

APPENDIX A  
TARRAWONGA COAL MINE THREATENED FAUNA INVESTIGATION REPORT

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THREATENED FAUNA INVESTIGATION REPORT



PREPARED BY  
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## EXECUTIVE SUMMARY

Tarrawonga Coal Pty Ltd (TCPL) owns the Tarrawonga Coal Mine (TCM) located approximately 42 kilometres (km) north of Gunnedah and 15 km north-east of Boggabri in the Gunnedah Basin, New South Wales (NSW). The TCM commenced operations in 2006 and an extension to the mine was approved under State (NSW) and Commonwealth Project approvals in 2013.

As part of the NSW Project approval for the TCM, TCPL will implement a Rehabilitation Strategy to progressively rehabilitate the post-mine landforms and re-establish vegetation and habitat for native flora and fauna (including threatened species). TCPL will also implement a Biodiversity Offset Strategy in the surrounding region. The Biodiversity Offset Strategy involves management and restoration of predominantly woodland and forest habitats.

An investigation of factors likely to enhance or impede the effective long-term provision of suitable habitat for a number of threatened fauna species was undertaken in 2014. This report documents the outcomes of that investigation to satisfy Condition 45 (a) and (b) of the TCM NSW Project Approval (PA 11\_0047). The provision of suitable habitats to support individual or populations of threatened species does not in itself ensure the presence of any such species in the restored or remediated landscapes in the future. However it is possible to seek to optimise the potential for such species to ultimately locate into these landscapes.

Condition 45 of TCM Project Approval (PA 11\_0047) requires the investigation to include the following threatened species:

- **Threatened birds:** Turquoise Parrot (*Neophema pulchella*), Masked Owl (*Tyto novaehollandiae*), Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*), Speckled Warbler (*Chthonicola sagittata*), Hooded Robin (south-eastern form) (*Melanodryas cucullata cucullata*), Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*) and Varied Sittella (*Daphoenositta chrysoptera*).
- **Threatened mammals:** Squirrel Glider (*Petaurus norfolcensis*) and Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*).

Other threatened species are also covered by this investigation upon OEH's request, namely: Pale-headed Snake (*Hoplocephalus bitorquatus*), Koala (*Phascolarctos cinereus*), Large-eared Pied Bat (*Chalinolobus dwyeri*) and Corben's Long-eared Bat (Greater Long-eared Bat or South-eastern Long-eared Bat) (*Nyctophilus corbeni*).

These species all inhabit woodland and forest habitats.

The investigation involved:

- consideration of the threatened fauna listing advice/final determinations;
- consideration of relevant threatened fauna management guidelines;
- consideration of relevant threatened fauna recovery plans;
- consideration of scientific literature pertaining to rehabilitation and restoration;
- consideration of reports published by Boggabri Coal Pty Ltd (in recognition of the proximity of the Boggabri Coal Mine to the TCM);
- consultation with suitably qualified restoration specialists;

- consultation with the NSW Office of Environment and Heritage and North West Local Land Services; and
- consideration of relevant conditions under the TCM Project Approval (PA 11\_0047) and Commonwealth Approval Decision 2011/5923.

A variety of different factors relevant to the provision of suitable habitat for the suite of threatened species have been identified. However of these, the following two appear to be the most important – provision of habitat resources for each species across the restored and rehabilitated landscape and managing threatening processes. The actual return of such threatened species to these future landscapes will also depend on source populations being available away from the restored remediated landscapes and the availability of potential movement pathways for such species between potential source populations and the restored and rehabilitated landscapes.

A separate Implementation Plan has been developed to maximise the prospects for provision of viable areas of suitable habitat for threatened species on the offset areas and the mine site.

## 1 INTRODUCTION

### 1.1 BACKGROUND

The Tarrawonga Coal Mine (TCM) is an open cut coal mining operation located approximately 42 kilometres (km) north of Gunnedah and 15 km north-east of Boggabri in the Gunnedah Basin, New South Wales (NSW) (Figures 1 and 2). The TCM is owned by Tarrawonga Coal Pty Ltd (TCPL), which is a joint venture between Whitehaven Coal Limited (Whitehaven) (70 percent [%] interest) and Boggabri Coal Pty Limited (BCPL) (a wholly owned subsidiary of Idemitsu Australia Resources Pty Ltd) (30% interest).

The TCM commenced operations in 2006 and an extension to the mine (i.e. the Tarrawonga Coal Project) was approved under State (NSW) and Commonwealth Project approvals in 2013. In January 2013, the Tarrawonga Coal Project was granted NSW Project approval under the NSW *Environmental Planning and Assessment Act* by the Planning Assessment Commission under delegation of the Minister for Planning and Infrastructure. The Tarrawonga Coal Project was granted approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 11 March 2013 (Commonwealth Approval Decision 2011/5923).

As part of the NSW Project approval for the TCM, TCPL will implement:

- a Rehabilitation Strategy to progressively rehabilitate the post-mine landforms and re-establish vegetation and habitat for native flora and fauna (including threatened species); and
- a Biodiversity Offset Strategy in the surrounding region with habitat for a number of threatened fauna species.

#### ***Rehabilitation Strategy***

Condition 40 of TCM Project Approval (PA 11\_0047) requires 752 hectares (ha) of vegetation to be re-established on the post-mine landforms. An objective is to revegetate the post-mine landforms with a mixture of native woodland and forest (approximately 752 ha). The rehabilitation areas will be designed to provide habitat for native flora and fauna (albeit, some habitat resources [e.g. natural tree hollows] will be absent for many decades).

#### ***Biodiversity Offset Strategy***

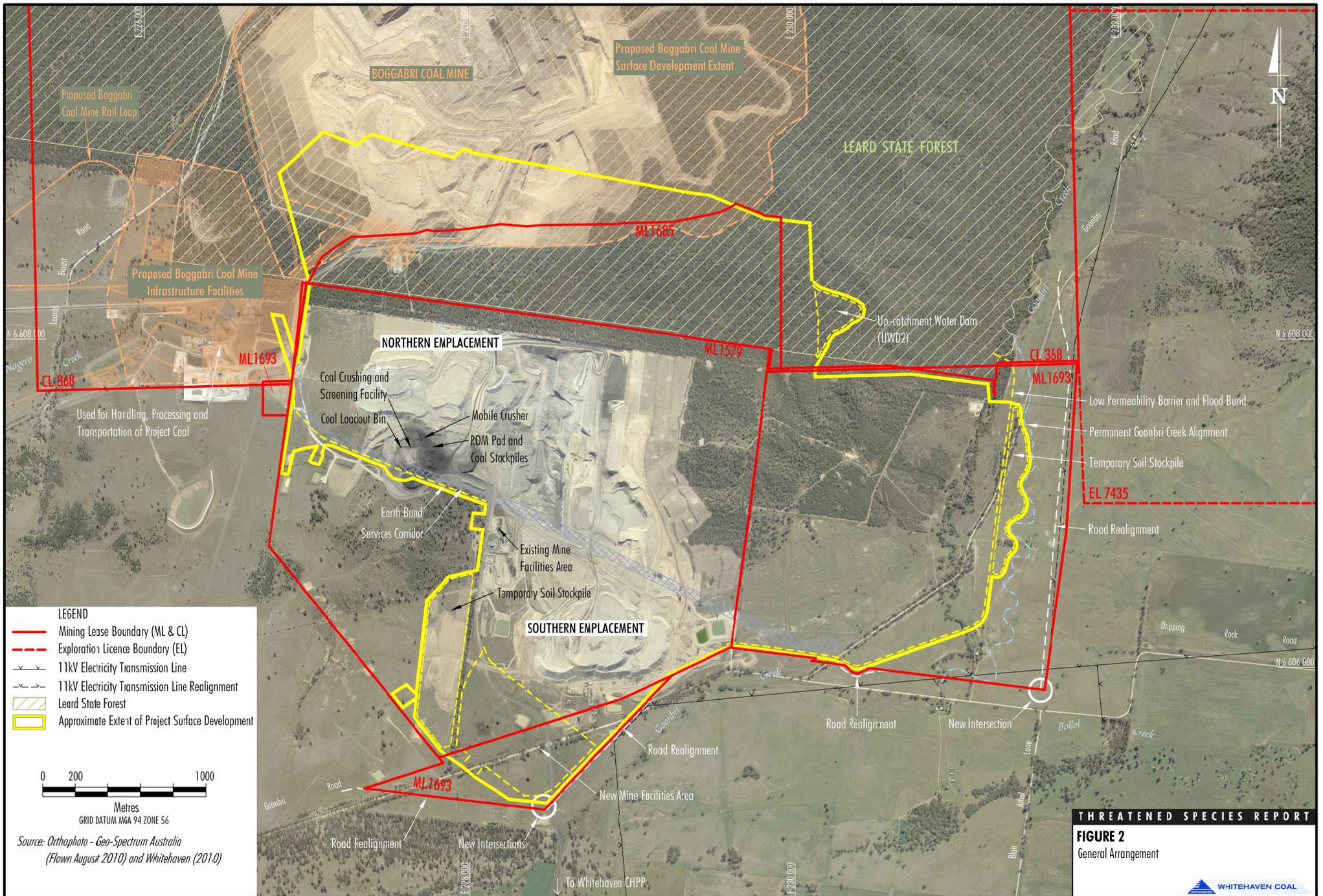
The biodiversity offset areas under Condition 40 of TCM Project Approval (PA 11\_0047) are required to cover a minimum of 1,660 ha of land (Figure 3).

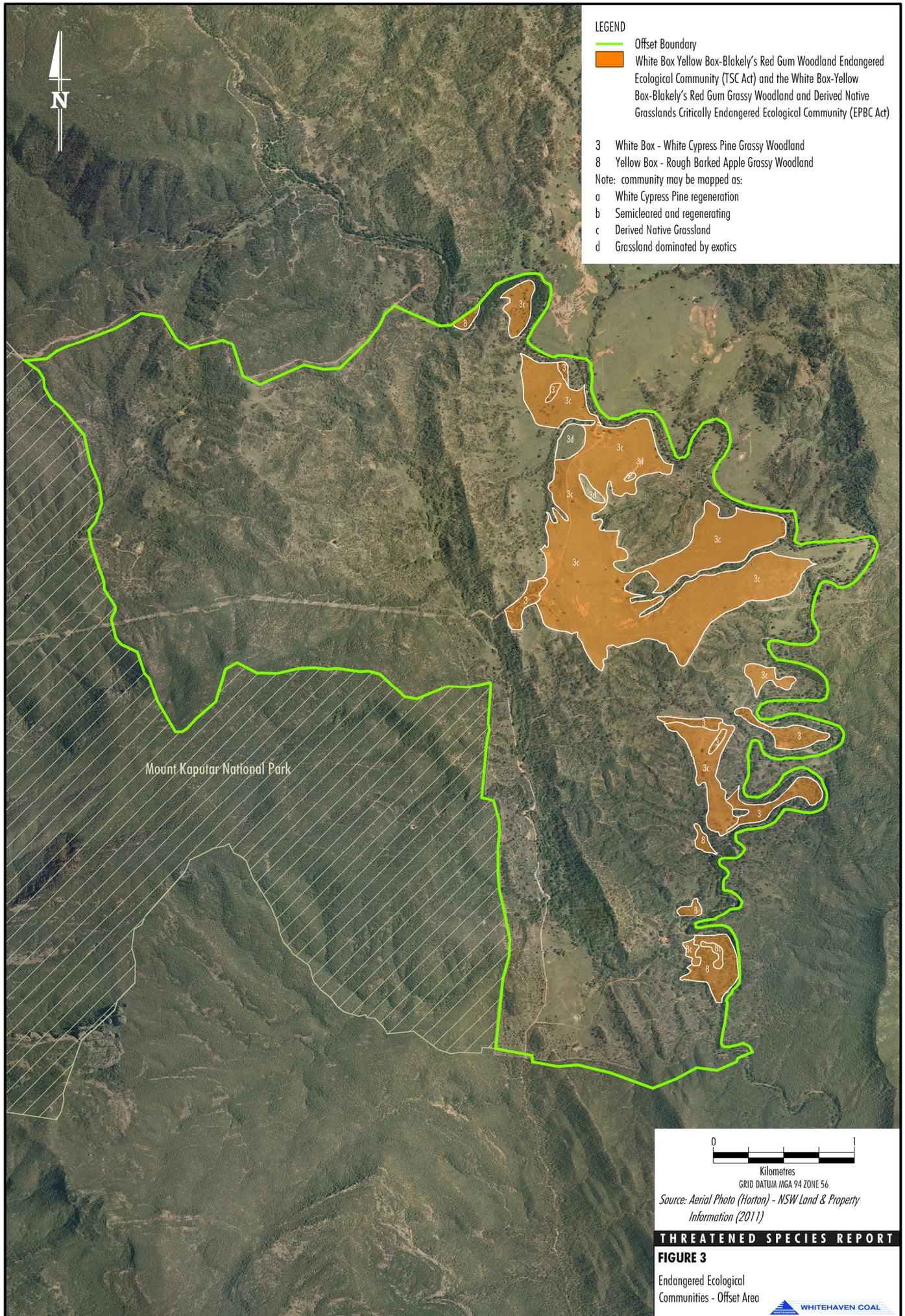
#### ***Long-term Maintenance***

The long-term maintenance of Box-Gum Woodland/provision of habitat would be facilitated through:

1. long-term security of the offset areas and woodland on the rehabilitation areas by the mechanisms specified in the Project Approval (i.e. management will be required to be undertaken in accordance with a conservation agreement and/or protected area [e.g. National Park or Nature Reserve] management arrangement).
2. lodgement of conservation and biodiversity bond for the offset areas with the DP&E (noting that the bond will only be released once the offset strategy is completed generally in accordance with completion criteria).







### **Threatened Species Investigation**

Condition 45 of TCM Project Approval (PA 11\_0047) requires:

1. an investigation of factors likely to enhance or impede the prospects for providing viable stands (areas) of suitable habitat for threatened fauna species (i.e. an Investigation Report – this document);
2. an implementation plan to maximise the prospects for providing viable stands (areas) of suitable habitat for threatened fauna species on the offset areas and on the mine site (i.e. an Implementation Plan); and
3. revision of the Biodiversity Management Plan (BMP).

Figure 4 contains a flow diagram that shows how the Investigation Report, Implementation Plan and the BMP (and TCM Rehabilitation Management Plan [RMP]) relate to each other.

This document (the Investigation Report) identifies factors likely to enhance or impede the prospects for providing viable areas of suitable habitat for threatened fauna species. The factors identified in this report will be considered in the Implementation Plan to maximise the likely prospects for providing viable areas of suitable habitat for threatened fauna species on the offset areas and on the mine site.

The outcome of the Implementation Plan is the creation of ‘checklists’ for implementing the Rehabilitation Strategy and Biodiversity Offset Strategy (where they relate to provision of habitat for threatened species). The approved Implementation Plan will be incorporated into a revised BMP and a revised RMP.

### **Relevant Threatened Species**

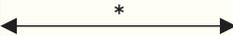
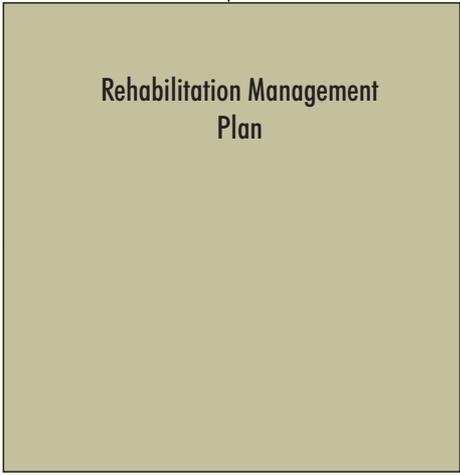
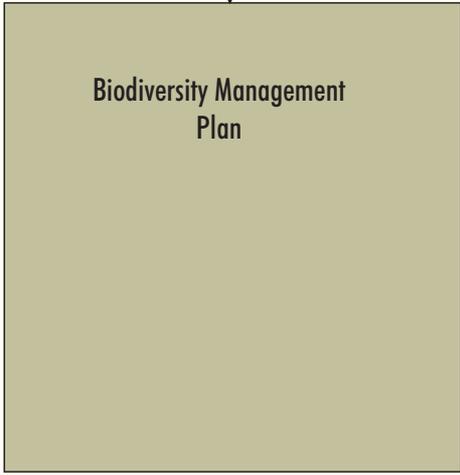
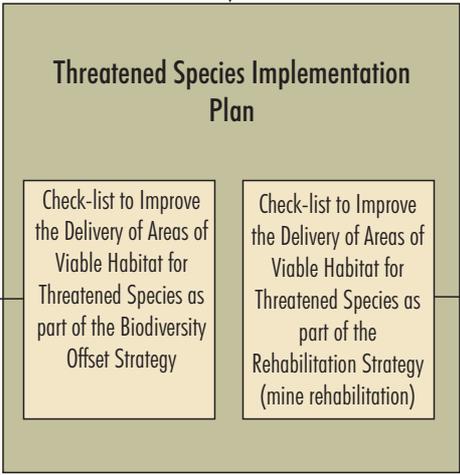
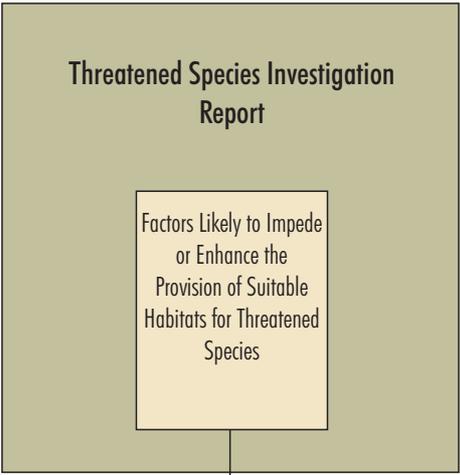
Condition 45 of TCM Project Approval (PA 11\_0047) requires the investigation to include the following threatened species:

- **Threatened birds:** Turquoise Parrot (*Neophema pulchella*), Masked Owl (*Tyto novaehollandiae*), Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*), Speckled Warbler (*Chthonicola sagittata*), Hooded Robin (south-eastern form) (*Melanodryas cucullata cucullata*), Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*) and Varied Sittella (*Daphoenositta chrysoptera*).
- **Threatened mammals:** Squirrel Glider (*Petaurus norfolcensis*) and Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*).

These species all inhabit woodland and/or forest habitats.

Other threatened species are also covered by this investigation upon OEH's request, namely: Pale-headed Snake (*Hoplocephalus bitorquatus*), Koala (*Phascolarctos cinereus*), Large-eared Pied Bat (*Chalinolobus dwyeri*) and Corben's Long-eared Bat (Greater Long-eared Bat or South-eastern Long-eared Bat) (*Nyctophilus corbeni*).

In 2014, a second investigation was undertaken by Whitehaven into the factors likely to enhance or impede the effective restoration or re-establishment of the White Box – Yellow Box – Blakely's Red Gum Grassy Woodland Endangered Ecological Community (Box-Gum Woodland EEC) listed under the NSW *Threatened Species Conservation Act, 1995* (Whitehaven, 2014). This implementation plan recognises that many of the threatened fauna species use the Box-Gum Woodland as habitat and therefore this implementation plan incorporates actions aimed at enhancing prospects for the effective restoration and rehabilitation of this habitat.



*\* Integration of relevant mine rehabilitation components in the Biodiversity Management Plan.*

**FIGURE 4**  
Threatened Species Investigation and Implementation Plan

The provision of suitable habitats to support individual or populations of threatened species does not in itself ensure the presence of any such species in the restored or remediated landscapes in the future. However it is possible to seek to optimise the potential for such species to ultimately locate into these landscapes. The actual return of such threatened species to these future landscapes will also depend on source populations being available away from the restored remediated landscapes and the availability of potential movement pathways for such species between potential source populations and the restored and rehabilitated landscapes.

**1.2 OBJECTIVES**

The purpose of this report is to satisfy Condition 45 (a) and (b) of TCM Project Approval (PA 11\_0047) (Table 1) by documenting the investigation of factors likely to enhance or impede the protection, rehabilitation and long-term maintenance and provision of viable stands (areas) of suitable habitat for the species listed in Section 1.1, specifically focusing on:

- effective restoration of degraded remnants of potential habitat for the threatened species in offset areas; and
- re-establishment of viable habitat in the longer term for threatened species on disturbed areas (both offset areas and the site).

**Table 1  
Condition 45 of Project Approval (PA 11\_0047)**

Condition
<p>45. The Proponent shall:</p> <p>(a) investigate, in consultation with OEH and the Namoi CMA, all factors likely to enhance or impede the effective long term provision of suitable habitat(s) for the following species: Speckled Warbler, Brown Treecreeper, Grey-crowned Babbler, Hooded Robin, Varied Sittella, Turquoise Parrot, Masked Owl, Yellow-bellied Sheath Tail Bat and Squirrel Glider;</p> <p>(b) within 12 months of the date of this approval (and if possible, in conjunction with Stage 2 of the Leard Forest Mining Precinct Regional Biodiversity Strategy), submit a report of this investigation and provide an implementation plan to ensure delivery of suitable areas of viable habitat for the species included in (a) above, for approval by the Director-General; and</p> <p>(c) incorporate the approved implementation plan into the revised Biodiversity Management Plan, required under condition 52.</p>

A complete list of species covered by this investigation is provided in Table 2.

**Table 2**  
**Threatened Fauna Species Relevant to the RMP and BMP**

Scientific Name	Common Name	Conservation Status	
		TSC Act <sup>1</sup>	EPBC Act <sup>2</sup>
<b>Reptiles</b>			
<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake	V	-
<b>Birds</b>			
<i>Neophema pulchella</i>	Turquoise Parrot	V	-
<i>Tyto novaehollandiae</i>	Masked Owl	V	-
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)	V	-
<i>Chthonicola sagittata</i>	Speckled Warbler	V	-
<i>Melanodryas cucullata cucullata</i>	Hooded Robin (south-eastern form)	V	-
<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)	V	-
<i>Daphoenositta chrysoptera</i>	Varied Sittella	V	-
<b>Mammals</b>			
<i>Phascolarctos cinereus</i>	Koala	V	V
<i>Petaurus norfolcensis</i>	Squirrel Glider	V	-
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	V	-
<i>Nyctophilus corbeni</i>	Corben's Long-eared Bat (Listed as South-eastern Long-eared Bat under EPBC)	V	V
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V

<sup>1</sup> Threatened species listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) (September 2014).

<sup>2</sup> Threatened species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) (September 2014).

It has not been possible to prepare this report in conjunction with Stage 2 of the Leard Forest Mining Precinct Regional Biodiversity Strategy being co-ordinated by the DP&E as it is yet to be developed. Nevertheless, this report is consistent with the intent of the Stage 2 of the Leard Forest Mining Precinct Regional Biodiversity Strategy in that it seeks to improve the performance of the offset areas and has been prepared jointly with the Maules Creek Coal Mine.

### 1.3 CONSULTATION

This investigation report was finalised following consultation with the following stakeholders in accordance with Condition 50(a) of MCCM Project Approval (PA 10\_0138) (Table 1):

- Office of Environment and Heritage (OEH);
- North West Local Land Services (formerly the Namoi Catchment Management Authority); and
- DP&E.

This investigation report was revised in light of comments by or discussions with those stakeholders before it was submitted to DP&E for approval.

In their letter (dated 22 October 2014), OEH provided the following comments not directly related to this investigation report:

*OEH offers the following suggestions regarding the level of detail it expects should be included in the revisions of the RMP and BMP. This includes:*

- *detailed descriptions, maps and area on each offset property for each condition state of the EEC and other vegetation types, and management area, if different*
- *maps and area of the estimated area of habitat of each threatened species, and condition class if known*
- *details of the presence of important structural, floristic and habitat elements present (eg caves, cliff lines, raptor nests, areas with abundant hollow-bearing trees, fallen debris, flora species specifically identified as providing habitat resources for threatened species etc.)*
- *mapping and/or imagery and photographs which illustrate threats that can be mapped, such as weeds and erosion. Baseline data of the current extent of each threat described should also be provided (baseline information is required to assess the change in the level of the threat and to monitor success over time against relevant performance targets)*
- *objectives for managing biodiversity values for each management area, strategies and timing to be implemented to manage biodiversity threats and to ensure that biodiversity values are improved*
- *identified measurable performance measures and targets, how progress is to be measured and reported and at what intervals,*
- *completion criteria for each threat in each management area eg the area or number of individuals of a weed species per management domain, based on the level of the acceptable threat. Targets should relate to actual biodiversity outcomes, including species requirements at different times, rather than simply inputs and outputs,*
- *a risk assessment, trigger points and subsequent corrective actions to be implemented if the monitoring program identifies that the performance targets and therefore biodiversity management objectives are not being met.*

TCM would consider the above suggestions in relation to revisions to the RMP or BMP (whichever is most applicable to the individual point).

## 2 METHODS

This investigation report has been prepared through:

- consideration of the threatened fauna species' listing advice/final determinations (OEH, 2014a; Department of the Environment [DotE], 2014);
- consideration of the threatened fauna species' profiles (OEH, 2014b; DotE, 2014);
- consideration of relevant threatened fauna recovery plans (e.g. Department of the Environment, Climate Change and Water [DECCW], 2011);
- consideration of scientific literature pertaining to rehabilitation and restoration (e.g. Noss, 1990; Freudenberger *et al.*, 2004; Society for Ecological Restoration International Science & Policy Working Group, 2004; Prober and Thiele, 2005; Gibson-Roy, 2010; Tongway and Ludwig, 2011; Goldin and Brookhouse, 2014);
- consideration of reports published by Boggabri Coal Pty Ltd (in recognition of the proximity of the Boggabri Coal Mine to the TCM);
- consultation with suitably qualified restoration specialists;
- consultation with OEH and North West Local Land Services;
- consideration of relevant conditions under the TCM Project Approval (PA 11\_0047) and Commonwealth Approval Decision 2011/5923; and
- consideration of survey data (e.g. vegetation mapping).

## 3 RESULTS

Table 3 provides a summary of the following information for each threatened species:

- the species habitat requirements relevant to the Rehabilitation Strategy and Offset Strategy;
- recognised threats to the species that are relevant to the Rehabilitation Strategy or Biodiversity Offset Strategy sourced from State and/or Commonwealth recovery plans or Government Websites (e.g. OEH, 2014b; DotE, 2014); and
- recognised recovery actions for the species that are relevant to the Rehabilitation Strategy or Biodiversity Offset Strategy sourced from State and/or Commonwealth recovery plans or Government Websites (e.g. OEH, 2014b; DotE, 2014).

Table 4 provides factors likely to impede or enhance the provision of habitat for threatened fauna in consideration of the information in Table 3.

As discussed in Section 1.1, a second investigation was undertaken by Whitehaven into the factors likely to enhance or impede the effective restoration or re-establishment of Box-Gum Woodland EEC) (Whitehaven, 2014). It is recognised that many of the threatened fauna species use Box-Gum Woodland as habitat and therefore Table 5 brings together a list of factors likely to impede or enhance the re-establishment and restoration of Box-Gum Woodland (sourced from Whitehaven, 2014).

**Table 3**  
**Habitat Requirements of Threatened Fauna**

Common Name	Habitat Requirements Relevant to the Rehabilitation Strategy and Offset Strategy	Threats Relevant to the Proposed Activities as Defined in the Government Guidelines	Relevant Recovery Actions Defined in the Government Guidelines
Pale-headed Snake	<ul style="list-style-type: none"> <li>Box-Gum Woodland EEC is potential habitat for this species (NSW Scientific Committee, 2011) (i.e. the factors in Table 4 are relevant to this species' habitat).</li> <li>This species is found mainly in dry eucalypt forests and woodlands, cypress forest and occasionally in rainforest or moist eucalypt forest (OEH, 2014b). In drier environments, it appears to favour habitats close to riparian areas (OEH, 2014b).</li> <li>The Pale-headed Snake shelters between loose bark and tree-trunks, or in hollow trunks and limbs of dead trees (OEH, 2014b).</li> <li>The main prey of this species is tree frogs although lizards and small mammals are also taken (OEH, 2014b).</li> </ul>	<ul style="list-style-type: none"> <li>Too frequent burning or grazing management which destroys old and dead trees and removes understorey vegetation (OEH, 2014b).</li> <li>Absence of suitable prey species, particularly in post-mine landscape.</li> <li>Time lapse required to reach appropriate successional stage in restoration and/or rehabilitation (e.g. development of tree hollows).</li> </ul>	<ul style="list-style-type: none"> <li>None defined (OEH, 2014b).</li> </ul>
Turquoise Parrot	<ul style="list-style-type: none"> <li>Box-Gum Woodland EEC is potential habitat for this species (NSW Scientific Committee, 2011) (i.e. the factors in Table 5 are relevant to this species' habitat).</li> <li>Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland (OEH, 2014b).</li> <li>Prefers to feed in the shade of a tree and spends most of the day on the ground searching for the seeds or grasses and herbaceous plants, or browsing on vegetable matter (OEH, 2014b).</li> <li>Nests in tree hollows, logs or posts (OEH, 2014b).</li> </ul>	<ul style="list-style-type: none"> <li>Lack of hollow-bearing trees (OEH, 2014b).</li> <li>Degradation of habitat through heavy grazing, firewood collection and establishment of exotic pastures (OEH, 2014b).</li> <li>Predation by foxes and cats (OEH, 2014b).</li> <li>Absence/lack of suitable foraging areas, particularly in post-mine landscape.</li> <li>Time lapse required to reach appropriate successional stage in restoration and/or rehabilitation.</li> </ul>	<ul style="list-style-type: none"> <li>Undertake fox and feral cat control programs in key habitat areas (OEH, 2014b).</li> <li>Retain areas of open woodland with grassy under-storey and adjoining grassland (OEH, 2014b).</li> <li>Protect hollow-bearing trees for nest sites. Younger mature trees should also be retained to provide replacements for the older trees when they eventually die and fall over (OEH, 2014b).</li> <li>Protect sites where Turquoise Parrots forage and nest from heavy, prolonged grazing (OEH, 2014b).</li> </ul>
Masked Owl	<ul style="list-style-type: none"> <li>Box-Gum Woodland EEC is potential habitat for this species (NSW Scientific Committee, 2011) (i.e. the factors in Table 5 are relevant to this species' habitat).</li> <li>Lives in dry eucalypt forests and woodlands from sea level to 1100 metres (OEH, 2014b).</li> <li>A forest owl, but often hunts along the edges of forests, including roadsides (OEH, 2014b).</li> <li>The typical diet consists of tree-dwelling and ground mammals, especially rats (OEH, 2014b).</li> <li>Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting (OEH, 2014b).</li> </ul>	<ul style="list-style-type: none"> <li>Loss of mature hollow-bearing trees and changes to forest and woodland structure, which leads to fewer such trees in the future (OEH, 2014b).</li> <li>A combination of grazing and regular burning is a threat, through the effects on the quality of ground cover for mammal prey, particularly in open, grassy forests (OEH, 2014b).</li> <li>Secondary poisoning from rodenticides (OEH, 2014b).</li> <li>Absence/lack of suitable foraging areas, particularly in post-mine landscape.</li> <li>Time lapse required to reach appropriate successional stage in restoration and/or rehabilitation.</li> <li>Absence of suitable prey species, particularly in post-mine landscape.</li> </ul>	<ul style="list-style-type: none"> <li>Retain hollow-bearing trees as well as large, mature trees that will provide hollows in the future (OEH, 2014b).</li> <li>Limit the use of pesticides used in suitable native habitat (OEH, 2014b).</li> </ul>
Brown Treecreeper (eastern subspecies)	<ul style="list-style-type: none"> <li>Box-Gum Woodland EEC is potential habitat for this species (NSW Scientific Committee, 2011) (i.e. the factors in Table 5 are relevant to this species' habitat).</li> <li>Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range (OEH, 2014b).</li> <li>Mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species.</li> <li>Also found in mallee and River Red Gum (<i>Eucalyptus camaldulensis</i>) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses. Usually not found in woodlands with a dense shrub layer.</li> <li>Fallen timber is an important habitat component for foraging. Forage for insects and other invertebrates amongst the litter, tussocks and fallen timber, and along trunks and lateral branches. Nectar from Mugga Ironbark (<i>Eucalyptus sideroxylon</i>) and paperbarks, and sap from an unidentified eucalypt are also eaten, along with lizards and food scraps (OEH, 2014b).</li> </ul>	<ul style="list-style-type: none"> <li>Ongoing degradation of habitat, particularly the loss of tree hollows and fallen timber from firewood collection and overgrazing (OEH, 2014b).</li> <li>Lack of regeneration of eucalypt overstorey in woodland due to overgrazing and too-frequent fires (OEH, 2014b).</li> <li>Loss of ground litter from compaction and overgrazing (OEH, 2014b).</li> <li>Absence/lack of suitable foraging areas, particularly in post-mine landscape.</li> <li>Time lapse required to reach appropriate successional stage in restoration and/or rehabilitation.</li> </ul>	<ul style="list-style-type: none"> <li>Modify grazing management practices that will maintain or improve habitat values and still allow some grazing to occur at strategic times of the year (OEH, 2014b).</li> <li>Do not allow further loss of dead standing or fallen timber from firewood collection or on-farm practices such as 'tidying up'; do not allow removal of hollow-bearing dead or living trees and stumps on private and public lands (OEH, 2014b).</li> <li>Fencing of known habitat to protect natural features and to allow natural regeneration (OEH, 2014b).</li> <li>Increase remnant size and connectivity through incentives and OEH threatened species extension services (Doerr <i>et al.</i>, 2011; OEH, 2014b).</li> </ul>

**Table 3 (Continued)**  
**Habitat Requirements of Threatened Fauna**

Common Name	Habitat Requirements Relevant to the Rehabilitation Strategy and Offset Strategy	Threats Relevant to the Proposed Activities as Defined in the Government Guidelines	Relevant Recovery Actions Defined in the Government Guidelines
Speckled Warbler	<ul style="list-style-type: none"> <li>Box-Gum Woodland EEC is potential habitat for this species (NSW Scientific Committee, 2011) (i.e. the factors in Table 5 are relevant to this species' habitat).</li> <li>Lives in a wide range of <i>Eucalyptus</i> dominated dry sclerophyll forests and woodlands that have a grassy understorey, often on rocky ridges or in gullies (Birdlife Australia, 2014; OEH, 2014a; OEH, 2014b).</li> <li>Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy (OEH, 2014b).</li> <li>Large, relatively undisturbed remnants are required for the species to persist in an area (OEH, 2014b).</li> <li>Nest is located in a slight hollow in the ground or the base of a low dense plant, often among grass tussocks, fallen branches and other litter (OEH, 2014a; OEH, 2014b)</li> </ul>	<ul style="list-style-type: none"> <li>Poor regeneration of grassy woodland habitats (OEH, 2014b).</li> <li>Modification and destruction of ground habitat through removal of litter and fallen timber, introduction of exotic pasture grasses, heavy grazing and compaction by stock and frequent fire (OEH, 2014b).</li> <li>Nest failure due to predation by native and non-native birds, cats, dogs and foxes particularly in fragmented and degraded habitats (OEH, 2014b).</li> <li>Absence/lack of suitable foraging areas, particularly in post-mine landscape.</li> <li>Time lapse required to reach appropriate successional stage in restoration and/or rehabilitation.</li> </ul>	<ul style="list-style-type: none"> <li>Undertake fox and feral cat control programs (OEH, 2014b).</li> <li>Retain dead timber on the ground in open woodland areas (OEH, 2014b).</li> <li>Limit firewood collection (OEH, 2014b).</li> <li>Encourage regeneration of habitat by fencing remnant stands (OEH, 2014b).</li> <li>Fence suitable woodland habitats, particularly those with unimproved pasture and an intact native ground plant layer (OEH, 2014b).</li> <li>Increase the size of existing remnants, planting trees and establishing buffer zones of unimproved uncultivated pasture around woodland remnants (Watson <i>et al.</i>, 2001; OEH, 2014b).</li> </ul>
Hooded Robin (south-eastern form)	<ul style="list-style-type: none"> <li>Box-Gum Woodland EEC is potential habitat for this species (NSW Scientific Committee, 2011) (i.e. the factors in Table 5 are relevant to this species' habitat).</li> <li>Prefers lightly wooded country, usually open eucalypt woodland, acacia shrub and mallee, often in or near clearings or open areas (OEH, 2014b).</li> <li>Requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses (OEH, 2014b).</li> <li>Often perches on low dead stumps and fallen timber or on low-hanging branches, using a perch-and-pounce method of hunting insect prey (OEH, 2014b).</li> </ul>	<ul style="list-style-type: none"> <li>Modification and destruction of ground habitat through heavy grazing and compaction by stock, removal of litter and fallen timber, introduction of exotic pasture grasses and frequent fire (OEH, 2014b).</li> <li>Absence/lack of suitable foraging areas, particularly in post-mine landscape.</li> <li>Time lapse required to reach appropriate successional stage in restoration and/or rehabilitation.</li> </ul>	<ul style="list-style-type: none"> <li>Retain dead timber on the ground in open woodland areas (OEH, 2014b).</li> <li>Enhance potential habitat through regeneration by reducing the intensity and duration of grazing (OEH, 2014b).</li> <li>Fence habitat to protect from long-term, intense grazing (OEH, 2014b).</li> <li>Increase the size of existing remnants, by planting trees and establishing buffer zones of un-modified, uncultivated pasture around woodland remnants (Watson <i>et al.</i>, 2001; OEH, 2014b).</li> </ul>
Grey-crowned Babbler (eastern subspecies)	<ul style="list-style-type: none"> <li>Box-Gum Woodland EEC is potential habitat for this species (NSW Scientific Committee, 2011) (i.e. the factors in Table 5 are relevant to this species' habitat).</li> <li>Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains (OEH, 2014b).</li> <li>Open woodlands dominated by mature eucalypts, with regenerating trees, tall shrubs, and an intact ground cover of grass and forbs (OEH, 2014b).</li> <li>Feed on invertebrates, either by foraging on the trunks and branches of eucalypts and other woodland trees or on the ground, digging and probing amongst litter and tussock grasses (OEH, 2014b).</li> <li>Nests are usually located in shrubs or sapling eucalypts, although they may be built in the outermost leaves of low branches of large eucalypts. (OEH, 2014b).</li> </ul>	<ul style="list-style-type: none"> <li>Heavy grazing and removal of coarse, woody debris within woodland remnants (OEH, 2014b).</li> <li>Absence/lack of suitable foraging areas, particularly in post-mine landscape.</li> <li>Time lapse required to reach appropriate successional stage in restoration and/or rehabilitation.</li> <li>Absence of suitable prey species, particularly in post-mine landscape.</li> </ul>	<ul style="list-style-type: none"> <li>Retain existing woodland vegetation (OEH, 2014b).</li> <li>Retain dead timber on the ground in open woodland areas (OEH, 2014b).</li> <li>Encourage regeneration of habitat by fencing remnant stands (OEH, 2014b).</li> <li>Increase the size of existing remnants, planting trees and establishing buffer zones of unimproved uncultivated pasture around woodland remnants (OEH, 2014b).</li> </ul>
Varied Sittella	<ul style="list-style-type: none"> <li>Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and <i>Acacia</i> woodland (OEH, 2014b).</li> <li>Feeds on arthropods gleaned from crevices in rough or decorticated bark, dead branches, standing dead trees and small branches and twigs in the tree canopy (OEH, 2014b).</li> </ul>	<ul style="list-style-type: none"> <li>Firewood collection (OEH, 2014b).</li> <li>Absence/lack of suitable foraging areas, particularly in post-mine landscape.</li> <li>Time lapse required to reach appropriate successional stage in restoration and/or rehabilitation.</li> <li>Absence of suitable prey species, particularly in post-mine landscape.</li> </ul>	<ul style="list-style-type: none"> <li>Increase the size of existing remnants by planting trees and establishing buffer zones (OEH, 2014b).</li> <li>Limit firewood collection and retain dead timber in open forest and woodland areas (OEH, 2014b).</li> <li>Encourage regeneration of habitat by fencing remnant stands and managing the intensity and duration of grazing (OEH, 2014b).</li> <li>Control weeds in areas of known habitat (OEH, 2014b).</li> </ul>

**Table 3 (Continued)**  
**Habitat Requirements of Threatened Fauna**

Common Name	Habitat Requirements Relevant to the Rehabilitation Strategy and Offset Strategy	Threats Relevant to the Proposed Activities as Defined in the Government Guidelines	Relevant Recovery Actions Defined in the Government Guidelines
Koala	<ul style="list-style-type: none"> <li>Box-Gum Woodland EEC is potential habitat for this species (NSW Scientific Committee, 2011) (i.e. the factors in Table 4 are relevant to this species' habitat).</li> <li>Inhabit eucalypt woodlands and forests (OEH, 2014b).</li> <li>Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species (OEH, 2014b).</li> <li>Appropriate food trees in high densities, and floristic diversity are important for this species (Department of Environment and Climate Change, 2008).</li> <li>Cypress pines and brush box are examples of shading trees necessary for the Koala (Department of Environment and Climate Change, 2008).</li> </ul>	<ul style="list-style-type: none"> <li>Predation by feral and domestic dogs (OEH, 2014b).</li> <li>Intense fires that scorch or kill the tree canopy (OEH, 2014b).</li> <li>Absence/lack of suitable foraging areas, particularly in post-mine landscape.</li> <li>Time lapse required to reach appropriate successional stage in restoration and/or rehabilitation.</li> <li>Absence of suitable browse trees particularly in post-mine landscape.</li> </ul>	<ul style="list-style-type: none"> <li>Undertake feral predator control (OEH, 2014b).</li> <li>Apply low intensity, mosaic pattern fuel reduction burns in or adjacent to Koala habitat (OEH, 2014b).</li> <li>Revegetate with suitable feed tree species and develop habitat corridors between populations (OEH, 2014b).</li> </ul>
Squirrel Glider	<ul style="list-style-type: none"> <li>Box-Gum Woodland EEC is potential habitat for this species (NSW Scientific Committee, 2011) (i.e. the factors in Table 5 are relevant to this species' habitat).</li> <li>Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas (OEH, 2014b).</li> <li>Prefers mixed species stands with a shrub or <i>Acacia</i> midstorey (OEH, 2014b).</li> <li>Diet varies seasonally and consists of <i>Acacia</i> gum, eucalypt sap, nectar, honeydew and manna, with invertebrates and pollen providing protein (OEH, 2014b).</li> <li>Require abundant tree hollows for refuge and nest sites (OEH, 2014b).</li> </ul>	<ul style="list-style-type: none"> <li>Loss of hollow-bearing trees (OEH, 2014b).</li> <li>Loss of flowering understorey and midstorey shrubs in forests (OEH, 2014b).</li> <li>Loss of hollow availability due to takeover by feral honeybees and exotic birds (OEH, 2014b).</li> <li>Absence/lack of suitable foraging areas, particularly in post-mine landscape.</li> <li>Time lapse required to reach appropriate successional stage in restoration and/or rehabilitation.</li> <li>Absence of suitable prey species/vegetation resources, particularly in post-mine landscape.</li> </ul>	<ul style="list-style-type: none"> <li>Retain den trees and recruitment trees (future hollow-bearing trees) (OEH, 2014b).</li> <li>Retain food resources, particularly sap-feeding trees and understorey feed species such as <i>Acacia</i> species and banksias (OEH, 2014b).</li> </ul>
Yellow-bellied Sheath-tail-bat	<ul style="list-style-type: none"> <li>Roosts singly in tree hollows and buildings. In treeless areas they are known to utilise mammal burrows (OEH, 2014b).</li> <li>Forages in most habitats across its very wide range, with and without trees (OEH, 2014b).</li> </ul>	<ul style="list-style-type: none"> <li>Loss of hollow-bearing trees (OEH, 2014b).</li> <li>Pesticides and herbicides may reduce the availability of insects, or result in the accumulation of toxic residues in individuals' fat stores (OEH, 2014b).</li> <li>Absence/lack of suitable foraging areas, particularly in post-mine landscape.</li> <li>Time lapse required to reach appropriate successional stage in restoration and/or rehabilitation.</li> <li>Absence of suitable prey species, particularly in post-mine landscape.</li> </ul>	<ul style="list-style-type: none"> <li>Retain stands of native vegetation, especially those with hollow-bearing trees (including dead trees), and retain other structures containing bats (OEH, 2014b).</li> <li>Reduce the use of pesticides in the environment (OEH, 2014b).</li> <li>Encourage regeneration and replanting of local flora species to maintain bat foraging habitat (OEH, 2014b).</li> </ul>
Corben's Long-eared Bat (Listed as South-eastern Long-eared Bat under EPBC)	<ul style="list-style-type: none"> <li>Occurs in a range of inland woodland vegetation types, including box, ironbark and cypress pine woodlands (DotE, 2014b).</li> <li>The species also occurs in Buloke woodland; Brigalow woodland; Belah woodland; Smooth-barked Apple (<i>Angophora leiocarpa</i>) woodland; River Red Gum (<i>Eucalyptus camaldulensis</i>) forests lining watercourses and lakes; Black Box (<i>E. largiflorens</i>) woodland; and dry sclerophyll forest (DotE, 2014b).</li> <li>In the Hunter Valley, NSW, the species has primarily been recorded in moister woodland of various eucalypt species with a distinct shrub layer frequently adjacent to watercourses. There are a small number of records from closed forest adjacent to dry sclerophyll woodlands (DotE, 2014b).</li> <li>Roosts in tree hollows, crevices, and under loose bark (OEH, 2014b).</li> </ul>	<ul style="list-style-type: none"> <li>Loss of remnant semi-arid woodland and mallee habitat (OEH, 2014b).</li> <li>Loss of hollow-bearing trees (OEH, 2014b).</li> <li>Application of pesticides in or adjacent to foraging areas (OEH, 2014b).</li> <li>Absence/lack of suitable foraging areas, particularly in post-mine landscape.</li> <li>Time lapse required to reach appropriate successional stage in restoration and/or rehabilitation.</li> <li>Absence of suitable prey species, particularly in post-mine landscape.</li> </ul>	<ul style="list-style-type: none"> <li>Retain remnant woodland and mallee vegetation (OEH, 2014b).</li> <li>Retain hollow-bearing trees and provide for hollow tree recruitment (OEH, 2014b).</li> <li>Minimise the use of pesticides in and adjacent to foraging areas (OEH, 2014b).</li> </ul>
Large-eared Pied Bat	<ul style="list-style-type: none"> <li>This species requires a combination of sandstone cliff/escarpment to provide roosting habitat that is adjacent to higher fertility sites, particularly box gum woodlands or river/rainforest corridors which are used for foraging (DotE, 2014b).</li> <li>Roosting has also been observed in disused mine shafts, caves, overhangs and it also possibly roosts in the hollows of trees (DotE, 2014b).</li> </ul>	<ul style="list-style-type: none"> <li>Loss of foraging habitat close to cliffs, caves and old mine workings from forestry activities and too-frequent burning, usually associated with grazing (OEH, 2014b).</li> <li>Damage to roosting and maternity sites from mining operations, and recreational caving activities (OEH, 2014b).</li> <li>Use of pesticides.</li> <li>Disturbance to roosting areas by goats (OEH, 2014b).</li> <li>Absence/lack of suitable foraging areas, particularly in post-mine landscape.</li> <li>Time lapse required to reach appropriate successional stage in restoration and/or rehabilitation.</li> <li>Absence of suitable prey species, particularly in post-mine landscape.</li> </ul>	<ul style="list-style-type: none"> <li>Protect known and potential habitat from burning at too-frequent intervals (OEH, 2014b).</li> <li>Avoid damage to known roosting and maternity sites from mining activities, and from recreational caving by contacting the OEH prior to activities (OEH, 2014b).</li> <li>Reduce the use of pesticides and consider alternatives where available (OEH, 2014b).</li> <li>Control goats to reduce disturbance to roosting sites (OEH, 2014b).</li> </ul>

**Table 4**  
**Factors Likely to Impede or Enhance the Provision of Habitat for Threatened Fauna**

Broad Factor	Factors Likely to Impede	Relevant Objective	Factors Likely to Enhance
<p>1. Adequate availability of prey species</p> <p>The restoration of native vegetation communities in the offset areas and revegetation of the post mine landform, together with the salvage and re-use of logs, hollows and surface litter, will over time provide a range of suitable habitats for invertebrates and vertebrates that provide a potential source of food for various threatened fauna species.</p> <p>The additional material provided in the columns to the right, provide specific examples of relevant threatened fauna species and how such goals can be achieved.</p>	<p>1a. Lack of invertebrates as a food source (Brown Treecreeper, Grey-crowned Babbler, Varied Sittella, Squirrel Glider) (OEH, 2014b)</p>	<p>Predominantly relevant to:</p> <ul style="list-style-type: none"> <li>establishment of habitat on the post-mine landform; and</li> <li>re-establishment of habitat on cleared (former agricultural) land in the offset areas.</li> </ul>	<ul style="list-style-type: none"> <li>Maximise salvage and reuse of timber/hollow logs and surface litter from the mine vegetation clearance activities to encourage invertebrates that provide a potential food source.</li> <li>Mulching to encourage invertebrates that provide a potential food source.</li> </ul>
	<p>1b. Lack of reptiles as a food source (Pale-headed Snake) (OEH, 2014b)</p>	<p>Predominantly relevant to:</p> <ul style="list-style-type: none"> <li>establishment of habitat on the post-mine landform; and</li> <li>re-establishment of habitat on cleared (former agricultural) land in the offset areas.</li> </ul>	<ul style="list-style-type: none"> <li>Maximise salvage and reuse of bush rocks from the mine vegetation clearance activities to encourage reptiles that provide a potential food source.</li> <li>Maximise salvage and reuse of timber/hollow logs from the mine vegetation clearance activities to encourage reptiles that provide a potential food source.</li> </ul>
	<p>1c. Lack of small mammals as a food source (Pale-headed Snake, Masked Owl) (DotE, 2014b; OEH, 2014b)</p>	<p>Predominantly relevant to:</p> <ul style="list-style-type: none"> <li>establishment of habitat on the post-mine landform; and</li> <li>re-establishment of habitat on cleared (former agricultural) land in the offset areas.</li> </ul>	<ul style="list-style-type: none"> <li>Maximise salvage and reuse of timber/hollow logs from the mine vegetation clearance activities to encourage small mammals that provide a potential food source (Manning <i>et al.</i> 2011).</li> <li>Place hollow limbs/nest boxes (in young trees without hollows) from the mine vegetation clearance activities to encourage small mammals that would provide a potential food source for predators.</li> </ul>
<p>2. Nesting (mainly birds)</p> <p>The restoration of native vegetation communities in the offset areas and revegetation of the post mine landform will over time provide suitable vegetation in which some threatened fauna species may nest. Additionally, salvage and re-use of logs, hollows and surface litter could facilitate other threatened fauna species to nest in the short-term.</p> <p>The additional material provided in the columns to the right, provide specific examples of relevant threatened fauna species and how such goals can be achieved.</p>	<p>2a. Lack of suitable vegetation (Masked Owl, Speckled Warbler, Grey-crowned Babbler) (OEH, 2014b)</p>	<p>Predominantly relevant to:</p> <ul style="list-style-type: none"> <li>establishment of habitat on the post-mine landform;</li> <li>re-establishment of habitat from derived grasslands in the offset areas; and</li> <li>re-establishment of habitat on cleared (former agricultural) land in the offset areas.</li> </ul>	<ul style="list-style-type: none"> <li>As part of a diverse seed mix/tube stock planting list, plant tall tree species.</li> <li>As part of a diverse seed mix/tube stock planting list, plant low, dense species (Speckled Warbler).</li> <li>As part of a diverse seed mix/tube stock planting list, plant eucalypts (Masked Owl, Grey-crowned Babbler).</li> <li>As part of a diverse seed mix/tube stock planting list, plant native, tussocky grasses (Speckled Warbler).</li> </ul>
	<p>2b. Lack of hollows (Turquoise Parrot, Masked Owl, Squirrel Glider) (OEH, 2014b)</p>	<p>Predominantly relevant to:</p> <ul style="list-style-type: none"> <li>establishment of habitat on the post-mine landform; and</li> <li>restoration of existing habitat in the offset areas.</li> </ul>	<ul style="list-style-type: none"> <li>Maximise salvage and reuse of timber/hollow logs from the mine vegetation clearance activities, including placement of hollow limbs in trees without hollows or as components of stag trees.</li> </ul>
	<p>2c. Lack of fallen timber (Speckled Warbler) (OEH, 2014b)</p>	<p>Predominantly relevant to:</p> <ul style="list-style-type: none"> <li>establishment of habitat on the post-mine landform;</li> <li>re-establishment of habitat from derived grasslands in the offset areas; and</li> <li>re-establishment of habitat on cleared (former agricultural) land in the offset areas.</li> </ul>	<ul style="list-style-type: none"> <li>Maximise salvage and reuse of fallen timber/hollow logs from the mine vegetation clearance activities.</li> </ul>
<p>3. Flora (mainly for foraging and roosting habitat)</p> <p>The restoration of native vegetation communities in the offset areas and revegetation of the post mine landform will over time provide suitable vegetation in which some threatened fauna species may forage and roost.</p> <p>The additional material provided in the columns to the right, provide specific examples of relevant threatened fauna species and how such goals can be achieved.</p>	<p>3a. Lack of suitable tree species (Pale-headed Snake, Turquoise Parrot, Masked Owl, Brown Treecreeper, Speckled Warbler, Hooded Robin, Grey-crowned Babbler, Varied Sittella, Koala, Squirrel Glider, Corben's Long-eared Bat, Large-eared Pied Bat) (Department of Environment and Climate Change, 2008; BirdLife Australia, 2014; DotE, 2014b; OEH, 2014b)</p>	<p>Predominantly relevant to:</p> <ul style="list-style-type: none"> <li>establishment of habitat on the post-mine landform;</li> <li>re-establishment of habitat from derived grasslands in the offset areas; and</li> <li>re-establishment of habitat on cleared (former agricultural) land in the offset areas.</li> </ul>	<ul style="list-style-type: none"> <li>Plant eucalypts (Pale-headed Snake, Turquoise Parrot, Masked Owl, Brown Treecreeper, Speckled Warbler, Hooded Robin, Grey-crowned Babbler, Varied Sittella, Koala, Squirrel Glider, Corben's Long-eared Bat), in particular: <ul style="list-style-type: none"> <li>box, ironbark and gum species (Squirrel Glider);</li> <li>White Box (<i>Eucalyptus albens</i>) (Brown Treecreeper, Grey-Crowned Babbler, Large-eared Pied Bat);</li> <li>Yellow Box (<i>E. melliodora</i>) (Brown Treecreeper, Grey-Crowned Babbler, Large-eared Pied Bat);</li> <li>Mugga Ironbark (<i>E. sideroxylon</i>)<sup>1</sup> (Brown Treecreeper);</li> <li>Blakely's Red Gum (<i>E. blakelyi</i>) (Brown Treecreeper, Grey-Crowned Babbler, Large-eared Pied Bat);</li> <li>stringybark species (Brown Treecreeper);</li> <li>rough-barked species (Brown Treecreeper, Varied Sittella);</li> </ul> </li> </ul>

**Table 4 (Continued)**  
**Factors Likely to Impede or Enhance the Provision of Habitat for Threatened Fauna**

Broad Factor	Factors Likely to Impede	Relevant Objective	Factors Likely to Enhance
<p>3. Flora (mainly for foraging and roosting habitat) (Cont.)</p> <p>The restoration of native vegetation communities in the offset areas and revegetation of the post mine landform will over time provide suitable vegetation in which some threatened fauna species may forage and roost.</p> <p>The additional material provided in the columns to the right, provide specific examples of relevant threatened fauna species and how such goals can be achieved.</p>	<p>3a. Lack of suitable tree species (Pale-headed Snake, Turquoise Parrot, Masked Owl, Brown Treecreeper, Speckled Warbler, Hooded Robin, Grey-crowned Babbler, Varied Sittella, Koala, Squirrel Glider, Corben's Long-eared Bat, Large-eared Pied Bat) (Department of Environment and Climate Change, 2008; BirdLife Australia, 2014; DotE, 2014b; OEH, 2014b) (Cont.)</p>		<ul style="list-style-type: none"> <li>- River Red Gum (<i>E. camaldulensis</i>) (Brown Treecreeper, Squirrel Glider, Corben's Long-eared Bat);</li> <li>- smooth-barked gum species (Varied Sittella); and</li> <li>- Black Box (<i>E. largiflorens</i>)<sup>1</sup> (Corben's Long-eared Bat)</li> <li>• Plant <i>Acacia</i> tree species (Barking Owl, Brown Treecreeper, Squirrel Glider).</li> <li>• Plant mallee species (Brown Treecreeper, Hooded Robin).</li> </ul>
	<p>3b. Lack of suitable shrubs (Brown Treecreeper, Hooded Robin, Grey-crowned Babbler) (OEH, 2014b)</p>	<p>Predominantly relevant to:</p> <ul style="list-style-type: none"> <li>• establishment of habitat on the post-mine landform;</li> <li>• re-establishment of habitat from derived grasslands in the offset areas; and</li> <li>• re-establishment of habitat on cleared (former agricultural) land in the offset areas.</li> </ul>	<ul style="list-style-type: none"> <li>• Plant <i>Acacia</i> shrub species (Hooded Robin).</li> <li>• Plant native shrubs (Brown Treecreeper).</li> <li>• Plant tall shrub species (Grey-crowned Babbler).</li> </ul>
	<p>3c. Lack of suitable ground cover (Turquoise Parrot, Brown Treecreeper, Speckled Warbler, Hooded Robin, Grey-crowned Babbler) (OEH, 2014b)</p>	<p>Predominantly relevant to:</p> <ul style="list-style-type: none"> <li>• establishment of habitat on the post-mine landform;</li> <li>• re-establishment of habitat from derived grasslands in the offset areas; and</li> <li>• re-establishment of habitat on cleared (former agricultural) land in the offset areas.</li> </ul>	<ul style="list-style-type: none"> <li>• Plant native grasses.</li> <li>• Plant native herbs (Turquoise Parrot).</li> <li>• Plant native forbs (Grey-crowned Babbler).</li> </ul>
	<p>3d. Dense shrub layer (Brown Treecreeper, Speckled Warbler) (OEH, 2014b)</p>	<p>Predominantly relevant to:</p> <ul style="list-style-type: none"> <li>• establishment of habitat on the post-mine landform;</li> <li>• re-establishment of habitat from derived grasslands in the offset areas; and</li> <li>• re-establishment of habitat on cleared (former agricultural) land in the offset areas.</li> </ul>	<ul style="list-style-type: none"> <li>• Correct spacing for species when planting seedlings.</li> </ul>
	<p>3e. Poor floristic diversity (Koala) (Department of Environment and Climate Change, 2008; OEH, 2014b)</p>	<p>Predominantly relevant to:</p> <ul style="list-style-type: none"> <li>• establishment of habitat on the post-mine landform;</li> <li>• re-establishment of habitat from derived grasslands in the offset areas; and</li> <li>re-establishment of habitat on cleared (former agricultural) land in the offset areas.</li> </ul>	<ul style="list-style-type: none"> <li>• Control for floristic diversity be means of planting a high number of both eucalypt and non-eucalypt species (Koala).</li> </ul>
<p>4. Remnant Area</p> <p>The restoration of native vegetation communities in the offset areas and revegetation of the post mine landform will over time increase the size of the existing vegetation patches.</p> <p>The additional material provided in the columns to the right, provide specific examples of relevant threatened fauna species and how such goals can be achieved.</p>	<p>4a. Small patch area are size (Speckled Warbler, Grey-crowned Babbler) (Radford <i>et al.</i>, 2005; OEH, 2014b)</p>	<p>Predominantly relevant to:</p> <ul style="list-style-type: none"> <li>• re-establishment of habitat from derived grasslands in the offset areas; and</li> <li>• re-establishment of habitat on cleared (former agricultural) land in the offset areas.</li> </ul>	<ul style="list-style-type: none"> <li>• Increase woodland patch area within the offset area (Prober <i>et al.</i>, 2002).</li> </ul>
<p>5. Structural Diversity</p> <p>The restoration of native vegetation communities in the offset areas and revegetation of the post mine landform, together with the salvage and re-use of logs, hollows and surface litter, will over time provide a range of suitable habitats for threatened fauna species.</p> <p>The additional material provided in the columns to the right provide specific examples of relevant threatened fauna species and how such goals can be achieved.</p>	<p>5a. Lack of dead stumps or fallen timber (Turquoise Parrot, Brown Treecreeper, Speckled Warbler, Hooded Robin, Varied Sittella) (OEH, 2014b)</p>	<p>Relevant to the post-mine landforms and the offset areas.</p>	<ul style="list-style-type: none"> <li>• Maximise salvage and reuse of timber/hollow logs from the mine vegetation clearance activities.</li> <li>• Restriction on firewood collection (OEH, 2014b).</li> <li>• Maximise salvage and reuse of timber/hollow logs from the mine vegetation clearance activities.</li> <li>• Place hollow limbs in young trees without hollows.</li> </ul>
	<p>5b. Lack of tree hollows (Pale-headed Snake, Brown Treecreeper, Yellow-bellied Sheath-tail-bat, Corben's Long-eared Bat) (DotE, 2014b; OEH, 2014b)</p>	<p>Relevant to the post-mine landforms and the offset areas.</p>	

**Table 4 (Continued)**  
**Factors Likely to Impede or Enhance the Provision of Habitat for Threatened Fauna**

Broad Factor	Factors Likely to Impede	Relevant Objective	Factors Likely to Enhance
<p>6. Feral Animals</p> <p>The RMP and BMP will describe procedures to monitor, prevent and control feral animals in the ongoing restoration, replanting and remediation phase of the Project.</p> <p>The additional material provided in the columns to the right, provide specific examples of relevant threatened fauna species and how such goals can be achieved.</p>	6a. Loss of food sources or indirect poisoning as a results of use of pesticides, insecticides or herbicides (Masked Owl, Yellow-bellied Sheathtail-bat, Large-eared Pied Bat) (OEH, 2014b)	Relevant to the post-mine landforms and the offset areas.	<ul style="list-style-type: none"> <li>Limit use of pesticides used in suitable native habitat (OEH, 2014b).</li> <li>Use herbicide sparingly (minimised through spot-spraying, basal spraying, stem injection or cut and paint application methods) (Department of Sustainability and the Environment [DSE], 2005; Rawlings <i>et al.</i>, 2010; DECCW, 2011).</li> </ul>
	6b. Competition with introduced Honeybees/exotic birds for nectar, pollen and tree hollows (Squirrel Glider) (OEH, 2014b)	Relevant to the post-mine landforms and the offset areas.	<ul style="list-style-type: none"> <li>Management of Honeybees<sup>2</sup>.</li> <li>Management of exotic bird species.</li> </ul>
	6c. Predation by feral animals (including foxes, cats, exotic birds and dogs) (Turquoise Parrot, Speckled Warbler, Koala) (OEH, 2014b)	Relevant to the post-mine landforms and the offset areas.	<ul style="list-style-type: none"> <li>Undertake feral predator control.</li> </ul>
	6d. Disturbance to roosting sites by goats (Large-eared Pied Bat) (OEH, 2014b)	Relevant to the post-mine landforms and the offset areas.	<ul style="list-style-type: none"> <li>Monitoring and control feral pigs and goats (Eddy, 2002; Rawlings <i>et al.</i>, 2010).</li> </ul>
<p>7. Weeds</p> <p>The RMP will describe procedures to prevent, monitor and control weeds. The RMP will also describe relevant targets and performance indicators for weed management.</p> <p>The additional material provided in the columns to the right, provide specific examples of relevant threatened fauna species and how such goals can be achieved.</p>	7a. Invasion of weeds (eg. Coolatai Grass), resulting in loss of important food plants (Varied Sittella) (OEH, 2014b)	Relevant to the post-mine landforms and the offset areas.	<ul style="list-style-type: none"> <li>Weed control (Condition 25[a] of the Approval Decision EPBC 2011/5923).</li> </ul>
<p>8. Regeneration</p> <p>The restoration of native vegetation communities in the offset areas and revegetation of the post mine landform, together with the salvage and re-use of logs, hollows and surface litter, will over time provide a range of suitable habitats for threatened fauna species.</p> <p>The additional material provided in the columns to the right, provide specific examples of relevant threatened fauna species and how such goals can be achieved.</p>	8a. Poor regeneration of habitat (Speckled Warbler) (OEH, 2014b)	Relevant to the post-mine landforms and the offset areas.	<ul style="list-style-type: none"> <li>Encourage regeneration by fencing (OEH, 2014b).</li> <li>Undertake new plantings (OEH, 2014b).</li> <li>Reduce intensity of grazing (OEH, 2014b).</li> </ul>
<p>9. Management</p> <p>See additional description provide in column one above.</p>	9a. Too frequent grazing management (Pale-headed Snake, Turquoise Parrot, Masked Owl, Brown Treecreeper, Speckled Warbler, Hooded Robin, Grey-crowned Babbler, Varied Sittella, Large-eared Pied Bat) (OEH, 2014b)	Relevant to the post-mine landforms and the offset areas.	<ul style="list-style-type: none"> <li>Fencing of areas undergoing revegetation to exclude grazing livestock and prevent grazing of seedlings (Eddy, 2002).</li> <li>Maintenance of fencing used to exclude livestock.</li> <li>Restriction of livestock access to maintain ground cover.</li> <li>Low stocking rates.</li> </ul>
	9b. Too frequent burning management (Pale-headed Snake, Masked Owl, Speckled Warbler, Koala, Large-eared Pied Bat) (OEH, 2014b)	Relevant to the post-mine landforms and the offset areas.	<ul style="list-style-type: none"> <li>No controlled burns whilst vegetation is establishing.</li> <li>Assess fuel loads.</li> <li>DECCW (2011) suggests fire frequency should be a minimum interval of 5 years and a maximum interval of 40 years. Rawlings <i>et al.</i>, (2010) recommends fire frequency in patches should be every 4 to 8 years.</li> <li>Controlled burns should be undertaken in a mosaic (i.e. retain some unburned areas (DECCW, 2011).</li> </ul>

<sup>1</sup> This species has not been recorded in the surrounds of the area to be rehabilitated and is therefore not proposed to be planted.

<sup>2</sup> Not proposed.

**Table 5**  
**Factors Likely to Impede or Enhance the Re-establishment and Restoration of Box-Gum Woodland**

Broad Factor	Factors Likely to Impede	Relevant Objective	Factors Likely to Enhance
1. Substrate	1a. Poor soil chemistry – depleted soil nutrients (Eddy, 2002)	Mine Rehabilitation – Establishment of Box-Gum Woodland on the post-mine landform	<ul style="list-style-type: none"> <li>Avoidance of soils with high or low pH, high salinity, low fertility or sodic soils.</li> <li>Rehabilitation trials focused on soil substrate.</li> <li>Nutrient management options: <ul style="list-style-type: none"> <li>Amelioration of soils with agricultural gypsum, compost (i.e. mulch saved during clearing activities) or fertilisers depending on the nutrient deficiency.</li> <li>Addition of woody debris to increase carbon levels (Harmon <i>et al.</i>, 1986; Debeljak, 2006; Manning <i>et al.</i>, 2013; Goldin and Brookhouse, 2014).</li> <li>Use of Biochar to increase soil carbon<sup>1</sup>.</li> </ul> </li> </ul>
		Offset Areas – Re-establishment of Box-Gum Woodland from derived grasslands (Condition State 2 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> <li>Limited and selective use of specific fertilisers to facilitate growth of tube stock (Eddy, 2002).</li> <li>Placement of woody debris to increase carbon and moisture levels (Goldin and Brookhouse, 2014).</li> </ul>
	1b. Poor soil chemistry – elevated soil nutrients, salinity and acid soils (Rawlings <i>et al.</i> , 2010; Department of the Environment, Climate Change and Water [DECCW], 2011)	Mine Rehabilitation – Establishment of Box-Gum Woodland on the post-mine landform	<ul style="list-style-type: none"> <li>Avoidance of soils with high or low pH, high salinity, low fertility or sodic soils.</li> <li>Application of minimum topsoil and subsoil depths (Condition 25[c] of the Approval Decision EPBC 2011/5923).</li> <li>Soil surveys and inventories prior to soil stripping (Condition 25[c] of the Approval Decision EPBC 2011/5923).</li> <li>Soil handling processes for removal, storage and re-layering of topsoil and subsoil (Condition 25[d] of the Approval Decision EPBC 2011/5923).</li> <li>Annual soil balances to manage soil handling.</li> <li>Rehabilitation trials focused on soil substrate.</li> </ul>
	1c. Poor soil chemistry – elevated soil nutrients (Prober <i>et al.</i> , 2002; Rawlings <i>et al.</i> , 2010; DECCW, 2011)	Offset Areas – Re-establishment of Box-Gum Woodland from derived grasslands (Condition State 2 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> <li>No application of fertilizers on soils with elevated concentrations of the same nutrients (Rawlings <i>et al.</i>, 2010).</li> <li>Nutrient management options to lower soil nitrogen and phosphorus levels: <ul style="list-style-type: none"> <li>Crash grazing periodically to remove nutrients locked in weeds (Rawlings <i>et al.</i>, 2010)<sup>2</sup>.</li> <li>Restriction of livestock access to limit further nutrient enrichment<sup>3</sup> (Rawlings <i>et al.</i>, 2010).</li> <li>Hay cutting (Rawlings <i>et al.</i>, 2010)<sup>4</sup>.</li> <li>Controlled burns (Rawlings <i>et al.</i>, 2010).</li> <li>Carbohydrate addition (Rawlings <i>et al.</i>, 2010)<sup>5</sup>.</li> <li>Topsoil removal (scalping) (cleared land only) (Gibson-Roy <i>et al.</i>, 2010; Rawlings <i>et al.</i>, 2010)<sup>6</sup>.</li> <li>No kill and pasture cropping (Rawlings <i>et al.</i>, 2010)<sup>7</sup>.</li> </ul> </li> </ul>
	1d. Poor soil chemistry – acid rock drainage	Mine Rehabilitation – Establishment of Box-Gum Woodland on the post-mine landform	<ul style="list-style-type: none"> <li>Selective identification and placement (burial) of potentially acid forming interburden materials (Condition 39[c] Schedule 3 of Project Approval 11_0047).</li> <li>Application of minimum topsoil and subsoil depths (Condition 25[c] of the Approval Decision EPBC 2011/5923).</li> </ul>
1e. Erosion and sedimentation (Rawlings <i>et al.</i> , 2010; DECCW, 2011; Tongway and Ludwig, 2011)	Mine Rehabilitation – Establishment of Box-Gum Woodland on the post-mine landform	<ul style="list-style-type: none"> <li>Establishing vegetation cover as soon as practicable following disturbance.</li> <li>Application of a temporary sterile cover crop, or native grass covercrop established from native hays.</li> <li>Adjust seed and planting densities to maximise ground cover.</li> <li>Treatment of dispersive soils and spoils.</li> <li>Design of the batter slopes to be stable.</li> <li>Use of structural erosion controls (e.g. channel banks, slope drains and energy dissipaters).</li> <li>Exclusion of livestock (Rawlings <i>et al.</i>, 2010).</li> <li>Use of rock to stabilise batter surfaces.</li> <li>Ecological function analysis to identify constraints and requirements for specific management measures (Tongway and Ludwig, 2011).</li> </ul>	

<sup>1</sup> Not proposed to be used due to preferential use of mulch and woody debris from clearing activities.

<sup>2</sup> This method is not proposed to be undertaken as grazing livestock were removed from the offset area in 2010.

<sup>3</sup> Grazing livestock were removed from the offset area in 2010.

<sup>4</sup> This method is not proposed to be undertaken due to the extensive areas required to be revegetated.

<sup>5</sup> This method is only applicable over small areas (Rawlings *et al.*, 2010) and is therefore not proposed to be undertaken due to the extensive areas required to be revegetated.

<sup>6</sup> This method is only applicable to the cleared lands but is not proposed to be undertaken due to the extensive areas required to be revegetated and high disturbance of the technique.

<sup>7</sup> This method is only applicable to the derived grasslands but is not proposed to be undertaken in preference of other methods.

**Table 5 (Continued)**  
**Factors Likely to Impede or Enhance the Re-establishment and Restoration of Box-Gum Woodland**

Broad Factor	Factors Likely to Impede	Relevant Objective	Factors Likely to Enhance	
1. Substrate (Cont.)	1e. Erosion and sedimentation (Rawlings <i>et al.</i> , 2010; DECCW, 2011) (Cont.)	Offset Areas – Re-establishment of Box-Gum Woodland from derived grasslands (Condition State 2 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> <li>Targeting revegetation along drainage lines.</li> <li>Remediation of scalded areas.</li> <li>Restriction of livestock access<sup>8</sup> (particularly along drainage lines) (Rawlings <i>et al.</i>, 2010).</li> <li>Installation of new infrastructure in stable locations (e.g. access roads) (McIvor, 2002).</li> <li>Maximised re-use of existing infrastructure (e.g. access roads) instead of creating new infrastructure.</li> <li>Ecological function analysis to identify constraints and requirements for specific management measures (Tongway and Ludwig, 2011).</li> </ul>	
		Offset Areas – Restoration of Existing Box-Gum Woodland (Condition State 1 [Rawlings <i>et al.</i> , 2010])		
	1f. Soil compaction – inhibits germination of seeds or growth of seedlings (Eddy, 2002; Department of Sustainability and the Environment [DSE], 2005; Rawlings <i>et al.</i> , 2010; DECCW, 2011) Also adds to water logging issues.	Mine Rehabilitation – Establishment of Box-Gum Woodland on the post-mine landform		<ul style="list-style-type: none"> <li>Restriction of vehicle access to avoid compacting soil (Eddy, 2002; DSE, 2005).</li> <li>Pre-planting site preparation (e.g. ripping) (Rawlings <i>et al.</i>, 2010).</li> <li>Exclusion of livestock (Rawlings <i>et al.</i>, 2010).</li> <li>Mulching (Rawlings <i>et al.</i>, 2010).</li> <li>Use of spiked rollers/air jetting to aerate soils to depth of 30 cm.</li> </ul>
		Offset Areas – Re-establishment of Box-Gum Woodland from derived grasslands (Condition State 2 [Rawlings <i>et al.</i> , 2010])		<ul style="list-style-type: none"> <li>Restriction of vehicle access to avoid compacting soil (Eddy, 2002; DSE, 2005).</li> <li>Restriction of livestock access<sup>9</sup> (Rawlings <i>et al.</i>, 2010).</li> </ul>
		Offset Areas – Restoration of Existing Box-Gum Woodland (Condition State 1 [Rawlings <i>et al.</i> , 2010])		
	1g. Ground disturbance (Eddy, 2002; Rawlings <i>et al.</i> , 2010)	Offset Areas – Re-establishment of Box-Gum Woodland from derived grasslands (Condition State 2 [Rawlings <i>et al.</i> , 2010])		<ul style="list-style-type: none"> <li>Avoidance of revegetation techniques that involve high level of physical disturbance (i.e. cultivation, ripping and excavation) (Eddy, 2002; DECCW, 2011).</li> <li>Restriction of vehicle access to avoid unnecessary ground disturbance (DSE, 2005; Eddy, 2002).</li> <li>Fencing and signage.</li> </ul>
		Offset Areas – Restoration of Existing Box-Gum Woodland (Condition State 1 [Rawlings <i>et al.</i> , 2010])		
	1h. Depleted soil seed bank (DECCW, 2011)	Mine Rehabilitation – Establishment of Box-Gum Woodland on the post-mine landform		<ul style="list-style-type: none"> <li>Management of topsoil seed resource.</li> <li>Soil seed bank germination testing (rehabilitation trials).</li> <li>Supplementary seeding/tube stock planting (Gibson-Roy <i>et al.</i>, 2010).</li> </ul>
		Offset Areas		<ul style="list-style-type: none"> <li>Supplementary seeding/tube stock planting.</li> </ul>
	1i. Insufficient topsoil and/or topsoil depth (DECCW, 2011)	Mine Rehabilitation – Establishment of Box-Gum Woodland on the post-mine landform		<ul style="list-style-type: none"> <li>Application of minimum topsoil and subsoil depths (Condition 25[c] of the Approval Decision EPBC 2011/5923).</li> <li>Soil surveys and inventories prior to soil stripping (Condition 25[c] of the Approval Decision EPBC 2011/5923).</li> <li>Soil handling processes for removal, storage and re-layering of topsoil and subsoil (Condition 25[d] of the Approval Decision EPBC 2011/5923).</li> <li>Annual soil balances to manage soil handling.</li> </ul>
	1j. Poor soil water holding capacity (Eddy, 2002)	Mine Rehabilitation – Establishment of Box-Gum Woodland on the post-mine landform		<ul style="list-style-type: none"> <li>Amelioration of soils with compost/woody debris.</li> <li>Selective placement of soils.</li> <li>Addition of woody debris (Harmon <i>et al.</i>, 1986; Debeljak, 2006; Manning <i>et al.</i>, 2013, Goldin and Brookhouse, 2014).</li> </ul>
	1k. Instability of the final landform	Mine Rehabilitation – Establishment of Box-Gum Woodland on the post-mine landform		<ul style="list-style-type: none"> <li>Design of the batter slopes to be stable.</li> <li>Selective placement of soils.</li> <li>Use of rock to stabilise batter surfaces.</li> </ul>
	1l. Poor drainage of the final landform (Eddy, 2002)	Mine Rehabilitation – Establishment of Box-Gum Woodland on the post-mine landform		<ul style="list-style-type: none"> <li>Design of the batter slopes to be stable.</li> <li>Amelioration of soils with compost.</li> </ul>

<sup>8</sup> Grazing livestock were removed from the offset area in 2010.

<sup>9</sup> Grazing livestock were removed from the offset area in 2010.

**Table 5 (Continued)**  
**Factors Likely to Impede or Enhance the Re-establishment and Restoration of Box-Gum Woodland**

Broad Factor	Factors Likely to Impede	Relevant Objective	Factors Likely to Enhance
1. Substrate (Cont.)	1m. Lack of soil mycorrhizae	Mine Rehabilitation - Establishment of Box-Gum Woodland on the post-mine landform	<ul style="list-style-type: none"> <li>Application of minimum topsoil and subsoil depths.</li> <li>Soil surveys and inventories prior to soil stripping (Condition 25[c] of the Approval Decision EPBC 2011/5923).</li> <li>Soil handling processes for removal, storage and re-layering of topsoil and subsoil (Condition 25[d] of the Approval Decision EPBC 2011/5923).</li> <li>Use of rhizobial bacteria inoculants for acacia (CSIRO, 2005).</li> </ul>
2. Clearing	2a. Incidental clearing, fragmentation and fire wood collection	Mine Rehabilitation – Establishment of Box-Gum Woodland on the post-mine landform	<ul style="list-style-type: none"> <li>Restriction on clearing.</li> </ul>
		Offset Areas – Re-establishment of Box-Gum Woodland from derived grasslands (Condition State 2 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> <li>Restriction on clearing.</li> <li>Restriction on fire wood collection.</li> </ul>
		Offset Areas – Restoration of Existing Box-Gum Woodland (Condition State 1 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> <li>Use of low disturbance methods for site preparation in derived grasslands and existing Box-Gum Woodland.</li> </ul>
3. Livestock	3a. Grazing by cattle – ground disturbance, remove or destroy seeds, seedlings or plantings (DSE, 2005; Rawlings <i>et al.</i> , 2010)	Mine Rehabilitation – Establishment of Box-Gum Woodland on the post-mine landform	<ul style="list-style-type: none"> <li>Fencing of areas undergoing revegetation to exclude grazing livestock and prevent grazing of seedlings (Eddy, 2002).</li> <li>Maintenance of fencing used to exclude livestock.</li> </ul>
		Offset Areas	Grazing livestock were removed from the offset area in 2010.
4. Introduced flora species (weeds)	4a. Weed invasion – perennial and annual grasses, perennial herbs, annual and biennial herbs and woody weeds (DSE, 2005; Rawlings <i>et al.</i> , 2010; Gibson-Roy <i>et al.</i> , 2010; DECCW, 2011)	Mine Rehabilitation – Establishment of Box-Gum Woodland on the post-mine landform	<ul style="list-style-type: none"> <li>Weed control (Condition 25[a] of the Approval Decision EPBC 2011/5923).</li> <li>Establishing vegetation cover as soon as practicable following disturbance (Condition 25[b] of the Approval Decision EPBC 2011/5923).</li> <li>Application of a temporary sterile cover crop, or native grass covercrop established from native hays.</li> <li>Minimal unnecessary ground disturbance that may create opportunities for weeds (Rawlings <i>et al.</i>, 2010; DECCW, 2011).</li> <li>Nutrient management (e.g. exclusion of grazing livestock which add nutrients) (Prober <i>et al.</i>, 2002; Rawlings <i>et al.</i>, 2010).</li> <li>General weed hygiene (e.g. avoiding driving through weed infestations) (DECCW, 2011).</li> <li>Correct spacing for species when planting seedlings to avoid excessive shading (Rawlings <i>et al.</i>, 2010).</li> <li>Provisions to identify new invasive plant species (e.g. weed monitoring).</li> <li>Weed management options: <ul style="list-style-type: none"> <li>Physical Removal (e.g. removing weeds by felling or pulling) (Gibson-Roy <i>et al.</i>, 2010; Rawlings <i>et al.</i>, 2010).</li> <li>Herbicide (minimised through spot-spraying, basal spraying, stem injection or cut and paint application methods) (DSE, 2005; Rawlings <i>et al.</i>, 2010; DECCW, 2011).</li> </ul> </li> <li>Sowing of Kangaroo Grass to outcompete annual grass weeds (Prober <i>et al.</i>, 2002; Rawlings <i>et al.</i>, 2010).</li> </ul>
		Offset Areas – Re-establishment of Box-Gum Woodland from derived grasslands (Condition State 2 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> <li>Minimal unnecessary ground disturbance that may create opportunities for weeds (Eddy, 2002; DSE, 2005; Rawlings <i>et al.</i>, 2010).</li> <li>Light grazing in autumn and/or winter to reduce vigour of annual grass weeds<sup>10</sup> (Rawlings <i>et al.</i>, 2010).</li> </ul>
		Offset Areas – Restoration of Existing Box-Gum Woodland (Condition State 1 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> <li>Minimal unnecessary ground disturbance that may create opportunities for weeds (Eddy, 2002; DSE, 2005; Rawlings <i>et al.</i>, 2010).</li> </ul>
5. Herbicide	5a. Excessive herbicides – may have a negative effects on native species (Eddy, 2002)	All areas	<ul style="list-style-type: none"> <li>Use herbicide sparingly (minimised through spot-spraying, basal spraying, stem injection or cut and paint application methods) (DSE, 2005; Rawlings <i>et al.</i>, 2010; DECCW, 2011).</li> </ul>
6. Impacts from Animals (exotics and grazing native animals)	6a. Grazing by feral pigs and goats – remove or destroy seeds, seedlings or plantings (Eddy, 2002; Rawlings <i>et al.</i> , 2010; DECCW, 2011)	All areas	<ul style="list-style-type: none"> <li>Monitoring and control feral pigs and goats (Eddy, 2002; Rawlings <i>et al.</i>, 2010).</li> <li>Use of tree guards to protect young seedlings from browsing or grazing (Rawlings <i>et al.</i>, 2010).</li> </ul>
	6b. Rabbits and hares (Eddy, 2002; DSE, 2005; DECCW, 2011)	All areas	<ul style="list-style-type: none"> <li>Monitoring and control of rabbits and hares (Eddy, 2002; DSE, 2005; Rawlings <i>et al.</i>, 2010).</li> </ul>
	6c. Grazing native fauna species (e.g. kangaroos) (DECCW, 2011)	All areas	<ul style="list-style-type: none"> <li>Use of tree guards to protect young seedlings from browsing or grazing (Rawlings <i>et al.</i>, 2010).</li> <li>Fencing farm dams.</li> </ul>

<sup>10</sup> Grazing livestock were removed from the offset area in 2010.

**Table 5 (Continued)**  
**Factors Likely to Impede or Enhance the Re-establishment and Restoration of Box-Gum Woodland**

Broad Factor	Factors Likely to Impede	Relevant Objective	Factors Likely to Enhance
6. Impacts from Animals (exotics and grazing native animals) (Cont.)	6d. Feral foxes (Eddy, 2002; DECCW, 2011)	All areas	<ul style="list-style-type: none"> <li>Monitoring and control of feral foxes (Eddy, 2002; Rawlings <i>et al.</i>, 2010).</li> </ul>
	6e. Honeybees (DECCW, 2011)	All areas	<ul style="list-style-type: none"> <li>Management of honeybees<sup>11</sup>.</li> </ul>
	6f. Deer (DECCW, 2011)	All areas	<ul style="list-style-type: none"> <li>Management of Deer.</li> </ul>
	6g. Feral Cat (Eddy, 2002; DECCW, 2011)	All areas	<ul style="list-style-type: none"> <li>Management of the Feral Cat.</li> </ul>
	6h. Other Invasive Fauna	All areas	<ul style="list-style-type: none"> <li>Provisions to identify new invasive fauna species (e.g. fauna monitoring).</li> </ul>
7. Fire	7a. Uncontrolled bushfire (DECCW, 2011)	Mine Rehabilitation – Establishment of Box-Gum Woodland on the post-mine landform	<ul style="list-style-type: none"> <li>No controlled burns whilst vegetation is establishing.</li> <li>Maintain fire breaks and access.</li> <li>Assess fuel loads.</li> </ul>
		Offset Areas – Re-establishment of Box-Gum Woodland from derived grasslands (Condition State 2 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> <li>No controlled burns whilst vegetation is establishing.</li> <li>Controlled grazing to reduce biomass<sup>12</sup> (Rawlings <i>et al.</i>, 2010).</li> <li>Assess fuel loads.</li> </ul>
		Offset Areas – Restoration of Existing Box-Gum Woodland (Condition State 1 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> <li>DECCW (2011) suggests fire frequency should be a minimum interval of 5 years and a maximum interval of 40 years. Rawlings <i>et al.</i>, (2010) recommends fire frequency in patches should be every 4 to 8 years.</li> <li>Spring or autumn burns depending on a range of factors (Gibson-Roy <i>et al.</i>, 2010; Rawlings <i>et al.</i>, 2010).</li> <li>Maintain fire breaks and access.</li> <li>Assess fuel loads.</li> </ul>
	7b. Controlled burns – too infrequent - may result in overexposure of soil, erosive processes and weed invasion, or too frequent - may result in loss of species diversity (Gibson-Roy <i>et al.</i> , 2010; DECCW, 2011)	Mine Rehabilitation – Establishment of Box-Gum Woodland on the post-mine landform	<ul style="list-style-type: none"> <li>No controlled burns whilst vegetation is establishing.</li> <li>Assess fuel loads.</li> </ul>
		Offset Areas – Re-establishment of Box-Gum Woodland from derived grasslands (Condition State 2 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> <li>No controlled burns whilst vegetation is establishing.</li> <li>Assess fuel loads.</li> </ul>
		Offset Areas – Restoration of Existing Box-Gum Woodland (Condition State 1 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> <li>DECCW (2011) suggests fire frequency should be a minimum interval of 5 years and a maximum interval of 40 years. Rawlings <i>et al.</i> (2010) recommends fire frequency in patches should be every 4 to 8 years.</li> <li>Assess fuel loads.</li> <li>Spring or autumn burns depending on a range of factors (Rawlings <i>et al.</i>, 2010).</li> <li>Controlled burns should be undertaken in a mosaic (i.e. retain some unburned areas (DECCW, 2011).</li> <li>Maintain fire breaks and access.</li> </ul>
8. Floristics	8a. Poor diversity in the seed mix or tube stock	Mine Rehabilitation – Establishment of Box-Gum Woodland on the post-mine landform	<ul style="list-style-type: none"> <li>Monitoring of plant growth and survival (Rawlings <i>et al.</i>, 2010).</li> <li>Strategic and long term seed collection, management and storage.</li> <li>Site preparation and depth of sowing seed.</li> <li>Supplementary planting or reseeding of absent species.</li> </ul>
		Offset Areas – Re-establishment of Box-Gum Woodland from derived grasslands (Condition State 2 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> <li>Favour natural regeneration over seeding or planting in the first instance followed by seeding or planting if required (McIntyre, 2002).</li> </ul>
	8b. Unsuitable species in the seed mix or tube stock	Mine Rehabilitation – Establishment of Box-Gum Woodland on the post-mine landform	<ul style="list-style-type: none"> <li>Preferential use of local endemic (adapted) species (Rawlings <i>et al.</i>, 2010), however use of a high quality seed source over a low quality more local seed source (Broadhurst <i>et al.</i>, 2008 in DECCW, 2011).</li> </ul>
		Offset Areas – Re-establishment of Box-Gum Woodland from derived grasslands (Condition State 2 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> <li>Favour natural regeneration over seeding or planting in the first instance followed by seeding or planting if required (McIntyre, 2002).</li> </ul>
	8c. Shortage of sufficient seed or tube stock	All areas	<ul style="list-style-type: none"> <li>Review commercial seed and tube stock availability.</li> </ul>
	8d. Poor understorey diversity	All areas	<ul style="list-style-type: none"> <li>Planting of trees and shrubs at appropriate densities (DECCW, 2011).</li> <li>Use local endemic (adapted) species (Eddy, 2002; Rawlings <i>et al.</i>, 2010).</li> <li>Restore linkages to existing woodland patches.</li> <li>Assess whether ecological thinning is necessary (Rawlings <i>et al.</i>, 2010).</li> <li>Consider causing disturbance (e.g. through fire or grazing) (Eddy, 2002).</li> <li>Include a wide diversity of species in the seed mix (Gibson-Roy <i>et al.</i>, 2010).</li> </ul>

<sup>11</sup> Not proposed.

<sup>12</sup> Grazing livestock were removed from the offset area in 2010.

**Table 5 (Continued)**  
**Factors Likely to Impede or Enhance the Re-establishment and Restoration of Box-Gum Woodland**

Broad Factor	Factors Likely to Impede	Relevant Objective	Factors Likely to Enhance
8. Floristics (Cont.)	8e. Over-collection of seed for revegetation purposes (Eddy, 2002; DECCW, 2011)	All areas	<ul style="list-style-type: none"> <li>Review commercial seed and tube stock availability.</li> <li>Preferential use of local endemic (adapted) species (Rawlings <i>et al.</i>, 2010), however use of a high quality seed source over a low quality more local seed source (Broadhurst <i>et al.</i>, 2008 in DECCW, 2011).</li> </ul>
	8f. Lack of pollinators	All areas	<ul style="list-style-type: none"> <li>Promotion of bees through provision of habitat (e.g. general revegetation and regeneration).</li> </ul>
9. Native plant growth	9a. Poor native plant growth	Mine Rehabilitation – Establishment of Box-Gum Woodland on the post-mine landform	<ul style="list-style-type: none"> <li>Site preparation and depth of sowing seed.</li> <li>Fencing of areas undergoing revegetation to exclude grazing animals<sup>13</sup> (e.g. livestock).</li> <li>Management of pressure from feral grazing animals and native grazing animals.</li> <li>Correct spacing for species when planting seedlings to avoid excessive shading (Rawlings <i>et al.</i>, 2010).</li> <li>Supplementary seeding or planting.</li> <li>Revegetation trials.</li> <li>Preferential use of local endemic (adapted) species (Rawlings <i>et al.</i>, 2010), however use of a high quality seed source over a low quality more local seed source (Broadhurst <i>et al.</i>, 2008 in DECCW, 2011).</li> <li>Selective use of specific fertilisers only.</li> </ul>
		Offset Areas – Re-establishment of Box-Gum Woodland from derived grasslands (Condition State 2 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> <li>Site preparation and depth of sowing seed.</li> <li>Fencing of areas undergoing revegetation to exclude grazing livestock.</li> <li>Management of pressure from feral grazing animals and native grazing animals.</li> <li>Correct spacing for species when planting seedlings to avoid excessive shading (Rawlings <i>et al.</i>, 2010).</li> <li>Supplementary seeding or planting.</li> <li>Preferential use of local endemic (adapted) species (Rawlings <i>et al.</i>, 2010), however use of a high quality seed source over a low quality more local seed source (Broadhurst <i>et al.</i>, 2008 in DECCW, 2011).</li> </ul>
	9b. Poor seed germination	All areas	<ul style="list-style-type: none"> <li>Supplementary seeding or planting.</li> <li>Preferential use of local endemic (adapted) species (Rawlings <i>et al.</i>, 2010), however use of a high quality seed source over a low quality more local seed source (Broadhurst <i>et al.</i>, 2008 in DECCW, 2011).</li> <li>Smoke water<sup>14</sup>.</li> <li>Seed scarification for acacia or heat treatment.</li> </ul>
	9c. Dense overstorey and midstorey revegetation (e.g. White Cypress Pine) – sometimes regeneration is too successful and trees may compete with each other for light, water and nutrients (Rawlings <i>et al.</i> , 2010; DECCW, 2011)	All areas	<ul style="list-style-type: none"> <li>Assess whether ecological thinning is necessary (Rawlings <i>et al.</i>, 2010).</li> <li>Thinning with fire or manually (Rawlings <i>et al.</i>, 2010).</li> </ul>
	9d. Dense grass cover	All areas	<ul style="list-style-type: none"> <li>Consider causing disturbance (e.g. through fire or grazing) (Rawlings <i>et al.</i>, 2010).</li> </ul>
	9e. Disease (e.g. <i>Phytophthora cinnamomi</i> ) (DECCW, 2011)	All areas	<ul style="list-style-type: none"> <li>Hygiene protocols to minimise the risk of plant diseases (Rawlings <i>et al.</i>, 2010).</li> </ul>
	9f. Fungi or pathogens – may cause germination failure (seeds) (Rawlings <i>et al.</i> , 2010).	All areas	<ul style="list-style-type: none"> <li>Preferential use of local endemic (adapted) species (Rawlings <i>et al.</i>, 2010), however use of a high quality seed source over a low quality more local seed source (Broadhurst <i>et al.</i>, 2008 in DECCW, 2011).</li> </ul>
10. Fauna habitat	10a. Lack of bush rocks (Michael <i>et al.</i> , 2011)	All areas	<ul style="list-style-type: none"> <li>Maximise salvage and reuse of bush rocks.</li> </ul>
	10b. Lack of fallen timber/hollow logs (DECCW, 2011)	All areas	<ul style="list-style-type: none"> <li>Maximise salvage and reuse of timber/hollow logs.</li> </ul>
	10c. Lack of structural diversity (including lack of tree hollows) (Manning <i>et al.</i> , 2011; Michael <i>et al.</i> , 2011; Freudenberger <i>et al.</i> , 2004)	All areas	<ul style="list-style-type: none"> <li>Planting of scattered low shrubs, mid-sized shrubs and tall trees (Freudenberger <i>et al.</i>, 2004).</li> <li>Maximise salvage and reuse of timber/hollow logs including placement of hollow limbs in some select trees without hollows.</li> <li>Increase woodland patch size within the offset area (Prober <i>et al.</i> 2002).</li> </ul>

<sup>13</sup> Native animals would not be excluded. Feral animals would be controlled via other methods.

<sup>14</sup> This method is not proposed to be undertaken due to the extensive areas required to be revegetated.

**Table 5 (Continued)**  
**Factors Likely to Impede or Enhance the Re-establishment and Restoration of Box-Gum Woodland**

Broad Factor	Factors Likely to Impede	Relevant Objective	Factors Likely to Enhance
11. Surrounding land uses	11a. Agriculture – pesticides and herbicides	Offset Areas	<ul style="list-style-type: none"> <li>Increase woodland patch size within the offset area (Rawlings <i>et al.</i>, 2010).</li> <li>Communication with surrounding land users (either NPWS or private).</li> </ul>
	11b. Agriculture – exotic species (including incursions of stock and feral animals)	Offset Areas	<ul style="list-style-type: none"> <li>Increase woodland patch size within the offset area (Rawlings <i>et al.</i>, 2010).</li> <li>Communication with surrounding land users (either NPWS or private).</li> <li>Fencing and signage.</li> <li>Co-ordinated management of exotic species with surrounding land users.</li> </ul>
	11c. Agriculture – increased runoff	Offset Areas	<ul style="list-style-type: none"> <li>Increase woodland patch size within the offset area (Rawlings <i>et al.</i>, 2010).</li> <li>Communication with surrounding land users (either NPWS or private).</li> </ul>
	11d. Agriculture – nutrient enrichment	Offset Areas	<ul style="list-style-type: none"> <li>Increase woodland patch size within the offset area (Rawlings <i>et al.</i>, 2010).</li> <li>Communication with surrounding land users (either NPWS or private).</li> </ul>
12. Weather	12a. Drought	Mine Rehabilitation – Establishment of Box-Gum Woodland on the post-mine landform	<ul style="list-style-type: none"> <li>Monitoring for signs of water stress (dieback).</li> <li>Irrigation.</li> <li>Mulch.</li> </ul>
		Offset Areas – Re-establishment of Box-Gum Woodland from derived grasslands (Condition State 2 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> <li>Monitoring for signs of water stress (dieback).</li> <li>Limit grazing during drought periods (DECCW, 2011).</li> <li>Management of pressure from feral grazing animals and native grazing animals.</li> <li>Irrigation<sup>15</sup>.</li> <li>Mulch<sup>16</sup>.</li> </ul>
	12b. Flood/major rainfall	All areas	Refer to 1d. Erosion and sedimentation.
	12c. Wind	All areas	<ul style="list-style-type: none"> <li>Only use healthy seedlings (Rawlings <i>et al.</i>, 2010).</li> <li>Use of tree guards to protect young seedlings (Rawlings <i>et al.</i>, 2010).</li> </ul>
	12d. Climate change (DECCW, 2011)	All areas	<ul style="list-style-type: none"> <li>Restoration of Box-Gum Woodland (DECCW, 2011).</li> <li>Use of genetically diverse collections of seed sourced from large and health populations.</li> <li>Increase woodland patch size within the offset area (to provide links for movement of plant propagules and fauna).</li> <li>Provide increased connectivity through revegetation of derived grassland.</li> </ul>
	13. Management	13a. Unclear objectives	All areas
13b. Lack of maintenance		All areas	<ul style="list-style-type: none"> <li>Adaptive management (Rawlings <i>et al.</i>, 2010; Tongway and Ludwig, 2011).</li> </ul>
13c. Poor monitoring design (measurement of success)		All areas	<ul style="list-style-type: none"> <li>Monitor to determine effectiveness (Eddy, 2002; DECCW, 2011).</li> <li>Monitoring closely linked to objectives.</li> <li>Use of photo-points to monitor changes over time (Eddy, 2002).</li> </ul>
13d. Unqualified personnel		All areas	<ul style="list-style-type: none"> <li>Engage suitability qualified personnel.</li> </ul>

Note: The highlighted rows relate only to the Rehabilitation Strategy.

Source: Whitehaven (2014).

<sup>15</sup> This method is not proposed to be undertaken due to the extensive areas required to be revegetated.

<sup>16</sup> This method is not proposed to be undertaken due to the extensive areas required to be revegetated.

## **4 CONCLUSION**

This report documents factors likely to enhance or impede the effective long-term provision of suitable habitat for threatened species through the effective restoration of degraded habitats in offset areas or re-establishment of viable habitat on disturbed areas (both offset areas and the mine site).

A variety of different factors relevant to the provision of suitable habitat for the suite of threatened species have been identified. However of these, the following two appear to be the most important – provision of habitat resources for each species across the restored and rehabilitated landscape and managing threatening processes. The actual return of such threatened species to these future landscapes will also depend on source populations being available away from the restored remediated landscapes and the availability of potential movement pathways for such species between potential source populations and the restored and rehabilitated landscapes.

A separate Implementation Plan has been developed to maximise the prospects for provision of viable areas of suitable habitat for threatened species on the offset areas and the mine site.

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