	Sections of 65 m and 50 m	Under the PDNH alignment



Location	Underpass design	Dimensions (height x width) (mm)	Length (from opening to opening)	Comments
Whiteman Park	Box Culvert	1,200 x 1,200	65 m	Under the PDNH alignment
Whiteman Park	Box Culvert	1,200 x 1,200	Sections of 65 m and 15 m	Under the PDNH alignment
Whiteman Park	Box Culvert	1,200 x 1,200	Sections of 65 m and 15 m	Under the PDNH alignment
Ellenbrook	Dual Purpose Drainage/fauna culvert	Minimum of 300 x 300	65 m	Under the PDNH alignment
Ellenbrook	Dual Purpose Drainage/fauna culvert	Minimum of 300 x 300	65 m	Under the PDNH alignment
Maralla Road Bushland	2 x Box Culvert	1,200 x 3,000	70 m	Location of dual underpasses
Maralla Road Bushland	2 x Box Culvert	1,200 x 3,000	70 m	Location of dual underpasses
Maralla Road Bushland	2 x Box Culvert	1,200 x 3,000	70 m	Location of dual underpasses
Maralla Road Bushland	2 x Box Culvert	1,200 x 3,000	70 m	Location of dual underpasses
Bullsbrook	Dual Purpose Drainage/fauna culvert	Minimum of 300 x 300	Sections of 70 m and 30 m	Under the PDNH alignment
Bullsbrook	Dual Purpose Drainage/fauna culvert	Minimum of 300 x 300	85 m	Under the PDNH alignment
Bullsbrook	Dual Purpose Drainage/fauna culvert	Minimum of 300 x 300	75 m	Under the PDNH alignment
Bullsbrook	Dual Purpose Drainage/fauna culvert	Minimum of 300 x 300	Sections of 40 m and 12 m	Under the PDNH alignment
Bullsbrook/Muchea	Bridge	Unknown	Unknown	Bridge over Ellen Brook, includes fauna friendly design
Muchea	Dual Purpose Drainage/fauna culvert	Minimum of 300 x 300	80 m	Under the PDNH alignment
Muchea	Bridge	Unknown	Unknown	Bridge over Ellen Brook, includes fauna friendly design



To ensure the fauna underpasses will be effectively utilised, the final designs will be completed in consultation with a fauna underpass specialist. The final underpass designs will contain the following features known to encourage use by fauna and reduce the risk of predation (Bamford, 2011; QDMR, 2000):

- Objects for fauna to shelter on or in (furniture) will be installed.
- Where possible openings (sky lights) to allow natural light through will be constructed.
- Revegetation close to the underpass openings will be undertaken using local species.
- Natural flooring such as sand or gravel to help drain water. Fauna tend to avoid underpass locations with surface water present.
- The final 10 to 15 m of fauna fencing is angled towards the underpass opening.

Due to the significance of the ecological linkage at Maralla Road Bushland, wider underpasses have been planned to provide an increased openness ratio. The openness ratio relates to the length, height and width ratio. Higher openness ratios provide greater effectiveness for fauna use (QDMR, 2000). The portion of the proposal that intersects the Maralla Road Bushland runs parallel to a steep dune system. As fauna underpasses are most effective if they are at or slightly below ground level and do not have a steep gradient (QDMR, 2000), the dune system has limited the viable underpass locations to two areas. As such, each location will have fauna underpasses built in pairs (two 3,000 mm x 1,200 mm underpasses side by side) with a 10 to 20 m gap followed by another pair of underpasses. In total, eight underpasses (four pairs of underpasses) will be installed in the Maralla Road Bushland (see Figure 9.5).

To assess the effectiveness of the fauna underpasses, monitoring of the Maralla Road and Whiteman Park/Cullacabardee sites will be undertaken. A minimum of two surveys to identify the size of the population of fauna species most likely to use the underpasses (Western Grey Kangaroos, Southern Brown Bandicoots and Bobtail Skinks etc.) will be completed at least six months prior to construction. Monitoring of the fauna underpasses for a minimum of a year post construction will be completed. If fauna underpasses are deemed not to be effective, management options such as greater rehabilitation of surrounding vegetation and the installation of underpass furniture will be considered as a minimum.

The portion of the proposal intersecting with the Whiteman Park/Cullacabardee Bushland has a total of six fauna underpasses planned. As the site is located close to urban developments a smaller 1,200 mm x 1,200 mm underpass will be used. This will still allow for use by adult Western Grey Kangaroos and Western Brush Wallabies (recorded in the vicinity), but restrict passage by vehicles and bikes. The combination of underpasses and the cul-de-sac of Beechboro Road North would allow access between Cullacabardee Bushland and Whiteman Park. Underpass locations have been selected based on data from the fauna movement survey, road design and topography of the surrounding area.

The roadside vegetation alongside of the Tonkin/Reid Highway facilitates fauna movements between the remnant bushland in the vicinity. The proposal will intersect the Micro Garden Parks habitat reducing east and west fauna movement. Where the proposal design allows, roadside vegetation will be retained or revegetation undertaken to allow for fauna movements to continue.

To help facilitate fauna movement in other sections of the proposal, a total of nine dual use culverts are planned. These culverts act as both drainage culverts and fauna underpasses and use a design with either a raised ledge or separate raised culvert, to give fauna a dry passage while maintaining water flow. The size of the dual use culverts will be based on the drainage requirements of each culvert, but will allow for a minimum of a 300 mm raised ledge or pipe. Drainage lines are conduits for fauna movement as the thick vegetation associated with them provides shelter (MRWA, 2010). Two bridges will be created over Ellen Brook (see Figure 9.5). Bridges will be designed to be of sufficient height to allow fauna passage along the drainage line.



9.6 Residual Environmental Impact

Of the potential impacts identified, habitat loss and habitat fragmentation (including the associated loss of ecological connectivity) are the major residual impacts. These impacts can be readily managed to meet the EPA's objectives (as outlined in Section 9.1).

The proposal is likely to have a significant effect on both Black Cockatoo species (Carnaby's and Forest Red-tailed) based upon the Significant Impact Guidelines 1.1 (DOTE, 2013). However, with the appropriate mitigation measures (see Section 9.5) and offsets (see Chapter 17) the proposal is not expected to have an unacceptable effect on either Black Cockatoo species and will meet the EPA's objectives. A summary of impacts and mitigations for the proposal is covered in Table 9.7.

9.6.1 Habitat Loss

The proposal will result in the clearing of 159.3 ha of native fauna habitat, including 81.7 ha of Banksia Woodland, 43.1 ha of Eucalypt/Corymbia Woodland, 19 ha of Dampland habitat and 15.5 ha of Wetland habitat. The 159.3 ha of natural vegetation in the proposal footprint is distributed over a large distance (approximately 38 km) thus spreading the expected impacts. The design of the proposal has predominantly followed existing infrastructure, cleared areas or secondary fauna habitats (78.6% of the proposal footprint). The remaining portions of the proposal contain natural habitat (21.4%).

Approximately 201.8 ha of quality Carnaby's Cockatoo foraging habitat, 120.1 ha of quality Forest Red-tailed Black Cockatoo foraging habitat, 58.6 ha of Black Cockatoo roosting habitat, 737 trees with a DBH over 500 mm and 118.2 ha of potential Black Cockatoo breeding habitat will be impacted. These impacts will reduce the availability of foraging, roosting and future breeding resources at the local scale. However, the proposal footprint is not within the current breeding range of both Black Cockatoo species and no significant roost site locations have been recorded in the proposal footprint.


The proposal will clear Black Cockatoo habitat, including vegetation that provides food resources and roosting sites in the non-breeding season for the Carnaby's Cockatoo and Marri and Jarrah Woodland in an area of the southwest of WA that receives more than 600 mm of annual average rainfall. Under the critical habitat criteria in the recovery plan for the Carnaby's Cockatoo and the Forest Red-tailed Black Cockatoo both of these actions constitute a significant impact (DPAW, 2013a; Chapman, 2007). However, with the appropriate mitigation measures and offsets the proposal is not expected to have an unacceptable effect on either Black Cockatoo species and will meet the EPA's objectives (outlined in Section 9.1).

Due to the widespread distribution of the migratory avifauna (Rainbow Bee-eater, Great Egret and Cattle Egret) and non-reliance on habitats specific to the proposal, impacts to these species are not likely to be significant.

Vegetation clearing will result in the loss of habitat for species of ground dwelling conservation significant fauna, including the Black Striped-snake (124.8 ha), Jewelled Sandplain Ctenotus (81.7 ha), Western Brush Wallaby (124.8 ha) and Southern Brown Bandicoot (19 ha). These are the most likely species to be directly impacted by the proposal. Due to their limited dispersal ability they are more likely to be impacted by habitat fragmentation, road mortalities and loss of suitable habitat. The implementation of fauna underpasses, environmental management plan and fauna-proof fencing will lessen the impact to these species during the construction and operation phases of the proposal. The impact to ground-dwelling conservation significant fauna is not likely to be significant.

9.6.2 Ecological Connectivity

The loss of ecological connectivity is a potential issue, especially around Micro Gardens Park, Cullacabardee Bushland and the Maralla Road Bushland. Resident fauna populations at these locations will be affected by an increased risk of vehicle collisions and a higher susceptibility to impacts such as fire, disease and



predation which could lead to localised extinction. The 21 planned fauna underpasses and two bridges along the alignment will allow for the maintenance of ecological connectivity. Although fauna movements will be adversely impacted, the implementation of the appropriate size, location and design of fauna underpasses, in particular around the Maralla Road and Whiteman Park/Cullacabardee Bushlands, will lessen this impact to the lowest practicable level.

9.6.2.1 Maralla Road Bushland

The maintenance of ecological connectivity at the Maralla Road site is important due to the bottleneck that occurs between Ellenbrook Estate and Maralla Road. This location restricts access in both an east and west direction towards Bush Forever sites 300, 301 and 399, Ellenbrook Nature Reserve and Walyunga National Park. The proposal will inevitably cause a restriction on fauna movement throughout this area. The installation of eight (four dual) underpasses of 3,000 mm x 1,200 mm with appropriate design features will allow the maintenance of some level of ecological connectivity through this area.

9.6.2.2 Whiteman Park/Cullacabardee Bushland


The Cullacabardee Bushland forms part of an ecological linkage with the greater Whiteman Park Nature Reserve (Government of Western Australia, 2000b) that extends both east and west of the proposal. As the proposal intersects a portion of approximately 1,800 m of this site, fauna underpasses had to be spread out to ensure ecological connectivity was maintained along the entire distance. The installation of six underpasses of 1,200 mm x 1,200 mm with appropriate design features will allow the maintenance of some level of ecological connectivity through this area.

9.6.2.3 Micro Gardens Park


The ecological connectivity around the Micro Gardens Park area (Tonkin and Reid Highway intersection) is already highly disrupted by the current road network and infrastructure. However, through roadside vegetation maintained along the corridor some ecological linkage can occur. The level of linkage currently maintained is unknown, but a number of ground dwelling fauna species were recorded in the roadside vegetation including the diggings of the conservation significant Southern Brown Bandicoot (P5). The proposal will result in the loss of the majority of the roadside vegetation through this area with the widening of many of the roads. Where the proposal design allows, roadside vegetation will be retained or revegetation undertaken to allow for fauna movements to continue. Due to design restrictions of connecting with existing infrastructure (multiple large roads through the intersection) ecological connectivity could not be maintained through the use of underpasses.

Table 9.7 Summary of residual impacts to terrestrial fauna following implementation of management and mitigation measures


Type of impact	Predicted impact	Management and mitigation	Residual impact
Habitat loss	<ul style="list-style-type: none"> • Loss of fauna habitat from clearing vegetation. • Removal of Black Cockatoo habitat. 	<ul style="list-style-type: none"> • Avoidance of ecologically sensitive areas in design and a reduction in the proposal footprint design. • An EMP will be developed and implemented. • During construction use boundary fencing or flagging will be used. 	<ul style="list-style-type: none"> • Loss of 159.3 ha of natural fauna habitat. • Loss of Black Cockatoo habitat: <ul style="list-style-type: none"> – 201.8 ha Carnaby's Cockatoo foraging habitat. – 120.1 ha Forest Red-tailed Black Cockatoo foraging habitat. – 58.6 ha roosting habitat. – 120.1 ha potential breeding habitat (including 737 potential breeding trees). • Loss of conservation significant habitat: <ul style="list-style-type: none"> – 15.5 ha Great Egret habitat. – 271.2 ha Cattle Egret habitat. – 367.5 ha Rainbow Bee-eater habitat. – 81.7 ha Jewelled Sandplain Ctenotus habitat. – 124.8 ha Black Striped-snake, Western Carpet Python and Western Brush Wallaby habitat. – 19 ha Southern Brown Bandicoot habitat.



Type of impact	Predicted impact	Management and mitigation	Residual impact
Habitat fragmentation	<ul style="list-style-type: none"> Loss of ecological connectivity leading to increased risk of loss of genetic diversity and ecological diversity, increased risk of vehicle collisions and a higher susceptibility to impacts such as fire, disease and predation. 	<ul style="list-style-type: none"> Retain as much roadside vegetation as possible, especially along the Tonkin/Reid Highway section of the proposal footprint. A total of 21 fauna underpasses and two bridges are planned to be constructed in key locations along the alignment. Fauna underpass monitoring program will be developed. 	<ul style="list-style-type: none"> Fragmentation to fauna habitats will increase due to the proposal. However, the inclusion of fauna underpasses allows the maintenance of ecological connectivity to the greatest practicable extent.
Habitat degradation	<ul style="list-style-type: none"> Increased spread of weeds and dieback. Increased occurrence of rubbish dumping and vehicle tracks. Edge effects. 	<ul style="list-style-type: none"> Implement an environmental management plan to limit spread of weeds and dieback, rubbish and vehicle tracks caused during construction. Retain and translocate hollow logs to surrounding habitats. 	<ul style="list-style-type: none"> The proposed measures will limit the impacts created by weeds, dieback, vehicles tracks and rubbish during construction. These impacts are already common and widespread through the region and the proposal is unlikely to be the only cause of these impacts. There will be edge effects where the alignment abuts native vegetation.



Type of impact	Predicted impact	Management and mitigation	Residual impact
Fauna mortalities and feral predation	<ul style="list-style-type: none"> Increased risk of fauna mortalities from vehicle collision. Potential for fauna to be killed or injured during vegetation clearing. Increased predation of fauna due to loss of shelter. 	<ul style="list-style-type: none"> Inclusion of fauna fencing and fauna underpasses in appropriate areas. Retention and translocation of hollow logs to provide shelter against predation. The use of furniture in fauna underpasses. Revegetation close to fauna underpasses and the use of multiple fauna underpasses to reduce the risk of predation. Fauna warning signs on road to alert drivers of the potential risk. Trapping and translocation program to be completed prior to construction. Use of fauna spotters during clearing. 	<ul style="list-style-type: none"> The installation of fauna fencing and underpasses in areas most likely to contain fauna will assist species in having a safe passage across the alignment. The implementation of a trapping and translocation program and the use of fauna spotters will reduce the risk and harm to fauna during vegetation clearing. Inevitable fauna mortalities will occur during the construction and operation phases of the proposal, the management measures will lessen the risk and number of incidences.
Altered fire regime	<ul style="list-style-type: none"> Increased frequency, intensity and duration of fires started by unnatural causes. 	<ul style="list-style-type: none"> The risk of fire will be managed by minimising fuel load and controlling ignition sources during construction through the implementation of an EMP and an emergency response procedure. Impacts from fire during the operation phase of the proposal will be managed by the inclusion and maintenance of firebreaks. 	<ul style="list-style-type: none"> With appropriate management plans and the inclusion and maintenance of firebreaks the risk of fire and its potential damage will be reduced.



Type of impact	Predicted impact	Management and mitigation	Residual impact
Noise and light	<ul style="list-style-type: none"> Impacts may disrupt the natural behaviour of fauna in the close vicinity to the proposal, including disorientation of migratory or nocturnal fauna, increased physiological stress, the avoidance of habitats close to the proposal and the abandoning of previously used roost or nest sites. 	<ul style="list-style-type: none"> Lights will be directed towards construction activities to limit the amount of light spill to surrounding habitats. Where possible low level lighting will be used and artificial screening will be employed. The road lighting will comply with AS 1158 'Road Lighting' and consider AS 4282 'Control of the Obtrusive Effects of Outdoor Lighting' to reduce impacts from light pollution. 	<ul style="list-style-type: none"> Impacts to fauna from light and noise are difficult to quantify. Precautionary measures will be implemented to minimise the level of impact they potentially provide.
Hydrological alteration	<ul style="list-style-type: none"> Potential for groundwater and surface water flows to be disrupted leading to habitat degradation for water dependent vegetation. 	<ul style="list-style-type: none"> Fauna impacts from the drainage and groundwater alterations will be managed under the hydrological impacts outlined in Chapter 10. 	<ul style="list-style-type: none"> The flow of surface and ground water will not be severely impacted by the proposal. Habitat degradation due to altered hydrological flows is expected to be negligible.



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