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**NorthLinkWA**  
Perth-Darwin National Highway

# Condition Environmental Management Plan

## Fauna – Construction

Perth–Darwin National Highway (Swan Valley Section)

JANUARY 2019





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Document Control					
Revision	Date	Description	Prepared	Reviewed	Approved
A	04/07/2016	Draft (Coffey v1)	M. Holliday	E. Waterhouse	B. Napier
B	10/08/2016	Draft (Coffey v2)	M. Holliday	E. Waterhouse	E. Waterhouse
C	04/10/2016	Draft for consultation (Coffey v3)	M. Holliday T. Vu	B. Napier	D. Morley
0	22/11/2016	Final for submission to OEPA (Coffey v4)	T. Vu	B. Napier	D. Morley
1	23/12/2016	Addressed OEPA comments (Coffey v5)	T. Vu	D. Morley	D. Morley
2	07/02/2017	Addressed OEPA comments (Coffey v6)	M. Holliday	D. Morley	D. Morley
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4	08/01/2019	Amended following annual review (ELA v8)	D. Morley	J. Longstaff	J. Longstaff

Prepared by:



Coffey Services Australia Pty Ltd  
 Level 1, Bishops See, 235 St Georges Terrace  
 Perth WA 6000 Australia  
 t: +61 8 6218 2100  
 ABN: 55 139 460 521  
 coffey.com

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 EP2016/045



Eco Logical Australia Pty Ltd  
 Level 1, Bishops See, 235 St Georges Terrace  
 Perth WA 6000 Australia  
 t: +61 8 6218 2200  
 ABN: 87 096 512 088  
 ecoaus.com.au



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# 1 SUMMARY

This Condition Environmental Management Plan (Condition EMP) (this plan) is submitted in accordance with Ministerial Statement No. 1036 conditions 7-1 and 12-1 for the Perth–Darwin National Highway (Swan Valley Section) by Main Roads Western Australia. It is a revision of the previous version approved by the former Office of the Environmental Protection Authority (OEPA) on 15 February 2017 (reference NLWA-03-EN-RP-0050 / Rev 3).

This document sets out the environmental management actions to manage the potential impacts of the proposal on conservation significant fauna during construction.

Table 1 details the environmental management targets to measure achievement of the environmental objectives that must be met through implementation of the plan.

**Table 1 Fauna – Construction – Condition EMP summary**

Item	Details
Title of proposal	Perth–Darwin National Highway (Swan Valley Section)
Proponent name	Commissioner for Main Roads Western Australia
Ministerial Statement No.	1036
Purpose of this Condition EMP	The Fauna – Construction – Condition EMP is submitted to fulfil the requirements of conditions 7-1 and 12-1 of the above Statement.
EPA’s environmental objectives for the key environmental factors	To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.
Environmental objective	To ensure that impacts to conservation significant fauna are minimised as far as practicable during the final design and construction of the proposal.
Management targets	Management target 1: Fauna underpasses and the fauna bridge will be designed, situated and constructed using best practice guidelines in consultation with a fauna underpass specialist, and based on data from the fauna movement survey.
	Management target 2: Minimise mortality of conservation significant fauna during construction.
	Management target 3: No disturbance of active Black Cockatoo nests.



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## 2 CONTEXT, SCOPE AND RATIONALE

### 2.1 Description of the Proposal

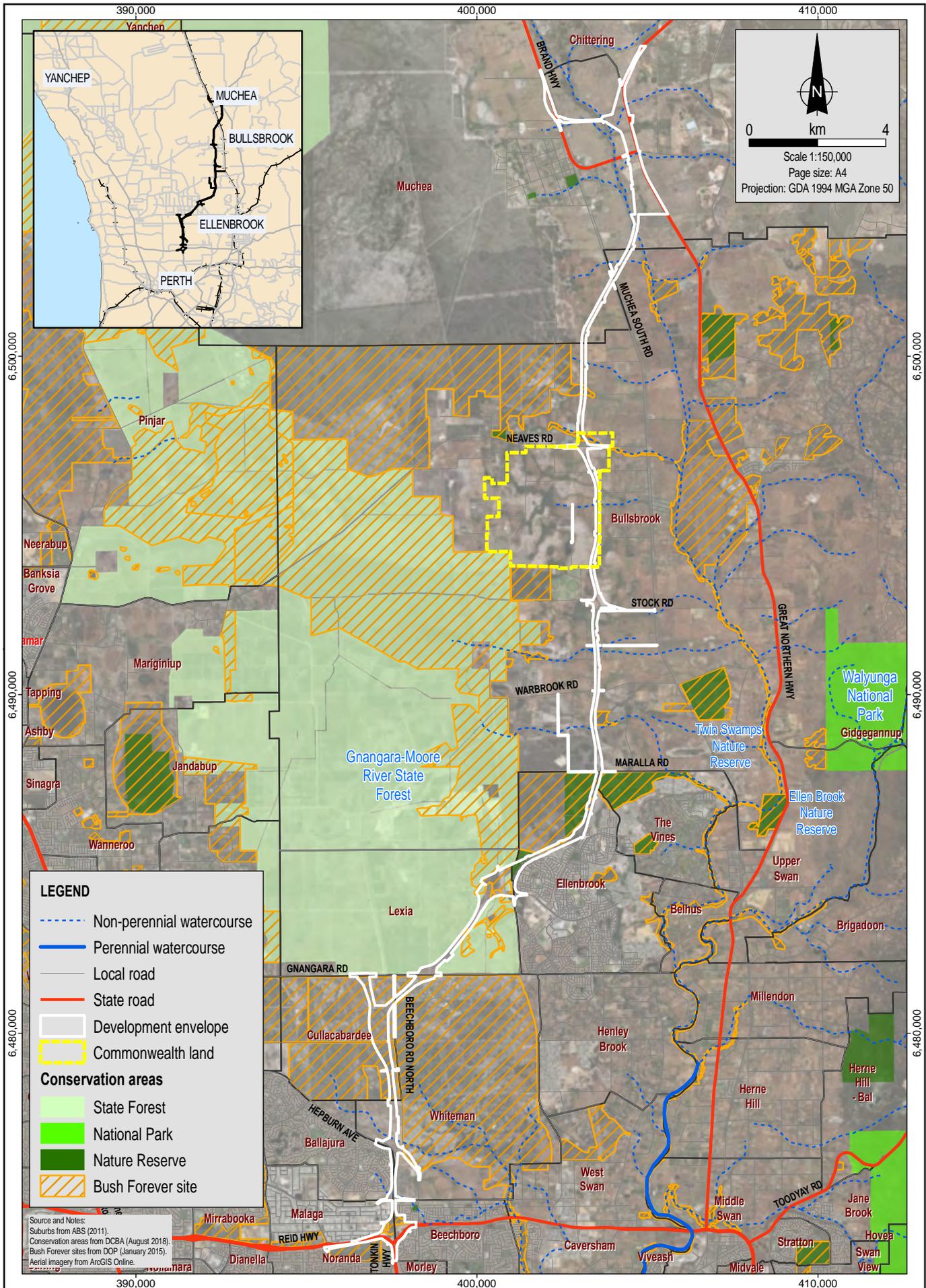
Main Roads Western Australia (MRWA) proposes to construct a new 38 km long section of the Perth–Darwin National Highway (PDNH) (Figure 1) between Malaga and Muchea, in Western Australia (the proposal). The proposal is a dual carriageway highway and will connect the intersection of Tonkin Highway and Reid Highway in the south with Great Northern Highway and Brand Highway in the north.

### 2.2 Key Environmental Factors

This plan specifically addresses the terrestrial fauna environmental factor, which is part of the Land theme. The relevance of this environmental factor to the proposal is presented in Table 2.

**Table 2 Environmental aspects of the proposal for terrestrial fauna (construction phase)**

Environmental aspect of the proposal	Affected species, populations and communities	Impact	Activity/Threatening process
Clearing of native vegetation.	<ul style="list-style-type: none"> <li>• Southern Brown Bandicoot (Quenda)</li> <li>• Western Brush Wallaby</li> <li>• Western Carpet Python</li> <li>• Jewelled Sandplain Ctenotus</li> <li>• Black-striped Snake</li> </ul>	Loss of ecological connectivity (habitat/ population fragmentation).	<ul style="list-style-type: none"> <li>• Loss of ecological connectivity leading to increased risk of loss of genetic diversity and ecological diversity.</li> <li>• Severance of ecological linkages.</li> <li>• Increased risk of fire, disease and predation.</li> <li>• Potential for fauna to be killed or injured by construction machinery during construction activities other than clearing.</li> </ul>
Clearing of native vegetation. Presence of open trenches.	<ul style="list-style-type: none"> <li>• Carnaby’s Black Cockatoo</li> <li>• Forest Red-tailed Black Cockatoo</li> <li>• Australia Bustard</li> <li>• Great Egret</li> <li>• Cattle Egret</li> <li>• Rainbow Bee-eater</li> <li>• Southern Brown Bandicoot (Quenda)</li> <li>• Western Brush Wallaby</li> <li>• Western Carpet Python</li> <li>• Jewelled Sandplain Ctenotus</li> <li>• Black-striped Snake</li> </ul>	Fauna mortalities and feral predation.	<ul style="list-style-type: none"> <li>• Increased risk of fauna mortalities from fauna trapped in trenches.</li> <li>• Potential for fauna to be killed or injured during vegetation clearing.</li> <li>• Increased predation due to loss of shelter.</li> </ul>



## 2.3 Requirements of the Condition

This plan is submitted in accordance with Ministerial Statement 1036, conditions 7-1 and 12-1 to 12-3 for the proposal.

As required under condition 5-1, this plan will be made publicly available for the life of the proposal.

The requirement of these conditions and where they are addressed in this plan are described in Table 3.

The former of Department of Parks and Wildlife (DPAW) was replaced by the Department of Biodiversity, Conservation and Attractions (DBCA) on 1 July 2017. References to DPAW in this plan have been changed to DBCA except for historical usage and direct quotations of the condition text from Ministerial Statement No. 1036.

**Table 3 Summary of conditions**

Condition No.	Condition	Section of this plan
7-1	Prior to the commencement of ground disturbing activities, or as otherwise agreed in writing by the CEO, the proponent shall prepare and submit Condition Environmental Management Plans to satisfaction of the CEO to demonstrate that the environmental objectives in condition 12-1 will be met.	This plan
7-2	The Condition Environmental Management Plans shall:	Section 3.2
	1. Prioritise risk-based management actions that will be implemented to meet the environmental objectives in condition 12-1.	
	2. Specify measurable management targets for determining the efficacy of the risk-based management actions.	Section 1 Section 3.3
	3. Specify monitoring to be conducted to measure the efficacy of management actions against management targets.	Section 3.4
	4. Specify, in the event that the management targets are not achieved a procedure for revision of management actions and changes to proposal activities. The procedure shall include an investigation to determine the cause of the management targets being exceeded.	Section 3.5
	5. Provide the format and timing for annual reporting required by condition 4-6 for: a) Verification of the implementation of management actions to demonstrate that condition 12-1 has been met for the reporting period. b) Reporting on the efficacy of management actions against management targets.	Section 3.6
	6. Provide for reporting when management actions are not implemented.	Section 3.6.2
7-3	After receiving notice in writing from the CEO that the Condition Environmental Management Plans satisfies the requirements of condition 7-2 for condition 12-1, the proponent shall prior to the commencement of ground disturbing activities: 1. Implement the provisions of the approved Condition Environmental Management Plan.	This plan

Condition No.	Condition	Section of this plan
	2. Continue to implement the approved Condition Environmental Management Plan until the CEO has confirmed by notice in writing that the proponent has met the relevant objectives specified in the approved Condition Environmental Management Plan and no longer needs to implement that particular Condition Environmental management Plan.	
7-4	<p>In the event that monitoring, tests, surveys or investigations indicate that management actions specified in the Condition Environmental Management Plan are not implemented or that management targets specified in the Condition Environmental Management Plans are exceeded, the proponent shall:</p> <ol style="list-style-type: none"> <li data-bbox="308 734 1270 810">1. Report the exceedance or failure to implement management actions in writing within 7 days of identification.</li> <li data-bbox="308 817 1270 893">2. Investigate to determine the cause of the management actions not being implemented and/or management targets being exceeded.</li> <li data-bbox="308 900 1270 1005">3. Investigate to provide information for the determination by the CEO of potential environmental harm or alteration of the environment that occurred due to the failure to implement management actions.</li> <li data-bbox="308 1012 1270 1451">4. Provide a report to the CEO within 60 days of the reporting required by condition 7-4(1). The report shall include:               <ol style="list-style-type: none"> <li data-bbox="395 1093 1270 1169">a) Cause for failure to implement management actions and/or management targets exceeded.</li> <li data-bbox="395 1176 1270 1207">b) The findings of the investigation required by conditions 7-4(2) and 7-4(3).</li> <li data-bbox="395 1214 1270 1319">c) Details of revised and/or additional management actions to be implemented to prevent exceedance of the management targets and/or ensure implementation of management actions.</li> <li data-bbox="395 1326 1270 1357">d) Relevant changes to proposal activities.</li> <li data-bbox="395 1364 1270 1440">e) Measures to prevent, control or abate the environmental harm which may have occurred.</li> </ol> </li> </ol>	Section 3.6.2
7-5	The proponent may review and revise the Condition Environmental Management Plans, or as otherwise specified by the CEO.	Section 4
7-6	The proponent shall implement the latest revision of the Condition Environmental Management Plan, which the CEO has confirmed by notice in writing, satisfies the requirements of condition 7-2.	Section 4
12-1	<p>The proponent shall manage the construction of the proposal to meet the following environmental objective:</p> <ol style="list-style-type: none"> <li data-bbox="308 1740 1270 1805">1. To ensure that impacts to conservation significant fauna are minimised as far as practicable during final design and construction of the proposal.</li> </ol> <p>Through implementation of the Fauna – Construction – Condition Environmental Management Plan approved by the CEO.</p>	Section 1
12-2	The proponent shall prepare the Fauna – Construction – Condition Environmental Management Plan required by condition 7-1 on advice of the Department of Parks and Wildlife.	Section 5

Condition No.	Condition	Section of this plan
12-3	The Fauna – Construction – Condition Environmental Management Plan shall include management actions, including but not limited to :	Section 3 Section 3.2
	1. Best practice design, including shape, size, furniture and sky lights of fauna underpasses.	
	2. Trapping and relocation of ground dwelling fauna prior to clearing.	Section 3.2
	3. Presence of fauna spotters during clearing.	Section 3.2
	4. Dispersal and relocation of fauna identified by fauna spotters as required by condition 12-3(3) during clearing.	Section 3.2
	5. Any trenching activities.	Section 3.2
6. Ensuring that if clearing is to be undertaken, the proponent shall use an appropriately experienced Black Cockatoo expert to thoroughly inspect the area for Black Cockatoo breeding activity, in particular nesting, and if the area is found to be in use, clearing in the area shall be postponed until such time as determined suitable, on the advice of the Department of Parks and Wildlife.	Section 3.2	

## 2.4 Rationale and Approach in Meeting the Environmental Objective

Results of baseline surveys and a number of assumptions and uncertainties inform the management approach for meeting the environmental objectives stated in Section 1. The identified management actions, management targets and proposed review and revision of management actions are aligned with the overall management approach.

### 2.4.1 Results of Baseline Fauna Surveys Conducted

Level 1 opportunistic and targeted Level 2 fauna surveys were undertaken in accordance with relevant guidelines. The Level 2 survey included track counts to determine appropriate locations for fauna underpasses to maintain ecological connectivity. The clearing of vegetation will result in the loss of 159.3 ha of natural fauna habitat.

#### Fauna Habitat

Four natural fauna habitats were recorded within the study area: Banksia Woodland, Eucalypt/Corymbia Woodland, Dampland and Wetland. Three secondary habitats were also recorded: Modified Vegetation, Paddock and Pine Plantation (Coffey, 2015a).

#### Fauna Assemblage

A total of 97 species were recorded during the Level 1 opportunistic survey and Level 2 trapping survey, including 1 fish, 6 amphibian, 19 reptile, 62 bird and 9 mammal species. No introduced species were recorded (Coffey, 2015b).

#### Conservation Significant Species

Four conservation significant species were recorded during the surveys (Coffey, 2015b):

- Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) – Endangered (*Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)) and Schedule 1 (*Wildlife Conservation Act 1950* (WC Act)).

- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) – Vulnerable (EPBC Act) and Schedule 1 (WC Act).
- Australian Bustard (*Ardeotis australis*) – Priority 4 (former Department of Parks and Wildlife (DPAW) Priority list).
- Southern Brown Bandicoot (*Isodon obesulus fusciventer*) (Quenda) – Priority 5 (DPAW Priority list).

A further seven species of conservation significance are considered likely to occur in the proposal footprint (Coffey, 2015b):

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

#### **Black Cockatoo Habitat**

The proposal footprint contains 737 potential breeding trees for Black Cockatoo that have a diameter at breast height (DBH) over 500 mm. A total of 13 trees contained suitable sized (at least 120 mm entrance size) hollows. There are no known breeding records for Black Cockatoos in the proposal footprint or its vicinity. No evidence of roosting was recorded during surveys for the Public Environmental Review (PER) and there are no known roost sites within the proposal footprint. Evidence of foraging was observed in the study area, showing that Black Cockatoos actively forage in the area (Coffey, 2015b).

#### **Ecological Connectivity**

The proposal predominantly extends north-south, potentially disrupting ecological connectivity in an east-west direction. Whiteman Park/Cullacabardee Bushland and Maralla Road Bushland were identified as being at risk of disrupted ecological connectivity (Coffey, 2015a).

Maralla Road Bushland (Figure 2A) forms part of Perth's regional ecological linkages. It links Bush Forever sites 300, 301 and 399, Ellenbrook Nature Reserve and Walyunga National Park (Coffey, 2015a).

The Cullacabardee Bushland links with Whiteman Park, forming part of Perth's regional ecological linkages (Government of Western Australia, 2000). This linkage connects Bush Forever sites 198 and 304 and extends east and west of the proposal footprint (Coffey, 2015a) (see Figure 2A).

Beechboro Road North, Gngangara Road, degraded vegetation associated with the transmission line easement, vehicle tracks and roadside fences are existing barriers to ecological connectivity, particularly for ground-dwelling fauna.

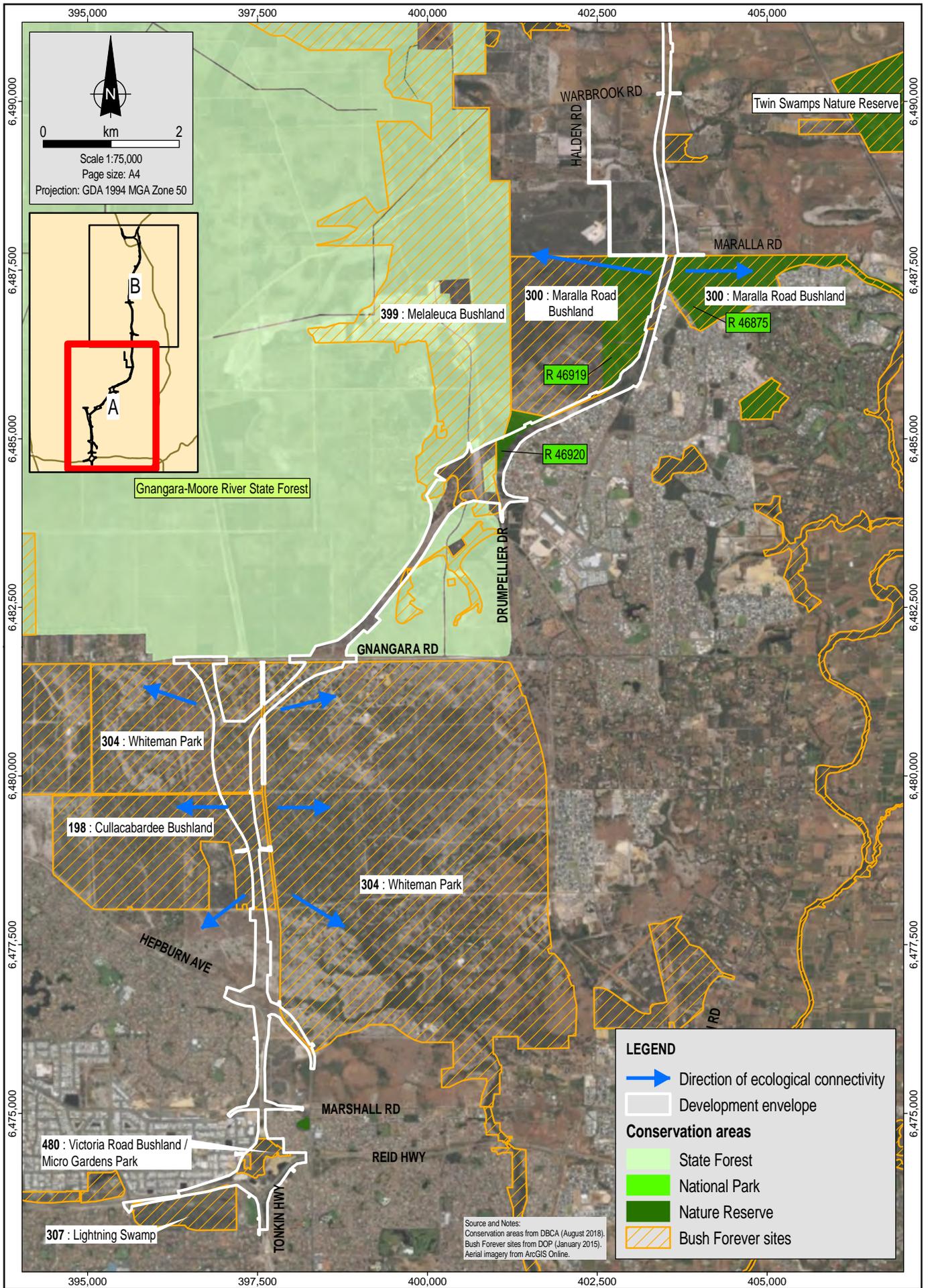
Bush Forever site 97 links with Bush Forever site 100 and continues into Bush Forever site 294 (Figure 2B). Neaves Road is an existing barrier for Bush Forever site 100 and the vegetation in this area is completely degraded (Coffey, 2014). An underpass in this area would have no benefit to fauna.

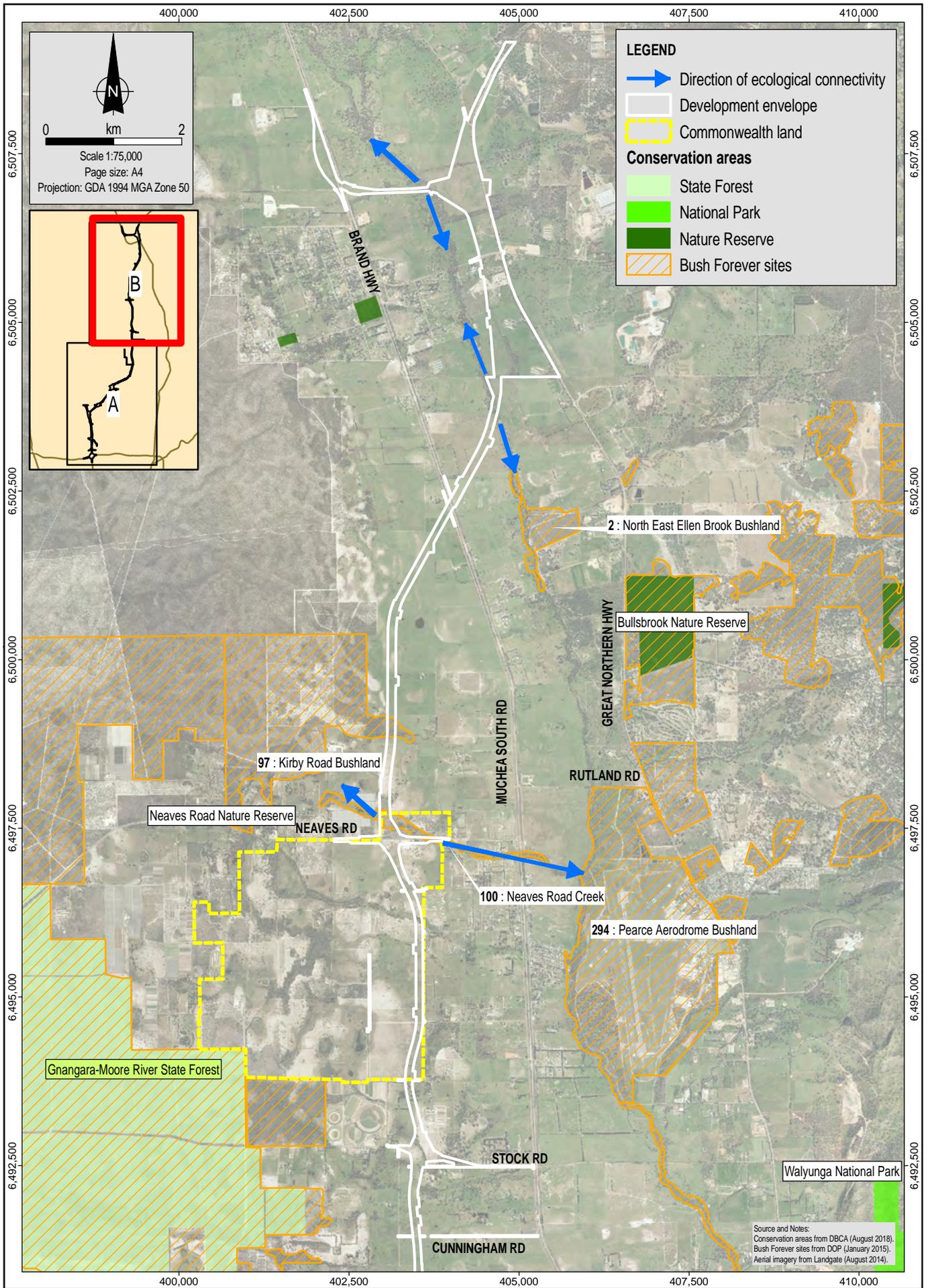


## **Fauna Movement**

A total of 255 fauna crossings were recorded at the Whiteman Park/Cullacabardee Bushland and 99 at Maralla Road Bushland. The majority of records at both sites belong to the Western Grey Kangaroo, other species recorded included Bobtail skinks, smaller skinks, snakes, goanna and emu (Coffey, 2015b).

Nine fauna crossing hotspots were identified at Whiteman Park/Cullacabardee Bushland; two were north of Baal Street and seven south of Baal Street. Two hotspots were located south of Maralla Road Bushland (Coffey, 2015b).





**LEGEND**

- Direction of ecological connectivity
- Development envelope
- Commonwealth land

**Conservation areas**

- State Forest
- National Park
- Nature Reserve
- Bush Forever sites

Source and Notes:  
 Conservation areas from DBCA (August 2016).  
 Bush Forever sites from DOP (January 2015).  
 Aerial imagery from Landgate (August 2014).

## 2.4.2 Key Assumptions and Uncertainties

The key assumption and uncertainties within this plan include:

- Fauna underpasses and fauna bridges are effective in maintaining ecological linkages.
- Direct impacts to fauna during construction are limited to mortality during construction activities (clearing and plant movement).
- Most fauna will disperse in front of the clearing front where they are able.
- Fauna fencing will exclude fauna from the road during operations limiting the potential for road mortality.
- Conservation significant species were assessed for their likelihood to occur within the proposal footprint, by reviewing current distribution, habitat requirement and location and age of previous records in the vicinity of the study area.
- Previously cleared areas within the development envelope do not contain habitat requirements or known records of conservation significant species. Conservation significant fauna are not expected to occur within previously cleared areas, therefore these areas do not require management during the construction of the proposal to meet the environmental objective.
- If any conservation significant species assumed not to occur in the proposal footprint were subsequently recorded, the proposed management actions would ensure there were no additional impact. Current management actions ensure conservation significant ground dwelling fauna such as the Western Quoll (which has been recently observed in the vicinity of the project area) would be trapped and relocated in the trapping program. The current distribution of Baudin's Cockatoo is outside the proposal footprint. Management actions in place for the other Black Cockatoos would mitigate impacts to this species (Coffey, 2015a).

## 2.4.3 Management Approach

The management approach has been informed by best practice and recent experience on similar road projects in Western Australia. The hierarchical approach taken focuses on avoiding ecologically sensitive areas through, for example, route selection. If not avoided, management aims to minimise the duration, intensity and/or extent of impacts on fauna during construction. Any significant unavoidable residual impacts on fauna will be offset.

## 2.4.4 Rationale for Choice of Management Targets

The Public Environmental Review (PER) for the proposal identified ecological connectivity loss, conservation significant fauna mortalities and degradation to fauna habitat from indirect impacts as significant environmental values with the potential to be impacted by the proposal. The rationale for the choice of management targets is described below.

**Management target 1: Fauna underpasses and the fauna bridge will be designed, situated and constructed using best practice guidelines in consultation with a fauna underpass specialist, and based on data from the fauna movement survey.**

This management target focuses on the design and construction of the fauna underpasses and the fauna bridge – if they are not designed and built to enable and encourage fauna use, they will not be effective in managing issues associated with loss of ecological connectivity, a key environmental objective for the proposal.

The disruption of ecological linkages and potential fragmentation of habitat that supports fauna populations is a key risk for the proposal. Fauna movement surveys found that Western Grey Kangaroos formed a large



percentage of the fauna moving through the area and along existing ecological linkages. Fauna underpasses and bridges have been shown to be effective for allowing the movement of species between previously linked or intact habitat, including for example the Western Grey Kangaroo. Locations for the fauna underpasses and the fauna bridge were identified based on the fauna movement survey.

**Management target 2: Minimise mortality of conservation significant fauna between Hepburn Avenue and Maralla Road during construction.**

This management target focuses on achieving a trapping and relocation program that is as effective as practicable in removing fauna from the proposal footprint and reduces the risk of mortality.

Fauna mortality has been identified as a key issue during construction. The number of fauna mortalities will be reduced by a trapping and relocation/translocation program prior to clearing vegetation. Quenda, a conservation significant species, is predicted to occur in the proposal footprint and is vulnerable to the impacts of the proposal. This territorial species has been chosen as the target species for the trapping and relocation program. Other species such as Western Grey Kangaroo are difficult to trap, disperse quickly, and are not suitable as a target species.

**Management target 3: No disturbance of active Black Cockatoo nests.**

Impacts to Black Cockatoos is a key risk during construction. Clearing of potential breeding trees will impact the Black Cockatoo's nesting activities during breeding season. Inspecting all Black Cockatoo breeding trees for active nest prior to any clearing disturbance will reduce disruption to the adults and fledglings ensuring the proposal does not disturb nesting birds until the chicks have fledged and left the nest.



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## 3 EMP PROVISIONS

### 3.1 Condition Environmental Objectives

Condition 12-1 sets out the environmental objective to be met during construction of the proposal:

- To ensure that impacts to conservation significant fauna are minimised as far as practicable during final design and construction of the proposal.

### 3.2 Management Actions to be Implemented

Risk-based management actions have been identified and prioritised to achieve the condition environmental objective (Table 4). These management actions focus the greatest management effort on reducing ecological connectivity loss and conservation significant fauna mortalities. These management actions were specifically developed to ensure that impacts to conservation significant fauna are minimised as far as practicable during the final design and construction of the proposal and will be implemented by MRWA for the Perth–Darwin National Highway (Swan Valley Section) Project.

**Table 4 Management actions to be implemented to achieve the environmental objective**

Risk and key impacts	Management actions	Risk-based priority
Loss of ecological connectivity	The underpass sizes and designs will be based on MRWA Design of Fauna Underpass (MRWA, 2010), topography at the site, expert advice (Chambers, pers. comm.) and information from relevant studies and reports (Bamford, 2011; MRWA, 2010; QDMR, 2000).	High
	Underpass dimensions will be based on the fauna recorded or expected to occur in the vicinity.	
	The underpasses at the Whiteman Park/Cullacabardee Bushland will be 1,200 mm high due to the abundance of Western Grey Kangaroo records in the fauna movement survey.	
	Multiple underpasses will be installed in each bushland to help facilitate movement between populations on either side of the proposal footprint and to facilitate escape routes in case of fire, flooding or other impacts at one location.	
	<p>The final underpass designs will incorporate the following features known to encourage use by fauna and reduce the risk of predation:</p> <ul style="list-style-type: none"> <li>• Objects for fauna to shelter on, under or in (furniture) will be locally sourced and will include sand, mulch, logs and rocks.</li> <li>• Where practicable, openings (sky lights) to allow natural light into the underpass.</li> <li>• Revegetation using local species close to the underpass openings to provide cover for animals approaching and entering, and leaving the underpasses.</li> <li>• Natural flooring such as sand or gravel.</li> <li>• Fencing to direct fauna towards the underpass entrance.</li> <li>• Dual-use underpasses will have a concrete substrate and will not contain furniture (furniture would be washed away by drainage flows).</li> </ul>	
	A fauna bridge will be constructed within Maralla Road bushland (see Section 3.2.2, Figure 3) to maintain connectivity between populations of conservation significant fauna on either side of the proposal footprint and to facilitate an escape route in case of fire, flooding or other impacts at one location.	
	The fauna bridge design will be based on best practice guidelines.	

Risk and key impacts	Management actions	Risk-based priority
	<p>The final fauna bridge design will incorporate the following features known to encourage use by fauna and reduce the risk of predation:</p> <ul style="list-style-type: none"> <li>• Bridge width of 12 m (external dimensions).</li> <li>• Vegetated bridge deck with minimum width of 10 m.</li> <li>• Minimum soil depth on bridge deck of 1 m.</li> <li>• Vegetation to be established on bridge deck will consist of locally native species.</li> <li>• Bridge deck vegetation to achieve at least 50% vegetation foliage cover after three years.</li> <li>• Objects for fauna to shelter on, under or in (furniture) will be locally sourced and will include sand, mulch, logs and rocks.</li> <li>• Fauna fencing along road reserve boundary to tie in with fauna overpass to guide fauna movement across overpass and prevent unauthorised human access from the road reserve.</li> <li>• Fencing and/or other control structures to be installed at each end of the fauna overpass to limit unauthorised human and vehicular access to fauna overpass.</li> </ul>	High
Mortality of conservation significant fauna	<p>Prior to clearing of native vegetation, a qualified fauna expert will undertake a trapping and relocation program for ground dwelling fauna in accordance with a licence to take fauna for education or public purpose issued under section 15 of the WC Act (or equivalent provision under the <i>Biodiversity Conservation Act 2016</i>, whichever is applicable at the time) by DBCA.</p> <p>Fauna trapping and relocation will be conducted in accordance with DBCA's Standard Operating Procedures (SOPs) (DPAW, 2016).</p> <p>DBCA will be contacted prior to the trapping and relocation program to assist with the identifying suitable relocation sites.</p> <p>The trapping and relocation will be implemented for five consecutive days prior to clearing activities in areas containing native vegetation.</p> <p>Immediately following clearing activities, road reserve fences will be installed to limit opportunities for fauna to return to the cleared area.</p>	Medium

Risk and key impacts	Management actions	Risk-based priority
	<p>The trapping program will include:</p> <ul style="list-style-type: none"> <li>• Site reconnaissance to determine suitable habitat for the relocations.</li> <li>• Recording the species, sex and condition (health) of the animal and GPS location of capture and relocation sites.</li> <li>• Cage traps suitable for Southern Brown Bandicoots (Quenda).</li> <li>• Traps set and checked each trapping night for a minimum of five nights.</li> <li>• Relocation of fauna found to a suitable habitat nearby.</li> <li>• Trapping until no conservation significant species are caught for two consecutive nights or otherwise determined by a fauna expert.</li> <li>• On days over 35°C or in extreme rain events, traps will be closed after checking in the morning and re-opening in the late afternoon, to avoid capture during the day.</li> <li>• Vegetation clearing will commence within 48 hours of the final trapping night once the trapping program is complete and traps have been removed.</li> </ul> <p>A report of the trapping program will be prepared, providing details of the methods used, number of animals caught and relocated, and location of where they were released.</p> <p>Fauna spotters will be present during clearing of native vegetation to supervise dispersal/relocation of any remnant fauna. Fauna will have time to disperse into adjacent native vegetation if captured and released or disturbed during clearing activities, where possible.</p> <p>Evidence of nesting Rainbow bee-eaters will be recorded and these areas temporarily avoided during clearing until the birds have left the nest.</p> <p>Excavations and trenches will be fenced to exclude fauna; or temporary fauna escape ramps will be constructed in excavations.</p> <p>Trenches will be inspected for trapped fauna and cleared by fauna spotters daily (early in the morning) and immediately prior to backfilling.</p> <p>While inspecting potential Black Cockatoo breeding trees for nesting activity, other conservation significant species will be relocated if found.</p>	

Risk and key impacts	Management actions	Risk-based priority
	<p>Inspect hollows after felling of trees for arboreal conservation significant fauna.</p> <p>Experienced persons who hold relevant DBCA fauna licences will be available on-call should fauna issues arise during construction.</p> <p>All personnel are to complete a site induction that will cover conservation significant fauna values within and adjacent to the development envelope.</p> <p>All personnel are to complete a site induction that will include procedures to contact an experienced person who holds relevant DBCA fauna licences for fauna issues, as required.</p> <p>Vegetation clearing should commence in the centre and move towards the planned clearing edge to allow remaining fauna to disperse into adjacent vegetation.</p>	
Disturbance of Black Cockatoo nests	<p>An appropriately qualified person will inspect potential Black Cockatoo breeding trees no more than seven days prior to clearing during the Black Cockatoo breeding season.</p> <p>Trees with active nests (eggs, chicks or fledglings) will be marked and a 10 m buffer will be applied around the tree using temporary fencing.</p> <p>Clearing in the area of active nests will be postponed until DBCA advised it is suitable to continue.</p>	High

### 3.2.1 Fauna Underpasses

Habitat (and fauna population) fragmentation will be managed through the installation of fauna underpasses and a fauna bridge.

The underpass design and locations are summarised in Table 5 and depicted in Figure 3. Most underpasses will be of a box culvert design and some will provide for dual use; i.e., cross-highway drainage as well as the movement of fauna under the highway. Appendix A shows the minimum design requirements for a precast box culvert.

### 3.2.2 Fauna Bridge

A fauna bridge will be constructed across the alignment, immediately north of Ellenbrook and south of Maralla Road (Table 5, Figure 3). Appendix B shows the concept design for the fauna bridge.

The fauna bridge concept design has the following nominal specifications:

- Bridge over the road carriageways.
- Bridge length of 50 m and width of 10 m (fauna access) including soil depth on bridge deck of 1 m.
- Vegetation to be established on bridge deck will consist of locally native species.
- Vegetation will be planted to support a completion criteria of 50% foliage coverage after three years.
- Objects for fauna to shelter on, under or in (furniture) will be locally sourced and will include sand, mulch, logs and rocks.
- Fauna fencing along road reserve boundary to tie in with fauna bridge to guide fauna movement across fauna bridge and prevent unauthorised human access from the road reserve.
- The bridge will be screened to prevent fauna falling off the bridge.
- Fencing and/or other control structures to be installed at each end of the fauna bridge to limit unauthorised human and vehicular access to fauna bridge.

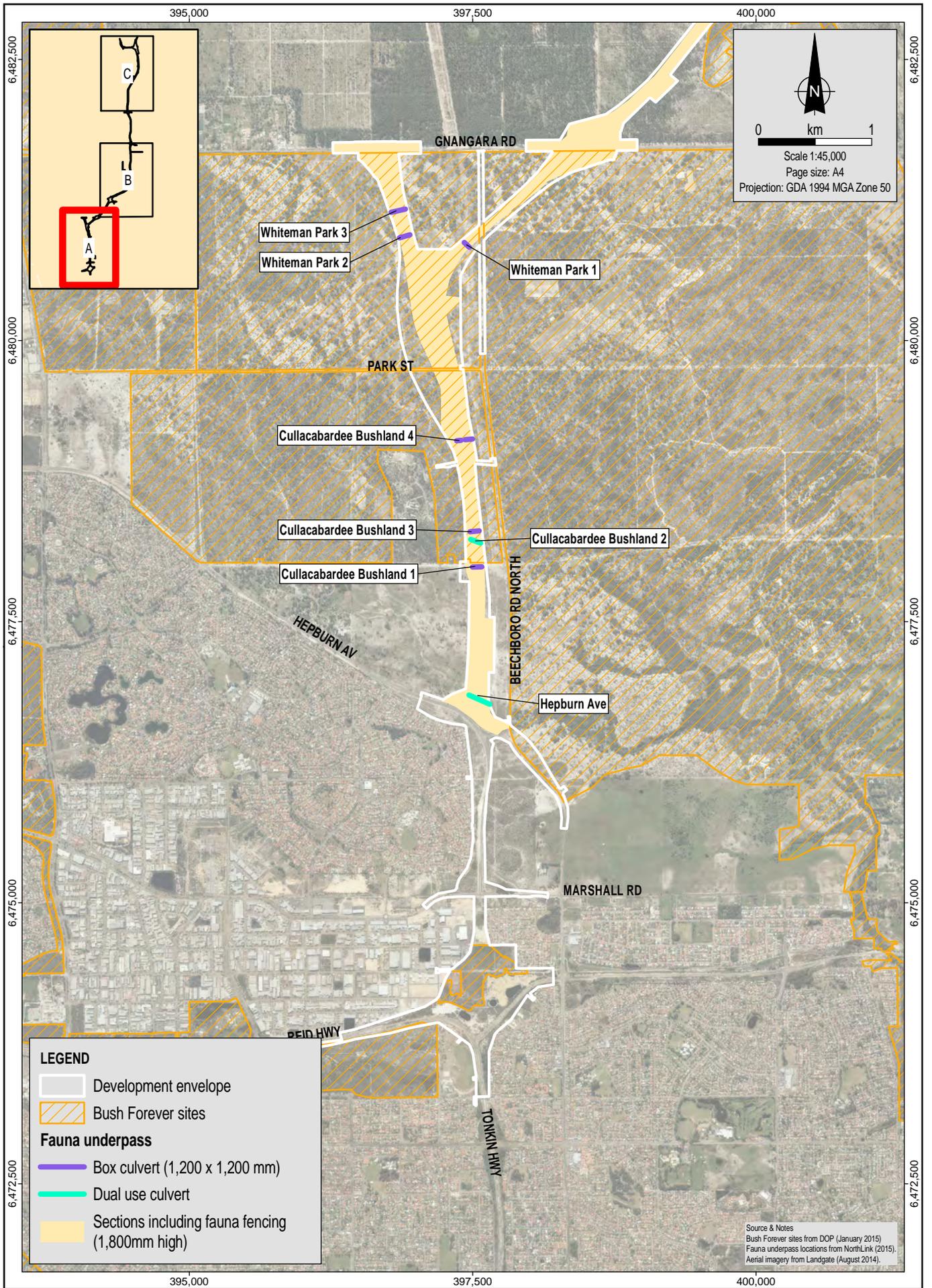
**Table 5 Summary of proposed fauna underpass and bridge design and locations**

Location	Design	Internal dimensions <sup>1</sup> (height x width)	Length (opening to opening)	Comments
Hepburn Avenue	Dual use drainage/fauna culvert	300 x 300 mm	Sections of 80 m, 20 m, 15 m	Under the proposal alignment
Cullacabardee Bushland 1	Box culvert	1,200 x 1,200 mm	82 m	Under the proposal alignment
Cullacabardee Bushland 2	Dual use drainage/fauna culvert	300 x 300 mm	90 m	Under the proposal alignment
Cullacabardee Bushland 3	Box culvert	1,200 x 1,200 mm	80 m	Under the proposal alignment
Cullacabardee Bushland 4	Box culvert	1,200 x 1,200 mm	Sections of 65 m, 50 m	Under the proposal alignment
Whiteman Park 1	Box culvert	1,200 x 1,200 mm	60 m	Under the proposal alignment

Location	Design	Internal dimensions <sup>1</sup> (height x width)	Length (opening to opening)	Comments
Whiteman Park 2	Box culvert	1,200 x 1,200 mm	Sections of 65 m, 15 m	Under the proposal alignment
Whiteman Park 3	Box culvert	1,200 x 1,200 mm	Sections of 65 m, 15 m	Under the proposal alignment
Ellenbrook 1	Dual use drainage/fauna culvert	300 x 300 mm	65 m	Under the proposal alignment
Ellenbrook2	Dual use drainage/fauna culvert	300 x 300 mm	65 m	Under the proposal alignment
Maralla Road Bushland	Fauna bridge	Minimum 12 m wide (10 m wide fauna access)	50 m	Bridge over proposal alignment, 10 m vegetated surface for fauna use only
Bullsbrook 1	Dual use drainage/fauna culvert	300 x 300 mm	Sections of 70 m, 44 m	Under the proposal alignment
Bullsbrook 2	Dual use drainage/fauna culvert	300 x 300 mm	Sections of 85 m, 50 m	Under the proposal alignment
Bullsbrook 3	Dual use drainage/fauna culvert	300 x 300 mm	76 m	Under the proposal alignment
Bullsbrook 4	Dual use drainage/fauna culvert	300 x 300 mm	Sections of 44 m, 12 m	Under the proposal alignment
Bullsbrook/ Muchea	Bridge	Unknown	Approx. 78 m	Bridge over Ellen Brook, design allows fauna movement underneath during periods of low or no flow
Muchea 1	Dual use drainage/fauna culvert	300 x 300 mm	86 m	Under the proposal alignment
Muchea 2	Bridge	Unknown	Approx. 33 m	Bridge over Ellen Brook, design allows fauna movement underneath during periods of low or no flow

Notes:

- Internal dimensions indicate headroom for enclosed spaces (e.g. fauna underpasses and dual use culverts) or available width for non-enclosed structures (e.g. bridges).



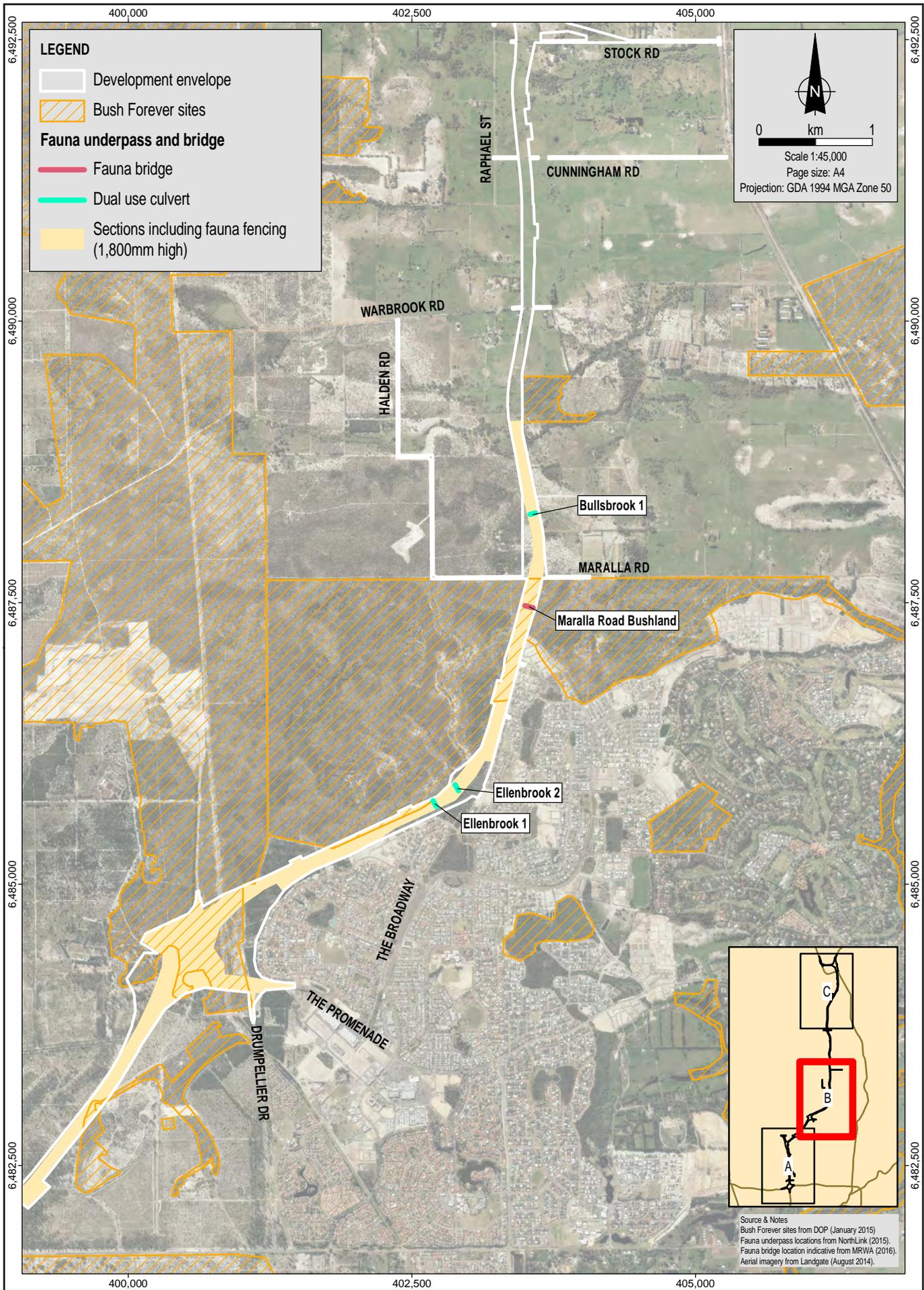
**LEGEND**

- Development envelope
- Bush Forever sites

**Fauna underpass**

- Box culvert (1,200 x 1,200 mm)
- Dual use culvert
- Sections including fauna fencing (1,800mm high)

Source & Notes  
 Bush Forever sites from DOP (January 2015)  
 Fauna underpass locations from NorthLink (2015).  
 Aerial imagery from Landgate (August 2014).

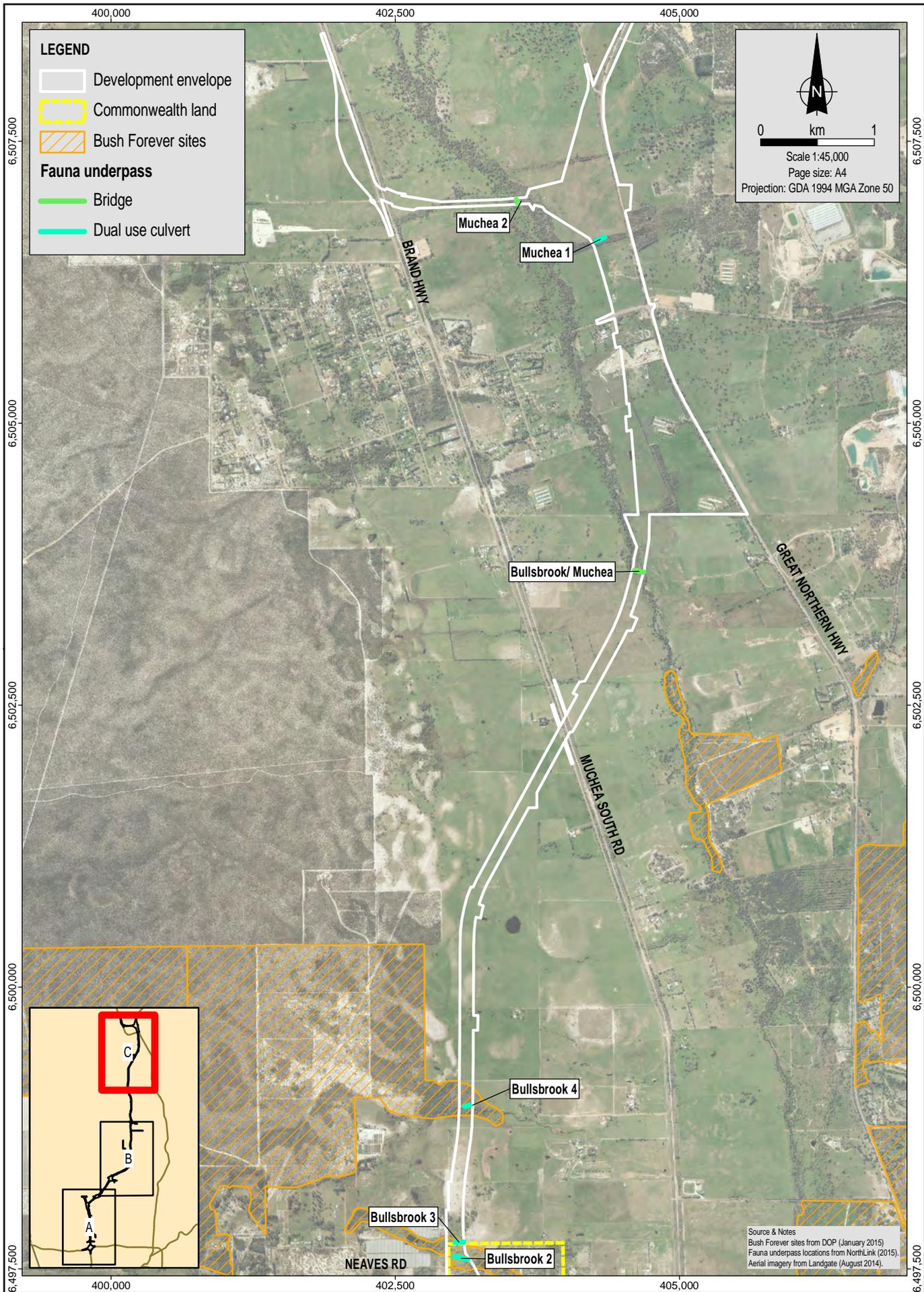


**LEGEND**

- Development envelope
- Bush Forever sites
- Fauna underpass and bridge**
- Fauna bridge
- Dual use culvert
- Sections including fauna fencing (1,800mm high)

0 km 1  
 Scale 1:45,000  
 Page size: A4  
 Projection: GDA 1994 MGA Zone 50

Source & Notes  
 Bush Forever sites from DOP (January 2015)  
 Fauna underpass locations from NorthLink (2015)  
 Fauna bridge location indicative from MRWA (2016).  
 Aerial imagery from Landgate (August 2014).



**LEGEND**

- Development envelope
- Commonwealth land
- Bush Forever sites

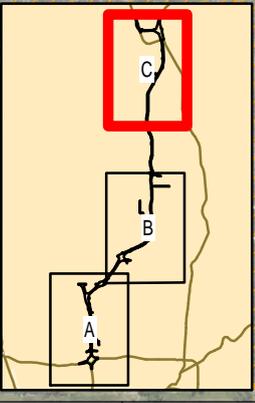
**Fauna underpass**

- Bridge
- Dual use culvert

  
 0 km 1  
 Scale 1:45,000  
 Page size: A4  
 Projection: GDA 1994 MGA Zone 50

6,507,500  
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Source & Notes  
 Bush Forever sites from DOP (January 2015)  
 Fauna underpass locations from NorthLink (2015)  
 Aerial imagery from Landgate (August 2014).

### 3.3 Management Targets

Management targets will be used to measure and report achievement against the environmental objective (Table 6).

**Table 6 Management target to measure the efficacy of management actions relative to the environmental objective**

Item	Detail
Condition environmental objective	To ensure that impacts to conservation significant fauna are minimised as far as practicable during the final design and construction of the proposal.
Management targets	Management target 1: Fauna underpasses and the fauna bridge will be designed, situated and constructed using best practice guidelines in consultation with a fauna underpass specialist, and based on data from the fauna movement survey.
	Management target 2: Minimise mortality of conservation significant fauna during construction.
	Management target 3: No disturbance of active Black Cockatoo nests.

### 3.4 Monitoring

The purpose of monitoring is to inform, through the management targets, if the condition environmental objective is being achieved and when management actions need to be reviewed and revised.

Monitoring will be undertaken for each management target as detailed in Table 7. The method, location, parameters and frequency of monitoring is specified. Early warning indicators provide advance warning that a management target may not be met. The results of monitoring will be compared against these indicators and will enable actions to be put in place to control the contributing processes so that the management objective can be met.

**Table 7 Monitoring to measure the efficacy of management actions against the management targets**

Indicator	Method	Location	Parameters	Frequency	Early warning indicator
<b>Management target 1:</b> Fauna underpasses and the fauna bridge will be designed, situated and constructed using best practice guidelines in consultation with a fauna underpass specialist, and based on data from the fauna movement survey.					
Fauna underpass design.	Fauna underpasses will be designed in accordance with MRWA Design of Fauna Underpasses, situated in areas based on data from the fauna movement survey and constructed with consideration	All fauna underpass locations (once constructed).	Within design specification. Presence of furniture (dual-use underpasses excluded).	Once, on installation of the underpass.	N/A – The underpass will be in or out of specification.

Indicator	Method	Location	Parameters	Frequency	Early warning indicator
	of guidance where available.				
Fauna bridge design	The fauna bridge will be designed and constructed in accordance with best practice guidelines and located based on data from the fauna movement survey.	Maralla Road fauna bridge.	Within design specification. Presence of furniture.	Once, on installation of the fauna bridge.	N/A – The fauna bridge will be in or out of specification.
			Vegetation cover.	Annually for three years, to assess vegetation cover.	Less than 30% vegetation cover after two years.
<b>Management target 2: Minimise mortality of conservation significant fauna during construction.</b>					
Mortality of conservation significant species.	Conduct walkover inspection of cleared areas for conservation significant species.	Within cleared areas containing native vegetation.	Number of fauna seen during clearing activities.	Daily after clearing has occurred.	Encounter two or more live or injured conservation significant species during clearing activities.
	Inspect trenches for trapped conservation significant fauna.	Trenches located in areas containing native vegetation.	Number of fauna found in trenches.	Daily (early in the morning) and immediately prior to backfilling.	Encounter two or more live or injured conservation significant species found in trench.
<b>Management target 3: No disturbance of active Black Cockatoo nests.</b>					
Disturbance of Black Cockatoo nests.	Observe marked breeding tree hollows for signs of disturbance by use of cameras on poles or cherry pickers.  Conduct walkover inspection of applied 10 m buffers around marked breeding trees for signs of disturbance.	Marked breeding trees and their applied 10 m buffers.	Signs of disturbance (temporary fence moved, prematurely vacated nests, broken eggs, and dead fledglings).	Weekly until fledglings leave the nest.	Construction works (especially clearing) occurring in the breeding season (August to December), within close proximity of marked breeding tree buffers.

### 3.5 Review and Revision of Management Actions

Where an early warning indicator is triggered, management actions are not implemented and/or a management target is not met, MRWA will:

- Investigate the cause of the management actions not being implemented and/or management targets being exceeded.
- Investigate to determine potential environmental harm or alteration of the environment that occurred due to failure to implement management actions
- Review the management actions (Table 4) and revise if required.
- Develop additional management actions where necessary.

Potential adaptive management actions are listed in Section 4.

### 3.6 Reporting Provisions

#### 3.6.1 Annual Compliance Assessment Report

The annual compliance assessment report (CAR) will include a summary of compliance against the management actions detailed in Table 4. The results of monitoring undertaken in Table 7 will be included in appendices to the CAR including the following information:

- Demonstration of compliance with maintenance requirements of fauna fences and underpasses.
- Documentation of monitoring undertaken.
- Comparison of monitoring results against the management targets and early warning indicators.
- Management actions undertaken, including revised or additional actions.

The CAR will also include information on the achievement or not of the environmental objective (Table 8). If the environmental objective has not been achieved during the reporting period, the CAR will include a description of revised and/or additional management actions to be implemented to achieve the targets, and an analysis of monitoring data to discern trends.

The CAR will be submitted in accordance with condition 4-6.

**Table 8 Environmental management plan reporting table**

<b>Key environmental factor: Fauna (Ministerial Statement 1036, conditions 12-1 to 12-3)</b>		
<b>Condition environmental objective and management target set in the Condition EMP</b>	<b>Reporting on the management objective and management target for [Month /Year] to [Month /Year].</b>	<b>Status<sup>1</sup></b>
<b>Condition environmental objective:</b> To ensure that impacts to conservation significant fauna are minimised as far as practicable during final design and construction of the proposal	Impacts to conservation significant fauna were minimised as far as practicable during construction.  Management targets 1, 2 and 3 have been met.	Yes/No

Notes:

1. The status of achievement of the condition environmental objectives is indicated as follows:

Yes - condition environmental objective achieved.

No - condition environmental objective not achieved.



### **3.6.2 Reporting on Management Actions not Implemented or Exceedance of the Management Targets**

In the event that the management target is exceeded (or not met), the CEO of the Department of Water and Environmental Regulation (DWER) will be advised in writing within seven days of identification of the exceedance.

A report will be provided to the CEO of the DWER within 60 days of a management target not being met including details on:

- The cause for failure to implement management actions and/or management targets to be exceeded.
- Findings of the investigation to determine potential environmental harm or alteration of the environment that occurred due to failure to implement management actions.
- Details of revised and/or additional management actions to be implemented to prevent exceedance of the management targets and/or ensure the implementation of management actions.
- Relevant changes to the proposal activities.
- Measures implemented to prevent, control or abate environmental harm which may have occurred.

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## 4 ADAPTIVE MANAGEMENT AND REVIEW OF THE EMP

### 4.1 Adaptive Management

MRWA will implement adaptive management to respond to any issues identified in implementation of management measures, monitoring and evaluation against the management targets, to more effectively meet the environmental objective.

Potential adaptive management actions include:

1. Failure to meet at least 50% foliage cover on the fauna bridge after three years:
  - Investigate cause (see Section 3.5).
  - Assess the effectiveness of chosen flora species planted in soil depth on bridge deck.
  - Replant vegetation.
  - Implement weed control measures.
2. Conservation significant fauna mortalities:
  - Investigate cause (see Section 3.5).
  - Enforce construction site speed limits.
  - Assess the effectiveness of training on management of fauna and amend training method if required.
  - Undertake targeted trapping if animals cannot egress fenced road reserve.
  - Implement a feral animal control program.
  - Inspect and repair any damaged/ineffective fauna fencing.
3. Conservation significant fauna mortalities associated with trenching activities:
  - Investigate cause (see Section 3.5).
  - Assess the effectiveness of temporary fencing around excavation and trenches and adjust fencing if required.
  - Assess the effectiveness of temporary fauna ramps within excavation and trenches and adjust ramps if required.
  - Review and revise methods used for installing fauna ramps within excavation and trenches.
4. Disturbance of Black Cockatoo nesting sites:
  - Investigate cause (see Section 3.5).
  - Review and revise as required methods used for locating and marking breeding trees.
  - Assess the effectiveness of training on avoiding disturbance to active nests and amend training method if required.
  - Increase buffer distance around breeding trees.
  - Assess the effectiveness of temporary fencing around breeding trees and adjust temporary fencing if required.

## 4.2 Review

This plan will be reviewed as required during the construction phase to determine if management actions require revision. Potential reasons or triggers for revising management actions include:

- Changes to construction methods and timing.
- Trigger of early warning indicators (as specified in Table 7).
- New or revised information becoming available about target species (specifically their behaviour and habitat requirements).
- Changes to action plans for target species developed under state or federal legislation.

In accordance with condition 7-5, MRWA may review and revise this plan or as otherwise specified by the CEO of the DWER.

The implementation of this plan will be audited.

The latest version of this plan will be implemented once the CEO of DWER has confirmed in writing that it satisfies the requirements of condition 7-2.

This plan will continue to be implemented until directed otherwise by the CEO of the DWER in accordance with condition 7-3(2).

## 5 STAKEHOLDER CONSULTATION

MRWA consulted with stakeholders while developing this plan, consistent with the EPA's expectations to align the plan with the principles of environmental impact assessment. This section provides a summary of consultation that occurred. The comments raised during consultations with stakeholders were considered in preparing the plan.

The former DPAW was consulted in accordance with condition 12-2.

A summary of the consultation and MRWA's response is included in Table 9.

**Table 9 Stakeholder consultation summary**

Date	Organisation	Summary of consultation	MRWA response to comments/concerns
12 and 18 February 2016	DPAW	Discussions and follow up correspondence between MRWA and DPAW on the fauna trapping and relocation program.  DPAW advised that development of the fauna trapping and relocation program should consider the program developed and implemented for Mitchell Freeway Extension. DPAW also recommended that advice be sought from Bamford Consulting on the merits or otherwise of a trapping program.	MRWA has considered the Mitchell Freeway Extension fauna trapping and relocation program in the development of this plan.  Advice will be sought from Bamford Consulting on the fauna trapping and relocation program during development of the program.
25 October 2016	DPAW – Swan Region and Environmental Management Branch	Workshop to discuss this Condition Environmental Management Plan.	MRWA has taken into account DPAW's comments and revised the plan where appropriate.



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## 6 REFERENCES

- Bamford. 2011. Roads and Wildlife. A Review of Purpose-Built Fauna Underpasses. July. Report prepared by M.J. and A.J. Bamford Consulting Ecologist for City of Armadale.
- Chambers, B. Research Fellow, School of Animal Biology, University of Western Australia. Telephone conversation. Late 2014.
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- MRWA. 2010. Design of Fauna Underpasses. A WWW publication accessed on 23 January 2015 at [https://www.mainroads.wa.gov.au/BuildingRoads/StandardsTechnical/RoadandTrafficEngineering/Roadsideltems/Pages/Design\\_of\\_Fauna\\_Underpasses.aspx](https://www.mainroads.wa.gov.au/BuildingRoads/StandardsTechnical/RoadandTrafficEngineering/Roadsideltems/Pages/Design_of_Fauna_Underpasses.aspx). Main Roads Western Australia, East Perth, Western Australia.
- QDMR. 2000. Fauna Sensitive Road Design. Queensland Department of Main Roads, Planning, Design and Environment Division, Brisbane, Queensland.



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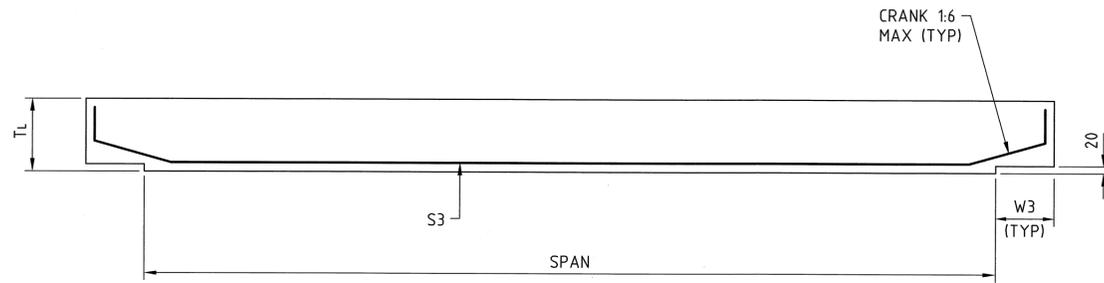
APPENDIX A

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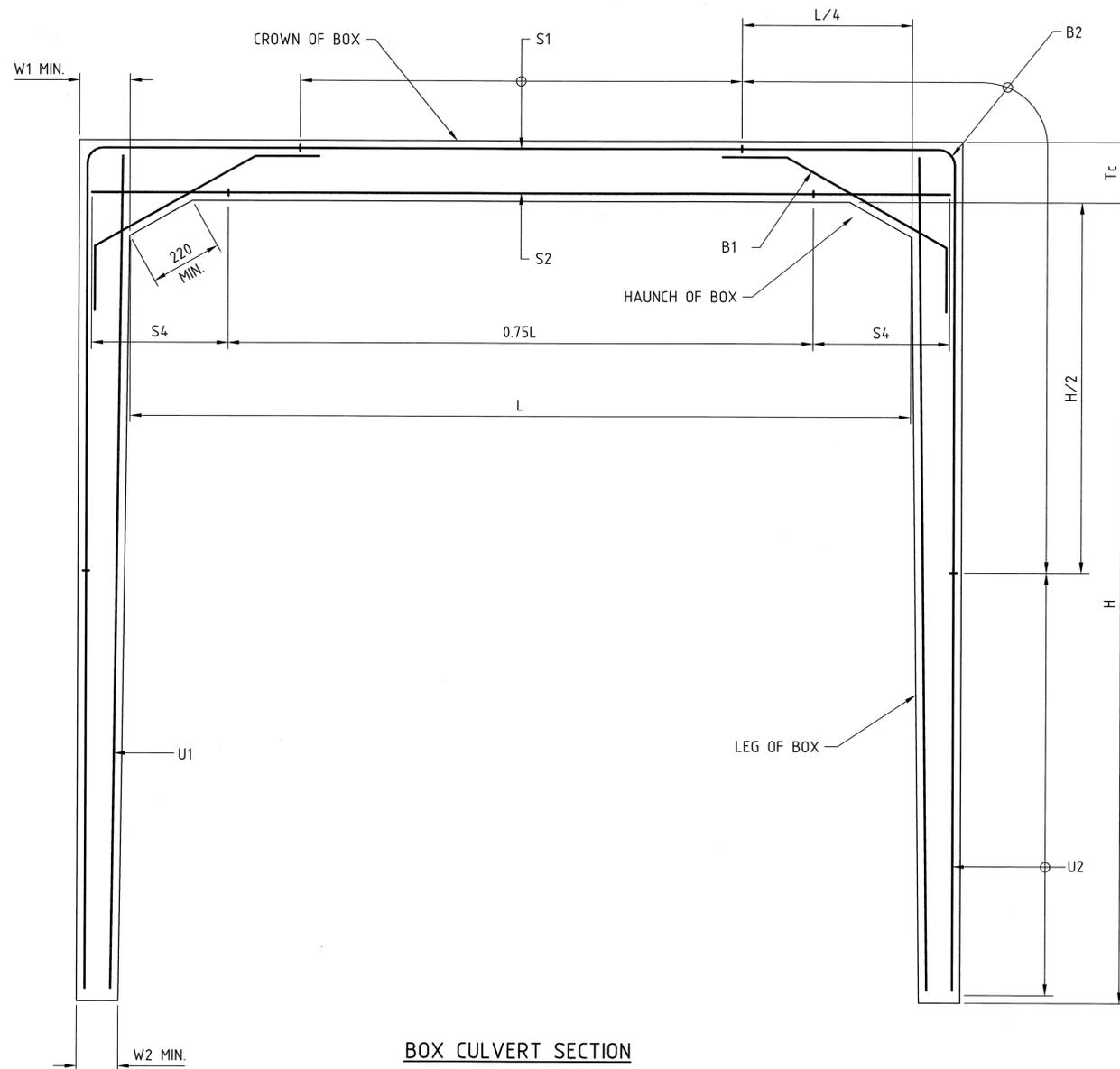
# Standard Contract Drawing for Box Culvert



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LINK SLAB SECTION



BOX CULVERT SECTION

PRECAST BOX SECTION NOM. (m)	CONCRETE DIMENSIONS					MINIMUM MAIN REINFORCEMENT						
	H (mm)	L (mm)	Tc MIN. (mm)	W1 MIN. (mm)	W2 MIN. (mm)	CROWN (mm)			HAUNCH (mm <sup>2</sup> )		LEG (mm <sup>2</sup> /LEG)	
						S1	S2	S4	B1	B2	U1	U2
1.5 x 0.9 x 1.2	900	1500	180	145	130	700	1630	890	700	810	600	600
1.5 x 1.2 x 1.2	1200	1500	180	145	130	700	1700	930	700	900	600	600
1.5 x 1.5 x 1.2	1500	1500	180	145	130	700	1760	960	700	1040	600	600
1.8 x 0.9 x 1.2	900	1800	190	150	130	740	1750	950	740	1150	600	600
1.8 x 1.2 x 1.2	1200	1800	190	150	130	740	1820	1000	740	1240	600	600
1.8 x 1.5 x 1.2	1500	1800	190	150	130	740	1890	1030	740	1360	600	600
1.8 x 1.8 x 1.2	1800	1800	190	150	130	740	1970	1080	740	1530	700	700
2.1 x 1.2 x 1.2	1200	2100	205	155	130	800	1890	1030	800	1460	600	700
2.1 x 1.5 x 1.2	1500	2100	205	155	130	800	1990	1090	800	1550	600	700
2.1 x 1.8 x 1.2	1800	2100	205	155	130	800	2070	1130	800	1700	700	700
2.1 x 2.1 x 1.2	2100	2100	205	155	130	800	2150	1180	800	1880	800	800
2.4 x 1.2 x 1.2	1200	2400	210	165	130	880	2130	1170	880	1760	600	1060
2.4 x 1.5 x 1.2	1500	2400	210	165	130	880	2240	1230	880	1830	600	990
2.4 x 1.8 x 1.2	1800	2400	210	165	130	880	2340	1280	880	1940	700	920
2.4 x 2.1 x 1.2	2100	2400	210	170	130	880	2430	1330	880	1940	800	830
2.4 x 2.4 x 1.2	2400	2400	210	170	130	880	2490	1360	880	2140	960	920
2.7 x 1.5 x 1.2	1500	2700	230	170	130	1000	2490	1360	1000	2140	600	1260
2.7 x 1.8 x 1.2	1800	2700	230	170	130	1000	2600	1430	1000	2230	700	1180
2.7 x 2.1 x 1.2	2100	2700	230	180	130	1000	2700	1480	1000	2190	800	1060
2.7 x 2.4 x 1.2	2400	2700	230	180	130	1000	2700	1480	1000	2350	960	1000
2.7 x 2.7 x 1.2	2700	2700	230	190	130	1000	2770	1520	1000	2400	1150	920
3.0 x 1.8 x 1.2	1800	3000	245	190	140	1100	2860	1570	1100	2230	700	1290
3.0 x 2.1 x 1.2	2100	3000	245	190	140	1100	2960	1620	1100	2330	800	1210
3.0 x 2.4 x 1.2	2400	3000	245	190	140	1100	3050	1670	1100	2480	960	1140
3.0 x 2.7 x 1.2	2700	3000	245	200	140	1100	3050	1670	1100	2500	1100	1040
3.0 x 3.0 x 1.2	3000	3000	245	200	140	1100	3130	1720	1100	2730	1440	980
3.3 x 1.8 x 1.2	1800	3300	270	200	150	1200	3130	1720	1200	2480	700	1520
3.3 x 2.1 x 1.2	2100	3300	270	200	150	1200	3240	1780	1200	2570	800	1440
3.3 x 2.4 x 1.2	2400	3300	270	200	150	1200	3350	1840	1200	2690	960	1360
3.3 x 2.7 x 1.2	2700	3300	270	220	150	1200	3350	1840	1200	2690	1100	1240
3.3 x 3.0 x 1.2	3000	3300	270	220	150	1200	3430	1880	1200	2890	1440	1180
3.3 x 3.3 x 1.2	3300	3300	270	220	150	1200	3500	1920	1200	2970	1650	1080
3.6 x 1.8 x 1.2	1800	3600	305	220	160	1350	3370	1850	1350	2700	700	1740
3.6 x 2.1 x 1.2	2100	3600	305	220	160	1350	3490	1910	1350	2770	800	1640
3.6 x 2.4 x 1.2	2400	3600	305	220	160	1350	3600	1980	1350	2880	960	1550
3.6 x 2.7 x 1.2	2700	3600	305	230	160	1350	3700	2030	1350	2880	1100	1410
3.6 x 3.0 x 1.2	3000	3600	305	230	160	1350	3700	2030	1350	3040	1440	1340
3.6 x 3.3 x 1.2	3300	3600	305	240	160	1350	3780	2070	1350	3040	1650	1190
3.6 x 3.6 x 1.2	3600	3600	305	240	160	1350	3850	2110	1350	3280	1980	1140

BOX CULVERT SECTIONS

LINK SLAB NOM. (m)	SPAN (mm)	MIN. THICKNESS Tc (mm)	MIN. MAIN REINF. S3 (mm <sup>2</sup> )	W3 MIN. (mm)
1.5 x 1.22	1500	175	2000	130
1.8 x 1.22	1800	185	2260	130
2.1 x 1.22	2100	200	2600	140
2.4 x 1.22	2400	220	2940	150
2.7 x 1.22	2700	240	3285	160
3.0 x 1.22	3000	260	3630	180
3.3 x 1.22	3300	280	3970	190
3.6 x 1.22	3600	300	4310	200

LINK SLABS  
CONCRETE AND REINFORCEMENT DETAILS

NOTES

- MINIMUM REQUIREMENTS HAVE BEEN BASED ON DESIGN TO SM1600 LOADING AS PER AS 5100.
- MINIMUM DEPTH OF FILL OR PAVEMENT REQUIRED OVER BOX CULVERTS SHALL BE 350 mm.
- FOR FILL OR PAVEMENT THICKNESS LESS THAN 350 mm, MINIMUM CROWN THICKNESS (Tc) AND REINFORCEMENT SHALL BE DESIGNED BY A PRACTICING STRUCTURAL ENGINEER.
- THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE MRWA CULVERT SPECIFICATION.
- CONCRETE SHALL BE CLASS S50. SEE MRWA SPECIFICATION FOR MIX DESIGN REQUIREMENTS.
- MINIMUM COVER TO REINFORCEMENT SHALL BE 40.
- THE TOLERANCE ON COVER SHALL BE -0mm TO +5mm.
- IF LEGS OF CULVERT ARE PARALLEL THEN THE DIMENSION W2 SHALL BE THE SAME AS DIMENSION W1.
- REINFORCEMENT SHALL BE HARD DRAWN STEEL WIRE OR GRADE 500 HOT ROLLED DEFORMED STEEL BARS CONFORMING TO AS/NZS 4671.
- MINIMUM MAIN REINFORCEMENT GIVEN IN TABLE IS FOR 1220 LENGTH OF UNIT. REFER TO MRWA SPECIFICATION FOR DISTRIBUTION STEEL REQUIREMENTS.
- SEE MRWA SPECIFICATION FOR BENDING AND FIXING TOLERANCES.
- CONTRACTOR SHALL SUBMIT PROPOSED REINFORCEMENT DETAILS WITH THE TENDER DOCUMENT.

No.	DATE	DESCRIPTION	AUTHORISED
<b>AMENDMENTS</b>			
<b>TECHNOLOGY AND ENVIRONMENT DIRECTORATE</b> PAVEMENT AND STRUCTURES ENGINEERING			
Telephone (08) 9323 4111		Fax (08) 9323 4136	
FILE No.	04/7045	JOB No.	
DRAWN	W. GILES AUGUST 2005	DESIGNED	P. BRADBURY SEPTEMBER 2001
CHECKED	T. SLATTERY AUGUST 2005	VERIFIED	[Signature] 24/8/05
APPROVED	[Signature]		



STRUCTURES ENGINEERING

STANDARD DRAWING  
MINIMUM DESIGN REQUIREMENTS FOR  
PRECAST BOX CULVERT UNITS  
FOR SPANS 1500mm AND LARGER AND  
FOR FILL HEIGHTS UP TO 4.5m

LOCAL AUTHORITY ( ) DRAWING NUMBER AMEND.

0530-1470

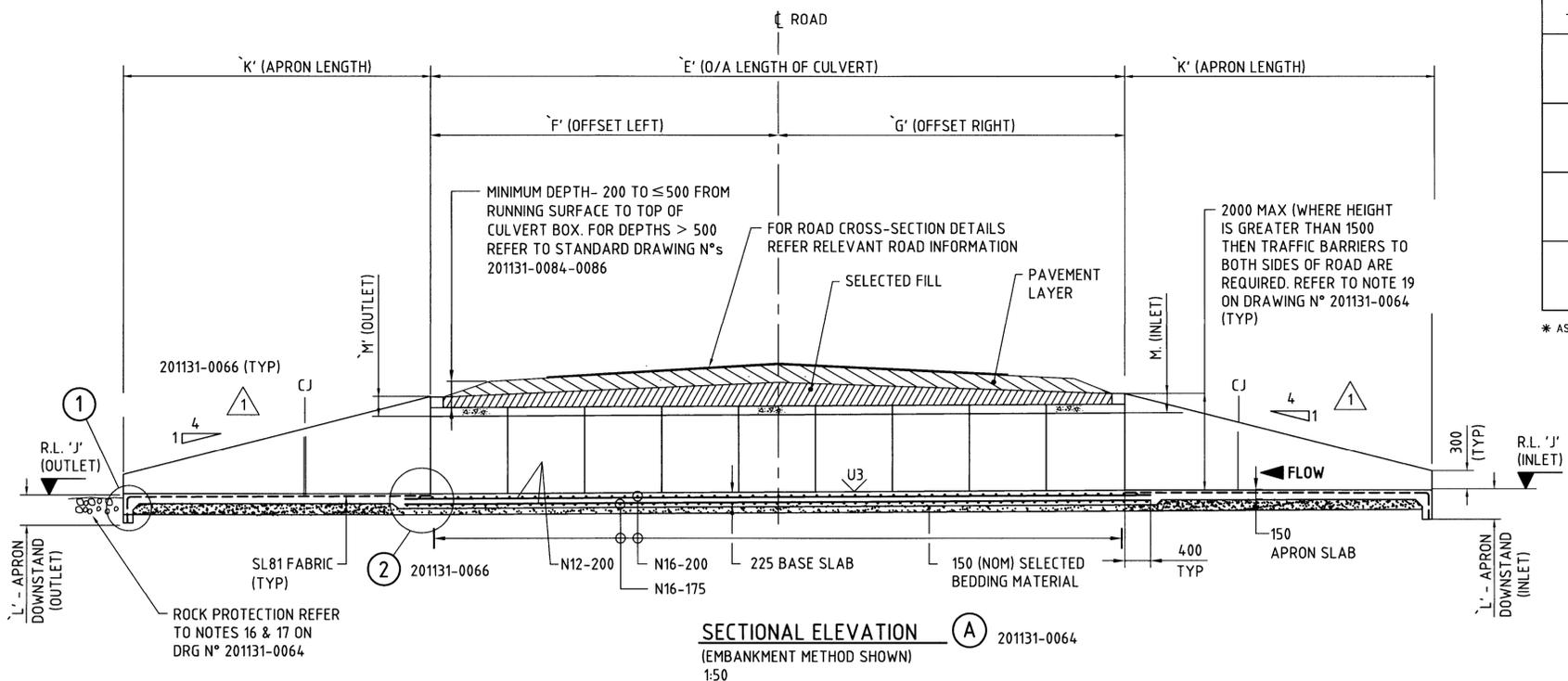
ROCK CLASS (SECTION THICKNESS)	ROCK SIZE * (m)	ROCK MASS (kg)	MINIMUM PERCENTAGE OF ROCK LARGER THAN
FACING (500mm)	0.40	100	0
	0.30	35	50
	0.15	2.5	90
LIGHT (750mm)	0.55	250	0
	0.40	100	50
	0.20	10	90
1/4 TONNE (1000mm)	0.75	500	0
	0.55	250	50
	0.30	35	90
1/2 TONNE (1250mm)	0.90	1000	0
	0.70	450	50
	0.40	100	90

\* ASSUMING A SPECIFIC GRAVITY OF 2.65 AND SPHERICAL SHAPE

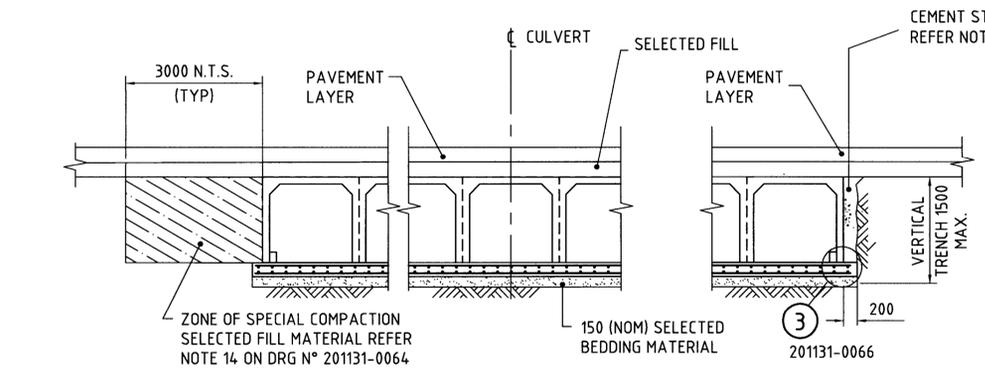
**ROCK PROTECTION TABLE**

AMENDMENTS		
No.	DESCRIPTION	APPROVED & DATE
1	WING WALL SLOPE CHANGED. NOTE 4 ADDED.	<i>[Signature]</i> 18.11.14

**NOTES**

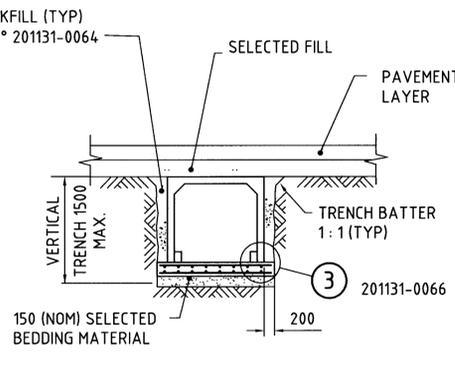


**SECTIONAL ELEVATION (EMBANKMENT METHOD SHOWN) 1:50**

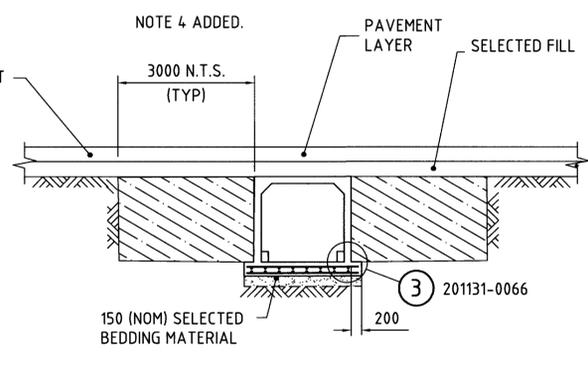


**SECTION (B) 201131-0064 (EMBANKMENT METHOD - MULTI BARRELS) 1:50**

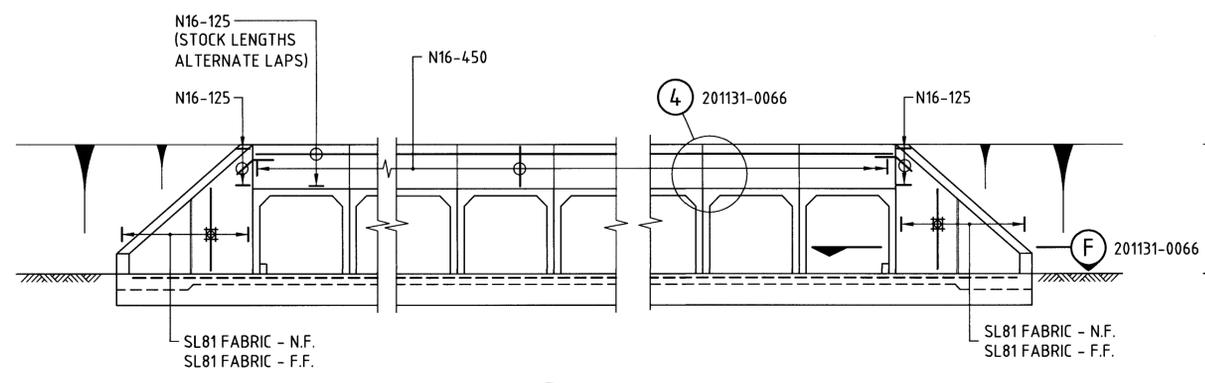
**SECTION (B) 201131-0064 (TRENCH METHOD - MULTI BARRELS) 1:50**



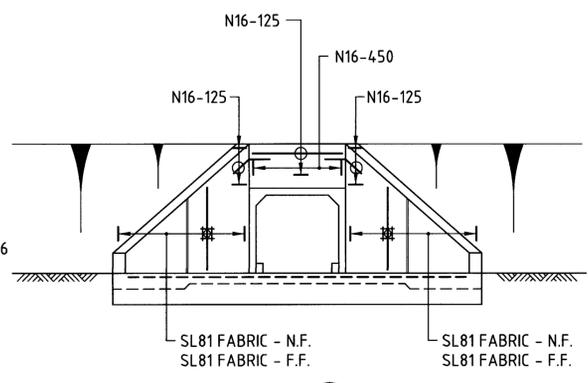
**SECTION (B) 201131-0064 (TRENCH METHOD - SINGLE BARREL) 1:50**



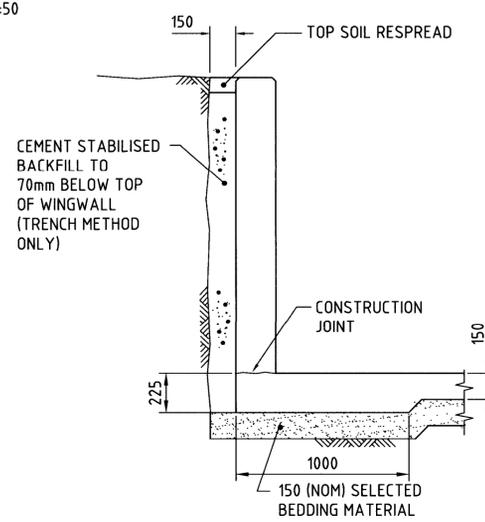
**SECTION (B) 201131-0064 (EMBANKMENT METHOD - SINGLE BARREL) 1:50**



**VIEW (C) 201131-0064 MULTI BARRELS 1:50**



**VIEW (C) 201131-0064 (SINGLE BARREL) 1:50**



**SECTION (D) 201131-0064 (NOTE: REINF NOT SHOWN) 1:20**

PRECAST DETAILS OF HEADWALLS, WINGWALLS & APRONS ARE TO BE SUBMITTED FOR REVIEW. REFER NOTE 18 ON DRAWING N° 201131-0064

- NOTES:**
- FOR GENERAL NOTES REFER TO DRAWING N° 201131-0064
  - FOR LETTERED DIMENSIONS SHOWN AS THUS 'K', REFER TO CULVERT SCHEDULE DRAWING.
  - IF MINIMUM DEPTH (SEE SECTIONAL ELEVATION (A)) IS ≤ 500 THEN REFER TO STANDARD DRAWING N°S 201131-0084-0086
  - FOR APRON LENGTH REFER TO STANDARD DRAWING No. 200131-064

THIS DRAWING SHALL BE READ IN CONJUNCTION WITH DRG. N°s 201131-0064 & 201131-0066 AND THE GENERAL ARRANGEMENT OR CULVERT SCHEDULE DRAWINGS.

Government of Western Australia  
**mainroads** WESTERN AUSTRALIA  
 PLANNING AND TECHNICAL SERVICES DIRECTORATE  
 ROAD AND TRAFFIC ENGINEERING BRANCH  
 WATERLOO CRESCENT Telephone (08) 9323 4111 EAST PERTH 6004 Fax (08) 9323 4430  
 FILE NUMBER **04/7045**  
 DESIGNED / DRAWN K.WONG/J.STANLEY/ K. KASIRI  
 VERIFIED A. LIM 15/12/11  
 APPROVED R. GROVE 16/12/11

**STANDARD DRAWING**  
**SMALL BOX CULVERTS - MIN COVER 200mm**  
 (MAX BOX SIZE 1200 x1200)  
 CONSTRUCTION DETAILS FOR BASE SLABS, APRON SLABS WINGWALLS, HEADWALLS - SHEET N° 2  
 LOCAL AUTHORITY MRWA DRAWING NUMBER  
**201131-0065-1**

1:20 0 200mm 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400 2600 2800 3000  
 1:50 0 0.5m 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5



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APPENDIX B

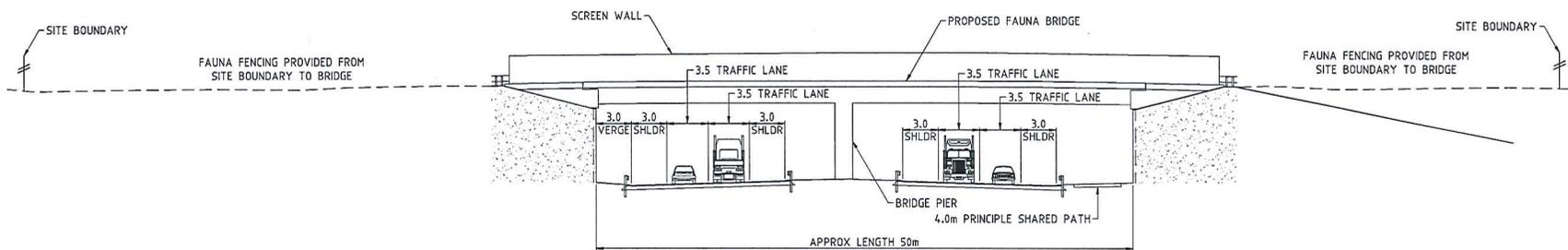
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# Fauna Bridge Concept Design

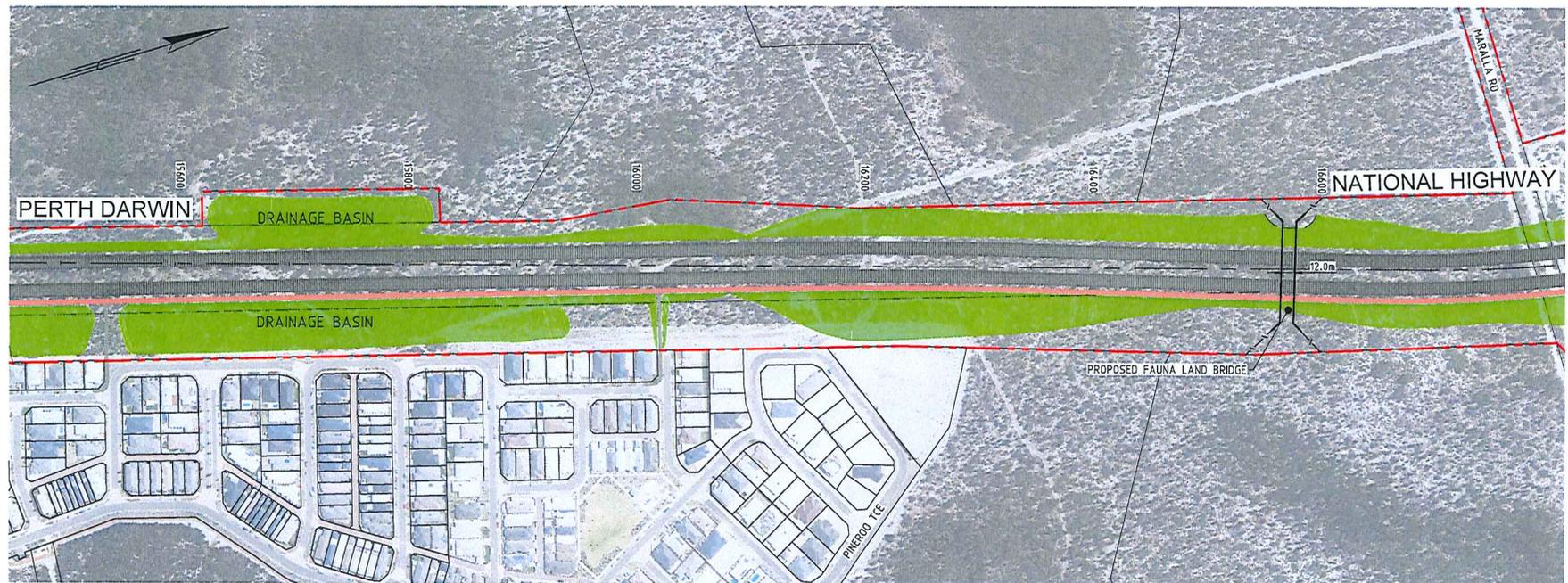


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- LEGEND:**
- + — REFERENCE LINE
  - - - - PROJECT DEVELOPMENT ENVELOPE
  - - - - - PROPOSED FAUNA FENCE
  - ▬▬▬▬▬ PROPOSED ROAD
  - ▬▬▬▬▬ PROPOSED PSP
  - ▬▬▬▬▬ PROPOSED SHARED PATH
  - ▬▬▬▬▬ PROPOSED EARTHWORKS



TYPICAL SECTION FAUNA LAND BRIDGE  
SCALE 1:200



PLAN  
SCALE 1:2000

**SKETCH ONLY**

**NorthLinkWA**



DATE	22/09/2016	PROJECT	NORTHLINK WA
SCALE	1:2000	TITLE	PERTH DARWIN NATIONAL HIGHWAY FAUNA LAND BRIDGE OPTION
GRID	PCG94		
PREPARED	EM		
SHEET	1 OF 1	PROJECT No.	P13362
		SKETCH No.	NLWA-00-RD-SK-0331
		REV	B

FILENAME: \\G:\CADD\PROJECTS\NORTHLINK\WA-00-RD-SK-0331\DWG - F101 - D:\EZZ\02\2016\_7\_6\22.PLT



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BG&E NorthLinkWA  
GPO Box 2776  
Cloisters Square  
Perth WA 6850



Australian Government



NorthLinkWA