

APPENDIX A

TARRAWONGA COAL MINE WHITE-BOX YELLOW-BOX BLAKELY'S RED GUM
WOODLAND ENDANGERED ECOLOGICAL COMMUNITY
INVESTIGATION REPORT

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WHITE-BOX YELLOW-BOX BLAKELY'S RED-GUM WOODLAND ENDANGERED
ECOLOGICAL COMMUNITY
INVESTIGATION REPORT



PREPARED BY
WHITEHAVEN COAL LIMITED

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EXECUTIVE SUMMARY

Tarrawonga Coal Pty Ltd (TCPL) owns the Tarrawonga Coal Mine (TCM) which is 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:

1. a Rehabilitation Strategy on the post-mine landforms that will focus on using species characteristic of the White Box – Yellow Box – Blakely's Red Gum Grassy Woodland, an endangered ecological community in NSW (herein referred to as the Box-Gum Woodland EEC); and
2. a Biodiversity Offset Strategy in the surrounding region that aims to enhance and restore Box-Gum Woodland EEC (woodland form) on disturbed (former agricultural) land with derived native grassland (which currently meets the criteria for the Box-Gum Woodland EEC [derived grassland form]).

It is recognised that aiming to re-establish or restore Box-Gum Woodland is likely to be difficult, particularly on post-mine landforms. However, the prospects for achieving a community that has characteristics of the Box-Gum Woodland EEC would be improved by understanding factors likely to enhance or impede restoration of the Box-Gum Woodland.

An investigation of factors likely to enhance or impede the effective restoration or re-establishment of the Box-Gum Woodland EEC was undertaken in 2014 by Whitehaven Coal Limited (a joint venture partner of TCPL). This report documents the outcomes of that investigation to satisfy Condition 43(b) and (c) of the TCM NSW Project Approval (PA 11_0047).

The investigation involved:

- consideration of the Box-Gum Woodland EEC listing advice/final determinations;
- consideration of relevant Box-Gum Woodland EEC management guidelines;
- consideration of relevant Box-Gum Woodland EEC 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.

Following this investigation, a separate Implementation Plan has been developed to maximise the prospects for rehabilitation and regeneration of the Box-Gum Woodland EEC 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 (70 percent [%] interest) and Boggabri Coal Pty Limited (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:

1. a Rehabilitation Strategy on the post-mine landforms that will focus on using species characteristic of the White Box – Yellow Box – Blakely's Red Gum Grassy Woodland, an endangered ecological community in NSW (herein referred to as the Box-Gum Woodland EEC); and
2. a Biodiversity Offset Strategy in the surrounding region that aims to enhance and restore Box-Gum Woodland EEC (woodland form) on disturbed (former agricultural) land with derived native grassland (which currently meets the criteria for the Box-Gum Woodland EEC [derived grassland form]).

Rehabilitation Strategy

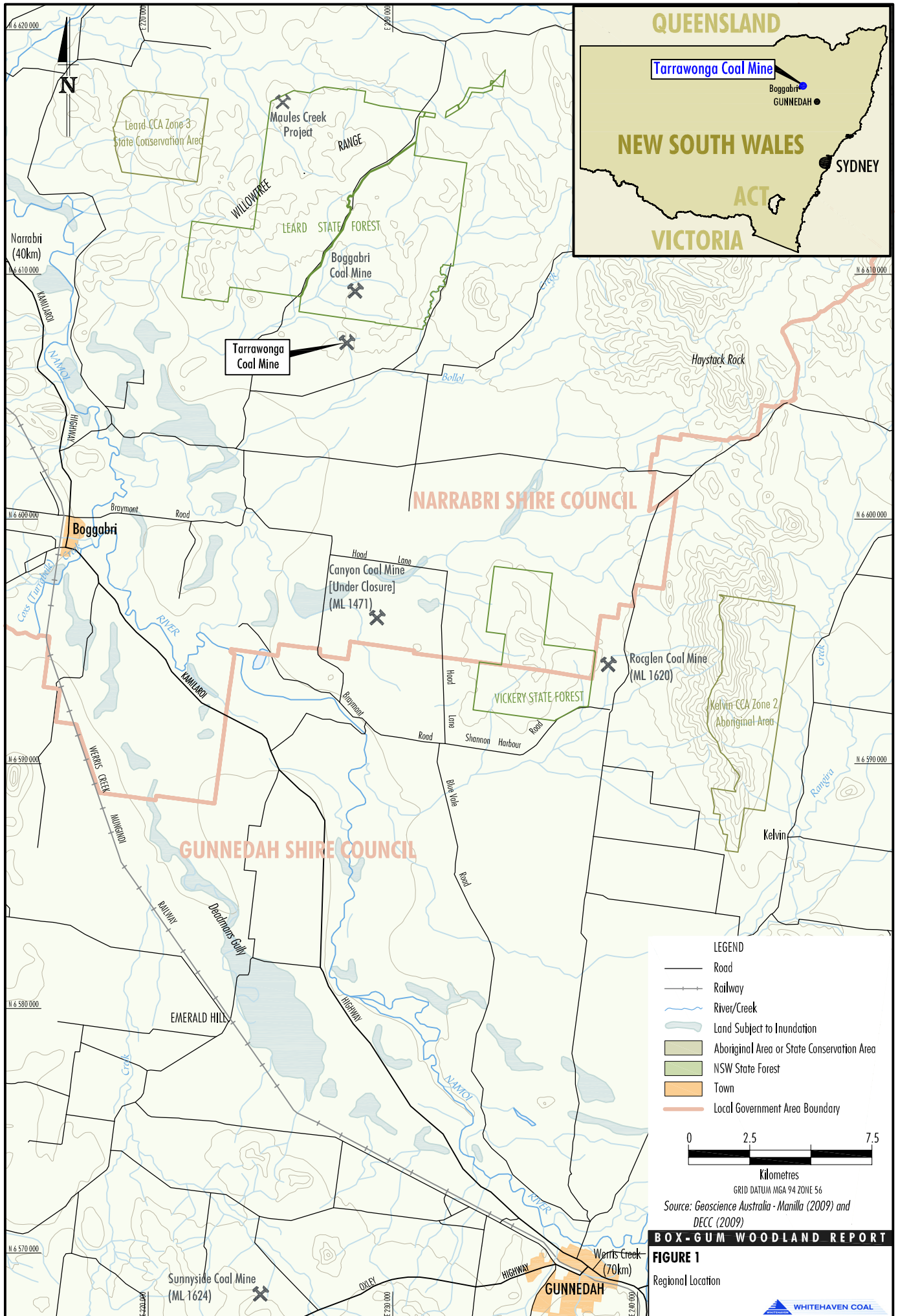
Condition 40 of TCM Project Approval (PA 11_0047) requires 752 hectares (ha) of vegetation to be re-established on the post-mine landforms. An objective is to revegetate the post-mine landforms with a mixture of native woodland and forest (approximately 752 ha). The focus is on using species characteristic of Box-Gum Woodland EEC.

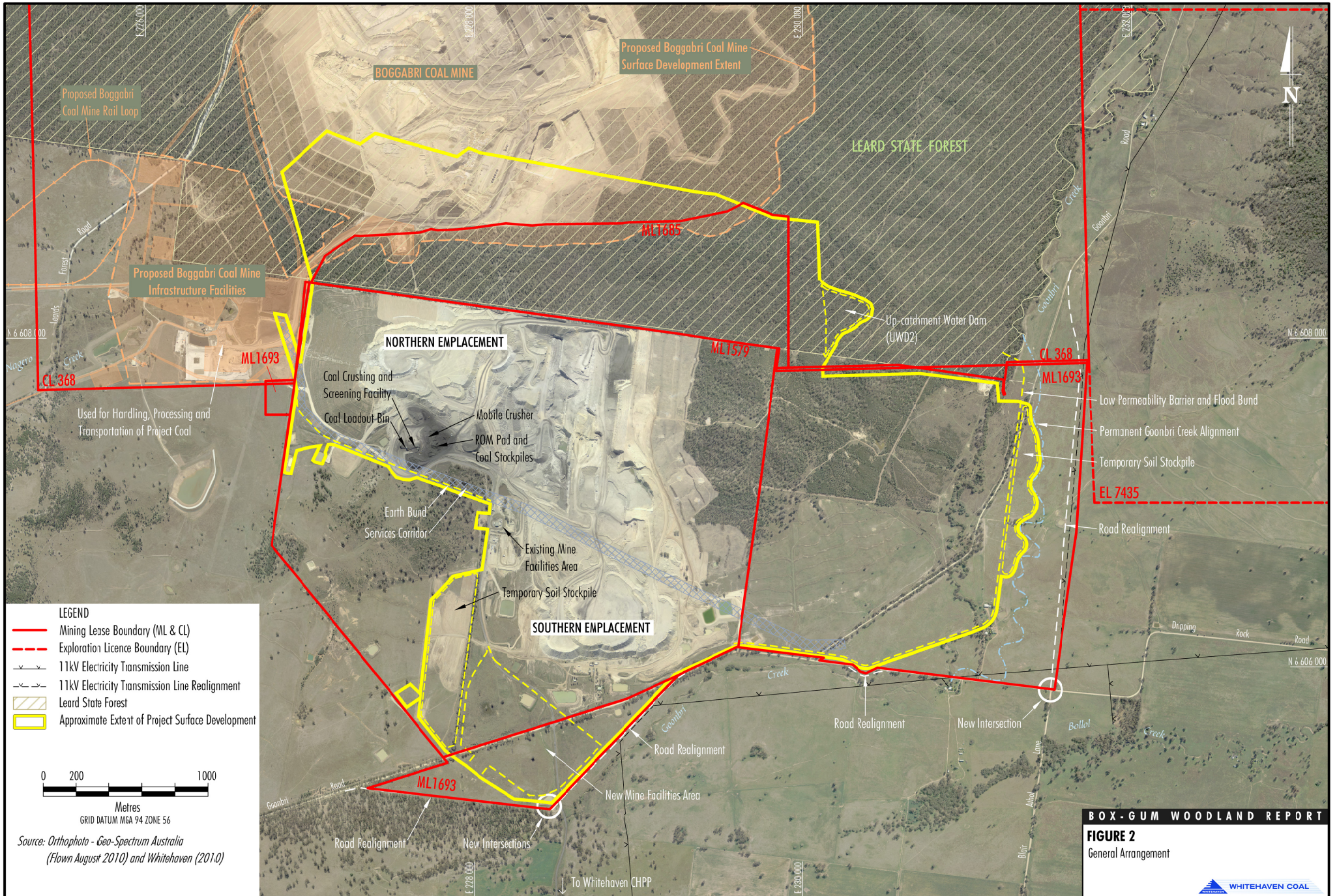
Biodiversity Offset Strategy

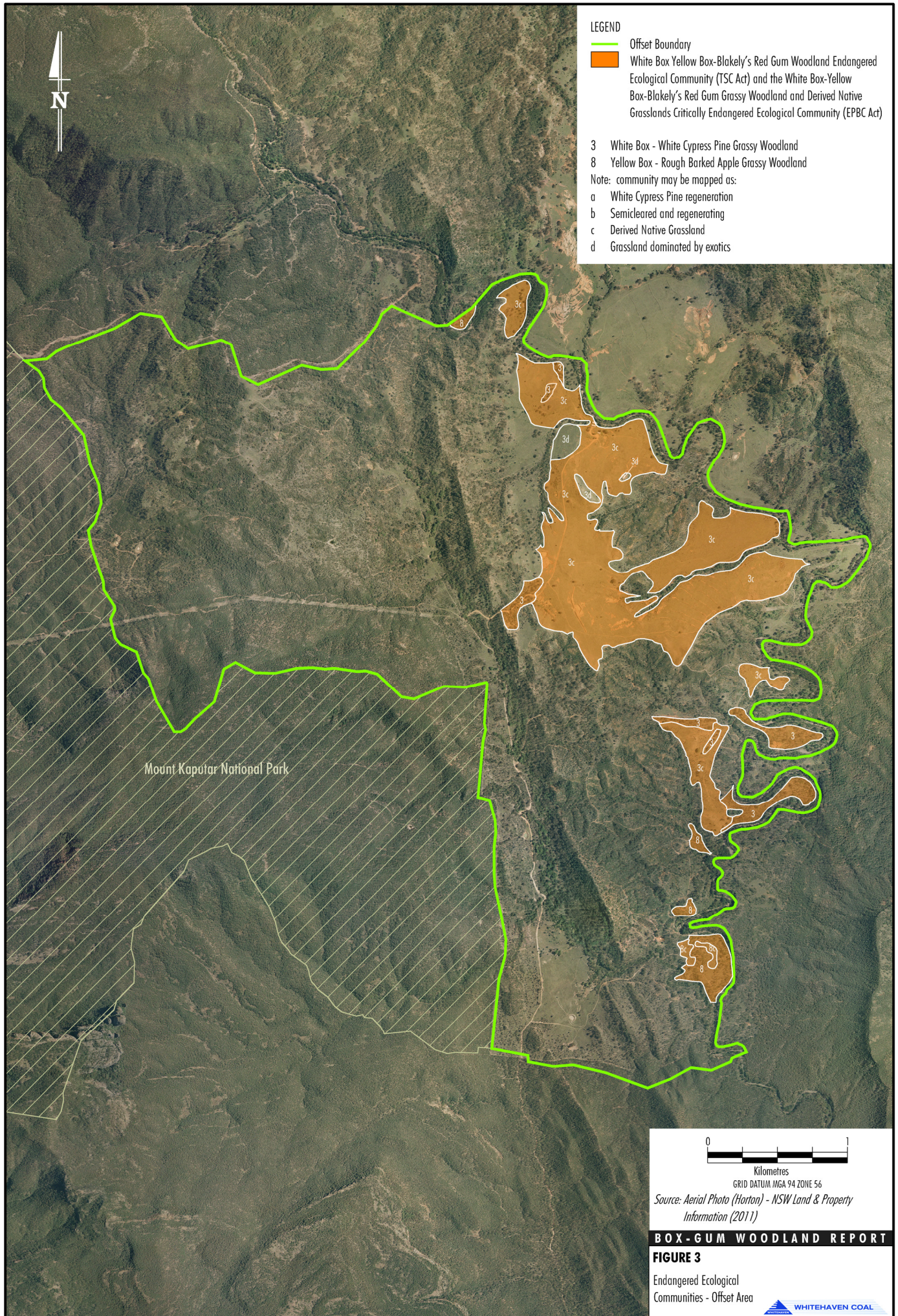
The biodiversity offset areas under Condition 40 of TCM Project Approval (PA 11_0047) are required to cover a minimum of 1,660 ha of land (Figure 3). The Box-Gum Woodland EEC is present in the offset areas in woodland form (approximately 37 ha) and derived grassland form (approximately 195 ha) (Figure 3). The Biodiversity Offset Strategy aims to re-establish Box-Gum Woodland in these two landscapes:

1. through enhancement of existing woodland remnants of the Box-Gum Woodland in varying conditions; and
2. in cleared (mostly grazing) land with predominantly native grassland groundcover (derived grasslands).

It is recognised that aiming to re-establish or restore Box-Gum Woodland is likely to be difficult. However, the prospects for achieving a community that has characteristics of the Box-Gum Woodland EEC would be improved by understanding factors likely to enhance or impede restoration of the Box-Gum Woodland.







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).

Box-Gum Woodland Investigation

Condition 43 of TCM Project Approval (PA 11_0047) requires:

1. an investigation of factors likely to enhance or impede the effective long term restoration of degraded remnants of the Box-Gum Woodland EEC in offset areas or regeneration of this EEC on disturbed areas (i.e. an Investigation Report – this document);
2. an implementation plan to maximise the prospects for rehabilitation and regeneration of the Box-Gum Woodland EEC (i.e. an Implementation Plan); and
3. revision of the Biodiversity Management Plan (BMP).

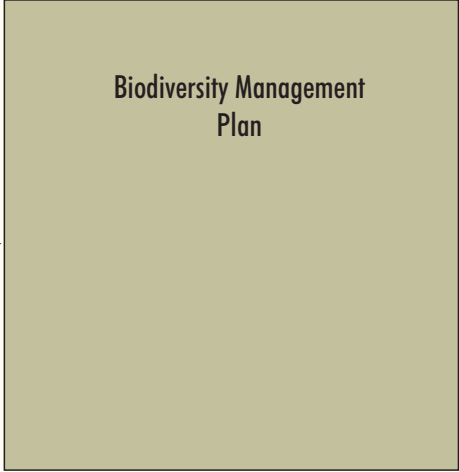
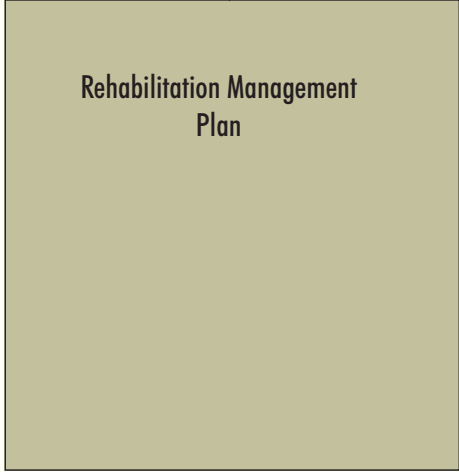
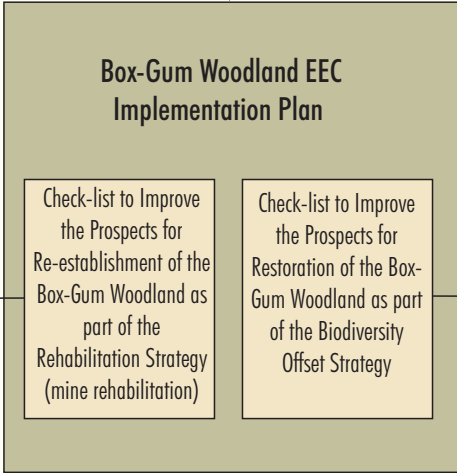
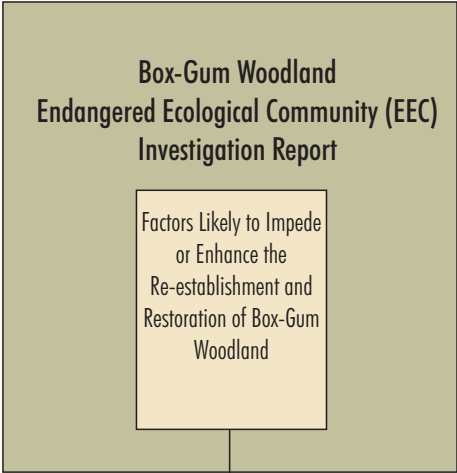
Figure 4 contains a flow diagram that shows how the Investigation Report, Implementation Plan and the BMP (and TCM Rehabilitation Management Plan [RMP]) relate.

This document (the Investigation Report) identifies factors likely to enhance or impede the effective long term restoration of degraded remnants of the Box-Gum Woodland EEC in offset areas or regeneration of this EEC on disturbed areas. The factors identified in this report will be considered in the Implementation Plan to maximise the prospects for rehabilitation and regeneration of the Box-Gum Woodland EEC. The outcomes of the Implementation Plan are '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.

1.2 OBJECTIVES

The purpose of this report is to satisfy Condition 43(b) and (c) of TCM Project Approval (PA 11_0047) (Table 1) by documenting the investigation of factors likely to enhance or impede the:

- effective restoration of degraded remnants of Box-Gum Woodland EEC in offset areas; or
- re-establishment of Box-Gum Woodland EEC on disturbed areas (both offset areas and the site).



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

FIGURE 4
Box-Gum Woodland EEC Investigation and
Implementation Plan

Table 1
Condition 43 of Project Approval (PA 11_0047)

Condition
<p>43. For the White Box – Yellow Box – Blakely's Red Gum Grassy Woodland Endangered Ecological Community the Proponent shall:</p> <p>(a) ensure that the Biodiversity Offset Strategy and site Rehabilitation Strategy is focused on protection rehabilitation, re-establishment and long-term maintenance of viable stands of this community;</p> <p>(b) investigate in consultation with OEH and the Namoi CMA, all factors likely to enhance or impede the effective long term restoration of degraded remnants of this EEC in offset areas or regeneration of this EEC on disturbed areas (both offset areas and the site);</p> <p>(c) within 24 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 maximise the prospects for rehabilitation and regeneration of this EEC on the offset areas and the site, for approval by the Director-General; and</p> <p>(d) incorporate the approved implementation plan into the revised Biodiversity Management Plan, required under Condition 43.</p>

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 43 (a) of TCM Project Approval (PA 11_0047) (Table 1):

- Office of Environment and Heritage (OEH); and
- 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 the 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 Box-Gum Woodland EEC listing advice/final determinations (OEH, 2014; Department of the Environment, 2014);
- consideration of relevant Box-Gum Woodland EEC management guidelines (Rawlings *et al.*, 2010);
- consideration of relevant Box-Gum Woodland EEC recovery plans (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

The results of the investigation are provided in Table 2.

Table 2
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"> Avoidance of soils with high or low pH, high salinity, low fertility or sodic soils. Rehabilitation trials focused on soil substrate. Nutrient management options: <ul style="list-style-type: none"> Amelioration of soils with agricultural gypsum, compost (i.e. mulch saved during clearing activities) or fertilisers depending on the nutrient deficiency. 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). Use of Biochar to increase soil carbon¹.
		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"> Limited and selective use of specific fertilisers to facilitate growth of tube stock (Eddy, 2002). Placement of woody debris to increase carbon and moisture levels (Goldin and Brookhouse, 2014).
	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"> Avoidance of soils with high or low pH, high salinity, low fertility or sodic soils. Application of minimum topsoil and subsoil depths (Condition 25[c] of the Approval Decision EPBC 2011/5923). Soil surveys and inventories prior to soil stripping (Condition 25[c] of the Approval Decision EPBC 2011/5923). Soil handling processes for removal, storage and re-layering of topsoil and subsoil (Condition 25[d] of the Approval Decision EPBC 2011/5923). Annual soil balances to manage soil handling. Rehabilitation trials focused on soil substrate.
		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"> No application of fertilizers on soils with elevated concentrations of the same nutrients (Rawlings <i>et al.</i>, 2010). Nutrient management options to lower soil nitrogen and phosphorus levels: <ul style="list-style-type: none"> Crash grazing periodically to remove nutrients locked in weeds (Rawlings <i>et al.</i>, 2010)². Restriction of livestock access to limit further nutrient enrichment³ (Rawlings <i>et al.</i>, 2010). Hay cutting (Rawlings <i>et al.</i>, 2010)⁴. Controlled burns (Rawlings <i>et al.</i>, 2010). Carbohydrate addition (Rawlings <i>et al.</i>, 2010)⁵. Topsoil removal (scalping) (cleared land only) (Gibson-Roy <i>et al.</i>, 2010; Rawlings <i>et al.</i>, 2010)⁶. No kill and pasture cropping (Rawlings <i>et al.</i>, 2010)⁷.
	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"> Selective identification and placement (burial) of potentially acid forming interburden materials (Condition 39[c] Schedule 3 of Project Approval 11_0047). Application of minimum topsoil and subsoil depths (Condition 25[c] of the Approval Decision EPBC 2011/5923).
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"> Establishing vegetation cover as soon as practicable following disturbance. Application of a temporary sterile cover crop, or native grass covercrop established from native hays. Adjust seed and planting densities to maximise ground cover. Treatment of dispersive soils and spoils. Design of the batter slopes to be stable. Use of structural erosion controls (e.g. channel banks, slope drains and energy dissipaters). Exclusion of livestock (Rawlings <i>et al.</i>, 2010). Use of benign (hard rock) mulch to stabilise batter surfaces. Ecological function analysis to identify constraints and requirements for specific management measures (Tongway and Ludwig, 2011). 	

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

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

³ Grazing livestock were removed from the offset area in 2010.

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

⁵ 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.

⁶ 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.

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

Table 2 (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"> Targeting revegetation along drainage lines. Remediation of scalded areas. Restriction of livestock access⁸ (particularly along drainage lines) (Rawlings <i>et al.</i>, 2010). Installation of new infrastructure in stable locations (e.g. access roads) (Mclvor, 2002). Maximised re-use of existing infrastructure (e.g. access roads) instead of creating new infrastructure. Ecological function analysis to identify constraints and requirements for specific management measures (Tongway and Ludwig, 2011). 	
		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"> Restriction of vehicle access to avoid compacting soil (Eddy, 2002; DSE, 2005). Pre-planting site preparation (e.g. ripping) (Rawlings <i>et al.</i>, 2010). Exclusion of livestock (Rawlings <i>et al.</i>, 2010). Mulching (Rawlings <i>et al.</i>, 2010). Use of spiked rollers/air jetting to aerate soils to depth of 30 cm.
		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"> Restriction of vehicle access to avoid compacting soil (Eddy, 2002; DSE, 2005). Restriction of livestock access⁹ (Rawlings <i>et al.</i>, 2010).
		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"> Avoidance of revegetation techniques that involve high level of physical disturbance (i.e. cultivation, ripping and excavation) (Eddy, 2002; DECCW, 2011). Restriction of vehicle access to avoid unnecessary ground disturbance (DSE, 2005; Eddy, 2002). Fencing and signage.
		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"> Management of topsoil seed resource. Soil seed bank germination testing (rehabilitation trials). Supplementary seeding/tube stock planting (Gibson-Roy <i>et al.</i>, 2010).
		Offset Areas		
	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"> Application of minimum topsoil and subsoil depths (Condition 25[c] of the Approval Decision EPBC 2011/5923). Soil surveys and inventories prior to soil stripping (Condition 25[c] of the Approval Decision EPBC 2011/5923). Soil handling processes for removal, storage and re-layering of topsoil and subsoil (Condition 25[d] of the Approval Decision EPBC 2011/5923). Annual soil balances to manage soil handling.
	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"> Amelioration of soils with compost/woody debris. Selective placement of soils. Addition of woody debris (Harmon <i>et al.</i>, 1986; Debeljak, 2006; Manning <i>et al.</i>, 2013, Goldin and Brookhouse, 2014).
	1k. Instability of the final landform	Mine Rehabilitation – Establishment of Box-Gum Woodland on the post-mine landform		<ul style="list-style-type: none"> Design of the batter slopes to be stable. Selective placement of soils. Use of benign (hard rock) mulch to stabilise batter surfaces.
	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"> Design of the batter slopes to be stable. Amelioration of soils with compost.
1m. Lack of soil mycorrhizae	Mine Rehabilitation - Establishment of Box-Gum Woodland on the post-mine landform	<ul style="list-style-type: none"> Application of minimum topsoil and subsoil depths. Soil surveys and inventories prior to soil stripping (Condition 25[c] of the Approval Decision EPBC 2011/5923). Soil handling processes for removal, storage and re-layering of topsoil and subsoil (Condition 25[d] of the Approval Decision EPBC 2011/5923). Use of rhizobial bacteria inoculants for acacia (CSIRO, 2005). 		

⁸ Grazing livestock were removed from the offset area in 2010.

⁹ Grazing livestock were removed from the offset area in 2010.

Table 2 (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
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"> Restriction on clearing.
		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"> Restriction on clearing. Restriction on fire wood collection.
		Offset Areas – Restoration of Existing Box-Gum Woodland (Condition State 1 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> Use of low disturbance methods for site preparation in derived grasslands and existing Box-Gum Woodland.
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"> Fencing of areas undergoing revegetation to exclude grazing livestock and prevent grazing of seedlings (Eddy, 2002). Maintenance of fencing used to exclude livestock.
		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"> Weed control (Condition 25[a] of the Approval Decision EPBC 2011/5923). Establishing vegetation cover as soon as practicable following disturbance (Condition 25[b] of the Approval Decision EPBC 2011/5923). Application of a temporary sterile cover crop, or native grass covercrop established from native hays. Minimal unnecessary ground disturbance that may create opportunities for weeds (Rawlings <i>et al.</i>, 2010; DECCW, 2011). Nutrient management (e.g. exclusion of grazing livestock which add nutrients) (Prober <i>et al.</i>, 2002; Rawlings <i>et al.</i>, 2010). General weed hygiene (e.g. avoiding driving through weed infestations) (DECCW, 2011). Correct spacing for species when planting seedlings to avoid excessive shading (Rawlings <i>et al.</i>, 2010). Provisions to identify new invasive plant species (e.g. weed monitoring). Weed management options: <ul style="list-style-type: none"> Physical Removal (e.g. removing weeds by felling or pulling) (Gibson-Roy <i>et al.</i>, 2010; Rawlings <i>et al.</i>, 2010). 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). Sowing of Kangaroo Grass to outcompete annual grass weeds (Prober <i>et al.</i>, 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"> Minimal unnecessary ground disturbance that may create opportunities for weeds (Eddy, 2002; DSE, 2005; Rawlings <i>et al.</i>, 2010). Light grazing in autumn and/or winter to reduce vigour of annual grass weeds¹⁰ (Rawlings <i>et al.</i>, 2010).
		Offset Areas – Restoration of Existing Box-Gum Woodland (Condition State 1 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> Minimal unnecessary ground disturbance that may create opportunities for weeds (Eddy, 2002; DSE, 2005; Rawlings <i>et al.</i>, 2010).
5. Herbicide	5a. Excessive herbicides – may have a negative effects on native species (Eddy, 2002)	All areas	<ul style="list-style-type: none"> 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).
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"> Monitoring and control feral pigs and goats (Eddy, 2002; Rawlings <i>et al.</i>, 2010). Use of tree guards to protect young seedlings from browsing or grazing (Rawlings <i>et al.</i>, 2010).
	6b. Rabbits and hares (Eddy, 2002; DSE, 2005; DECCW, 2011)	All areas	<ul style="list-style-type: none"> Monitoring and control of rabbits and hares (Eddy, 2002; DSE, 2005; Rawlings <i>et al.</i>, 2010).
	6c. Grazing native fauna species (e.g. kangaroos) (DECCW, 2011)	All areas	<ul style="list-style-type: none"> Use of tree guards to protect young seedlings from browsing or grazing (Rawlings <i>et al.</i>, 2010). Fencing farm dams.
	6d. Feral foxes (Eddy, 2002; DECCW, 2011)	All areas	<ul style="list-style-type: none"> Monitoring and control of feral foxes (Eddy, 2002; Rawlings <i>et al.</i>, 2010).
	6e. Honeybees (DECCW, 2011)	All areas	<ul style="list-style-type: none"> Management of honeybees¹¹.
	6f. Deer (DECCW, 2011)	All areas	<ul style="list-style-type: none"> Management of Deer.
	6g. Feral Cat (Eddy, 2002; DECCW, 2011)	All areas	<ul style="list-style-type: none"> Management of the Feral Cat.
	6h. Other Invasive Fauna	All areas	<ul style="list-style-type: none"> Provisions to identify new invasive fauna species (e.g. fauna monitoring).

¹⁰ Grazing livestock were removed from the offset area in 2010.

¹¹ Not proposed.

Table 2 (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
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"> No controlled burns whilst vegetation is establishing. Maintain fire breaks and access. Assess fuel loads.
		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"> No controlled burns whilst vegetation is establishing. Controlled grazing to reduce biomass¹² (Rawlings <i>et al.</i>, 2010). Assess fuel loads.
		Offset Areas – Restoration of Existing Box-Gum Woodland (Condition State 1 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> 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. Spring or autumn burns depending on a range of factors (Gibson-Roy <i>et al.</i>, 2010; Rawlings <i>et al.</i>, 2010). Maintain fire breaks and access. Assess fuel loads.
	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"> No controlled burns whilst vegetation is establishing. Assess fuel loads.
		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"> No controlled burns whilst vegetation is establishing. Assess fuel loads.
		Offset Areas – Restoration of Existing Box-Gum Woodland (Condition State 1 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> 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. Assess fuel loads. Spring or autumn burns depending on a range of factors (Rawlings <i>et al.</i>, 2010). Controlled burns should be undertaken in a mosaic (i.e. retain some unburned areas (DECCW, 2011). Maintain fire breaks and access.
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"> Monitoring of plant growth and survival (Rawlings <i>et al.</i>, 2010). Strategic and long term seed collection, management and storage. Site preparation and depth of sowing seed. Supplementary planting or reseeded of absent species.
		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"> Favour natural regeneration over seeding or planting in the first instance followed by seeding or planting if required (McIntyre, 2002).
	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"> 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).
		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"> Favour natural regeneration over seeding or planting in the first instance followed by seeding or planting if required (McIntyre, 2002).
	8c. Shortage of sufficient seed or tube stock	All areas	<ul style="list-style-type: none"> Review commercial seed and tube stock availability.
	8d. Poor understorey diversity	All areas	<ul style="list-style-type: none"> Planting of trees and shrubs at appropriate densities (DECCW, 2011). Use local endemic (adapted) species (Eddy, 2002; Rawlings <i>et al.</i>, 2010). Restore linkages to existing woodland patches. Assess whether ecological thinning is necessary (Rawlings <i>et al.</i>, 2010). Consider causing disturbance (e.g. through fire or grazing) (Eddy, 2002). Include a wide diversity of species in the seed mix (Gibson-Roy <i>et al.</i>, 2010).
	8e. Over-collection of seed for revegetation purposes (Eddy, 2002; DECCW, 2011)	All areas	<ul style="list-style-type: none"> Review commercial seed and tube stock availability. 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).
	8f. Lack of pollinators	All areas	<ul style="list-style-type: none"> Promotion of bees through provision of habitat (e.g. general revegetation and regeneration).

¹² Grazing livestock were removed from the offset area in 2010.

Table 2 (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
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"> Site preparation and depth of sowing seed. Fencing of areas undergoing revegetation to exclude grazing animals (e.g. livestock)¹³. Management of pressure from feral grazing animals and native grazing animals. Correct spacing for species when planting seedlings to avoid excessive shading (Rawlings <i>et al.</i>, 2010). Supplementary seeding or planting. Revegetation trials. 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). Selective use of specific fertilisers only.
		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"> Site preparation and depth of sowing seed. Fencing of areas undergoing revegetation to exclude grazing livestock. Management of pressure from feral grazing animals and native grazing animals. Correct spacing for species when planting seedlings to avoid excessive shading (Rawlings <i>et al.</i>, 2010). Supplementary seeding or planting. 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).
	9b. Poor seed germination	All areas	<ul style="list-style-type: none"> Supplementary seeding or planting. 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). Smoke water¹⁴. Seed scarification for acacia or heat treatment.
	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"> Assess whether ecological thinning is necessary (Rawlings <i>et al.</i>, 2010). Thinning with fire or manually (Rawlings <i>et al.</i>, 2010).
	9d. Dense grass cover	All areas	<ul style="list-style-type: none"> Consider causing disturbance (e.g. through fire or grazing) (Rawlings <i>et al.</i>, 2010).
	9e. Disease (e.g. <i>Phytophthora cinnamomi</i>) (DECCW, 2011)	All areas	<ul style="list-style-type: none"> Hygiene protocols to minimise the risk of plant diseases (Rawlings <i>et al.</i>, 2010).
	9f. Fungi or pathogens – may cause germination failure (seeds) (Rawlings <i>et al.</i> , 2010).	All areas	<ul style="list-style-type: none"> 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).
10. Fauna habitat	10a. Lack of bush rocks (Michael <i>et al.</i> , 2011)	All areas	<ul style="list-style-type: none"> Maximise salvage and reuse of bush rocks.
	10b. Lack of fallen timber/hollow logs (DECCW, 2011)	All areas	<ul style="list-style-type: none"> Maximise salvage and reuse of timber/hollow logs.
	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"> Planting of scattered low shrubs, mid-sized shrubs and tall trees (Freudenberger <i>et al.</i>, 2004). Maximise salvage and reuse of timber/hollow logs and placement of hollow limbs in select trees without hollows. Increase woodland patch size within the offset area (Prober <i>et al.</i> 2002).
11. Surrounding land uses	11a. Agriculture – pesticides and herbicides	Offset Areas	<ul style="list-style-type: none"> Increase woodland patch size within the offset area (Rawlings <i>et al.</i>, 2010). Communication with surrounding land users (either NPWS or private).
	11b. Agriculture – exotic species (including incursions of stock and feral animals)	Offset Areas	<ul style="list-style-type: none"> Increase woodland patch size within the offset area (Rawlings <i>et al.</i>, 2010). Communication with surrounding land users (either NPWS or private). Fencing and signage. Co-ordinated management of exotic species with surrounding land users.

¹³ Native animals would not be excluded. Feral animals would be controlled via other methods.

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

Table 2 (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 (Cont.)	11c. Agriculture – increased runoff	Offset Areas	<ul style="list-style-type: none"> Increase woodland patch size within the offset area (Rawlings <i>et al.</i>, 2010). Communication with surrounding land users (either NPWS or private).
	11d. Agriculture – nutrient enrichment	Offset Areas	<ul style="list-style-type: none"> Increase woodland patch size within the offset area (Rawlings <i>et al.</i>, 2010). Communication with surrounding land users (either NPWS or private).
12. Weather	12a. Drought	Mine Rehabilitation – Establishment of Box-Gum Woodland on the post-mine landform	<ul style="list-style-type: none"> Monitoring for signs of water stress (dieback). Irrigation. Mulch.
		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"> Monitoring for signs of water stress (dieback). Limit livestock grazing during drought periods¹⁵ (DECCW, 2011). Management of pressure from feral grazing animals and native grazing animals. Irrigation¹⁶. Mulch¹⁷.
	12b. Flood/major rainfall	All areas	Refer to 1d. Erosion and sedimentation.
	12c. Wind	All areas	<ul style="list-style-type: none"> Only use healthy seedlings (Rawlings <i>et al.</i>, 2010). Use of tree guards to protect young seedlings (Rawlings <i>et al.</i>, 2010).
	12d. Climate change (DECCW, 2011)	All areas	<ul style="list-style-type: none"> Restoration of Box-Gum Woodland (DECCW, 2011). Use of genetically diverse collections of seed sourced from large and health populations. Increase woodland patch size within the offset area (to provide links for movement of plant propagules and fauna). Provide increased connectivity through revegetation of derived grassland.
13. Management	13a. Unclear objectives	All areas	<ul style="list-style-type: none"> Define objectives (Eddy, 2002; Rawlings <i>et al.</i>, 2010). Management for patchiness (diversity) (Rawlings <i>et al.</i>, 2010).
	13b. Lack of maintenance	All areas	<ul style="list-style-type: none"> Adaptive management (Rawlings <i>et al.</i>, 2010; Tongway and Ludwig, 2011).
	13c. Poor monitoring design (measurement of success)	All areas	<ul style="list-style-type: none"> Monitor to determine effectiveness (Eddy, 2002; DECCW, 2011). Monitoring closely linked to objectives. Use of photo-points to monitor changes over time (Eddy, 2002).
	13d. Unqualified personnel	All areas	<ul style="list-style-type: none"> Engage suitability qualified personnel.

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

Source: Whitehaven (2014).

¹⁵ Native animals would not be limited during drought periods. General feral animal control measures would continue.

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

¹⁷ 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 restoration of degraded remnants of Box-Gum Woodland EEC in offset areas or re-establishment of the Box-Gum Woodland EEC on disturbed areas (both offset areas and the mine site). A separate implementation plan has been developed to maximise the prospects for rehabilitation and regeneration of the Box-Gum Woodland EEC on the offset areas and the mine site.

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