

MAULES CREEK MINE
WHITE-BOX YELLOW-BOX BLAKELY'S RED-GUM WOODLAND ENDANGERED
ECOLOGICAL COMMUNITY
IMPLEMENTATION PLAN



PREPARED BY
WHITEHAVEN COAL LIMITED

JANUARY 2015
Project No. WHC-21
Document No. 00646565.docx

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
EXECUTIVE SUMMARY	ES-1
1 INTRODUCTION	1
1.1 BACKGROUND	1
1.2 OBJECTIVES	8
1.3 CONSULTATION	8
2 METHODS	9
3 PROPOSED ACTIONS RELATING TO FACTORS LIKELY TO IMPEDE AND ENHANCE	9
4 IMPLEMENTATION PLAN	22
5 CONCLUSION	29
6 REFERENCES	30

LIST OF TABLES

Table 1	Condition 48 of Project Approval (PA 10_0138)
Table 2	Proposed Actions Relating to Factors Likely to Impede and Enhance the Re-establishment and Restoration of Box-Gum Woodland
Table 3	Implementation Plan for Re-establishing Box-Gum Woodland in the Mine Rehabilitation Phase
Table 4	Implementation Plan for the Box-Gum Woodland in the Offset Areas

LIST OF FIGURES

Figure 1	Project Location
Figure 2	Project Layout
Figure 3	Biodiversity Offset Strategy
Figure 4	Verified Box-Gum Woodland CEEC – Overview Map
Figure 5	Box-Gum Woodland EEC Investigation and Implementation Plan

LIST OF APPENDICES

Appendix A	Maules Creek Mine White-Box Yellow-Box Blakely's Red Gum Woodland Endangered Ecological Community Investigation Report
Appendix B	Box-Gum Woodland State and Transition Model

EXECUTIVE SUMMARY

Maules Creek Coal Pty Ltd (MCC) owns the Maules Creek Coal Mine (MCCM) located approximately 40 kilometres south-east of Narrabri, New South Wales (NSW). The MCCM commenced construction in December 2013 under State (NSW) and Commonwealth Project approvals. As part of the NSW Project approval for the MCCM, MCC will implement:

1. a Rehabilitation Strategy on the post-mine landforms that aims to re-establish 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 restore or re-establish Box-Gum Woodland EEC on disturbed (former agricultural) land.

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.

In 2014, Whitehaven Coal Limited (Whitehaven) (a joint venture partner of MCC) undertook an investigation of factors likely to enhance or impede the effective restoration or re-establishment of the Box-Gum Woodland EEC. Following that investigation, this implementation plan was developed to maximise the prospects for rehabilitation and regeneration of the Box-Gum Woodland EEC on the offset areas and on the mine site.

The investigation has resulted in the identification of 46 individual actions relating to the Rehabilitation Strategy and 52 individual actions relating to the Biodiversity Offset Strategy. The approved implementation plan will be incorporated into the Rehabilitation Management Plan and a revised Biodiversity Management Plan (due to be submitted to the Department of Planning and Environment in April 2015).

1 INTRODUCTION

1.1 BACKGROUND

The Maules Creek Coal Mine (MCCM) an open cut coal mining operation is located approximately 40 kilometres south-east of Narrabri, New South Wales (NSW) (Figures 1 and 2). The MCCM is owned by Maules Creek Coal Pty Ltd (MCC), a joint venture between Aston Coal 2 Pty Limited (a wholly owned subsidiary of Whitehaven Coal Limited [Whitehaven]) (75 percent [%]), ITOCHU Corporation (15%) and J-Power Corporation Pty Limited (10%).

The MCCM 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 on 23 October 2012. The MCCM was granted approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 11 February 2013 (Commonwealth Approval Decision 2010/5566).

As part of the NSW Project approval for the MCCM, MCC 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 44 of Maules Creek Coal Mine Project Approval (PA 10_0138) requires 2,078 hectares (ha)¹ 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 grassy woodland, shrubby woodland/open forest, riparian forest and 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* (Hansen Bailey, 2013). The Rehabilitation Strategy also includes the creation of riparian areas (Hansen Bailey, 2013). Condition 44 of Maules Creek Coal Mine Project Approval (PA 10_0138) requires a total of 544 ha to be revegetated with species characteristic of the Box-Gum Woodland EEC.

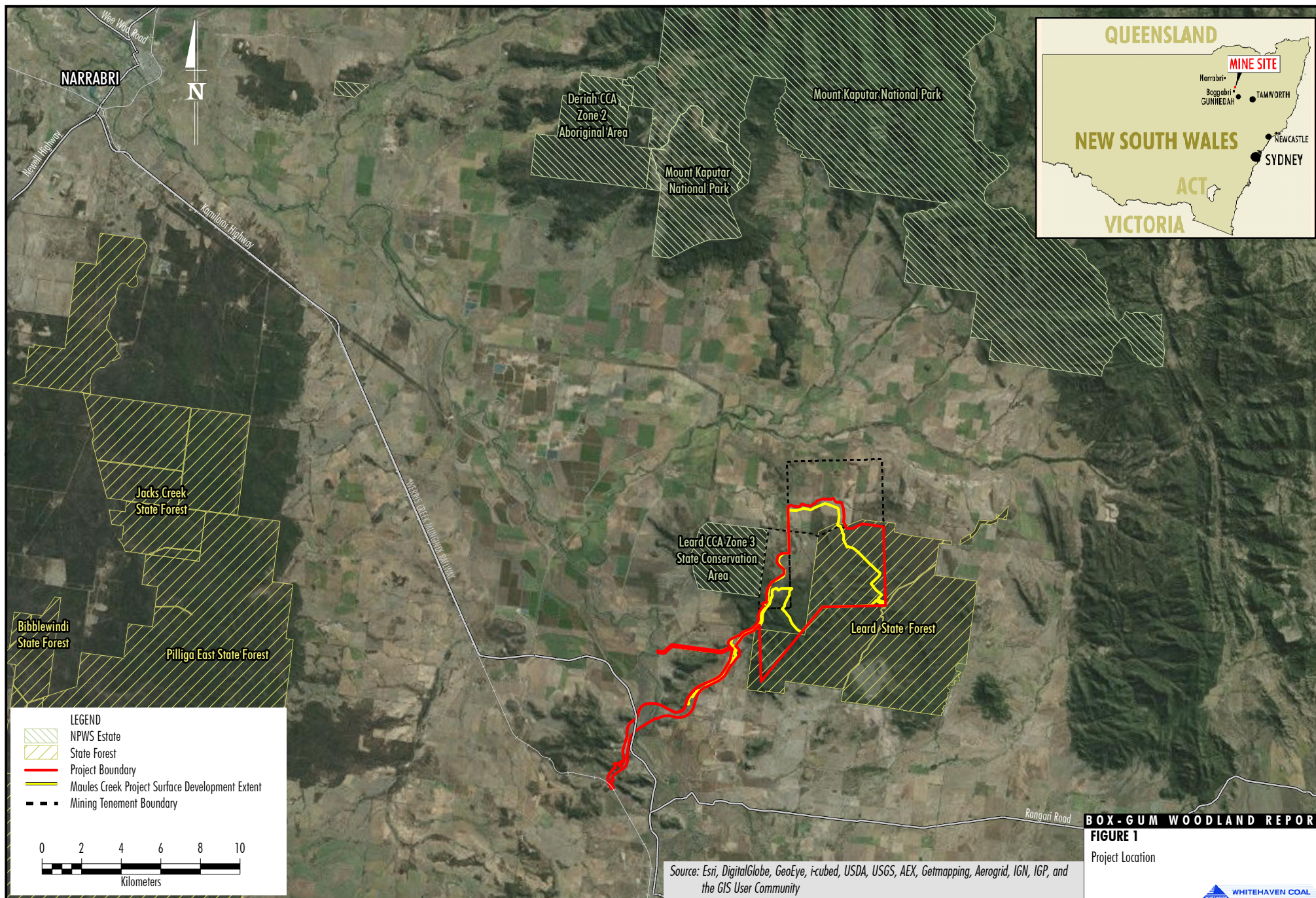
Biodiversity Offset Strategy

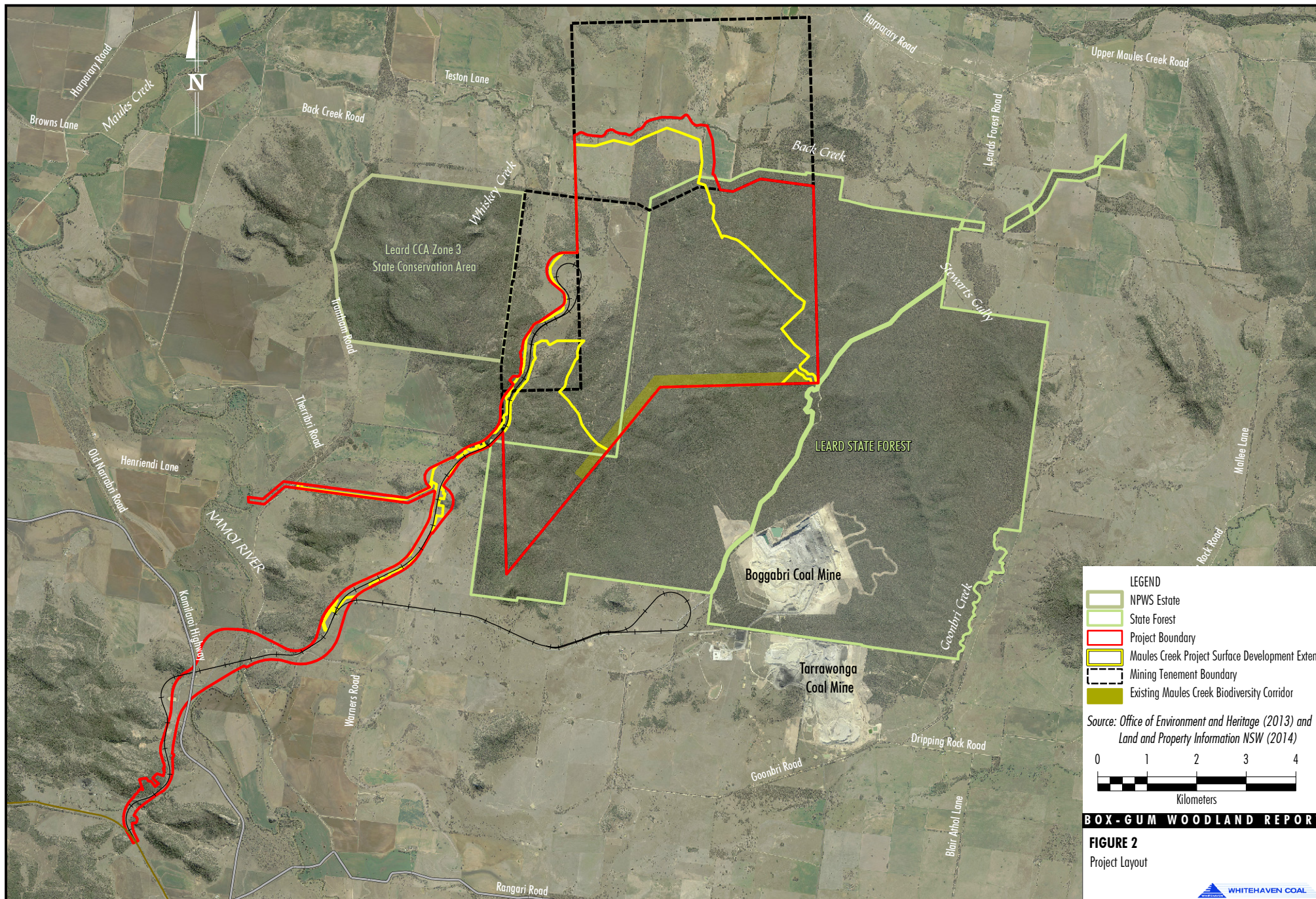
The biodiversity offset areas under Condition 44 of Maules Creek Coal Mine Project Approval (PA 10_0138) are required to cover a minimum of 10,333 ha² of land (Figure 3). The objectives of the offset areas are defined in the MCCM Biodiversity Management Plan (BMP) (Whitehaven, 2014a):

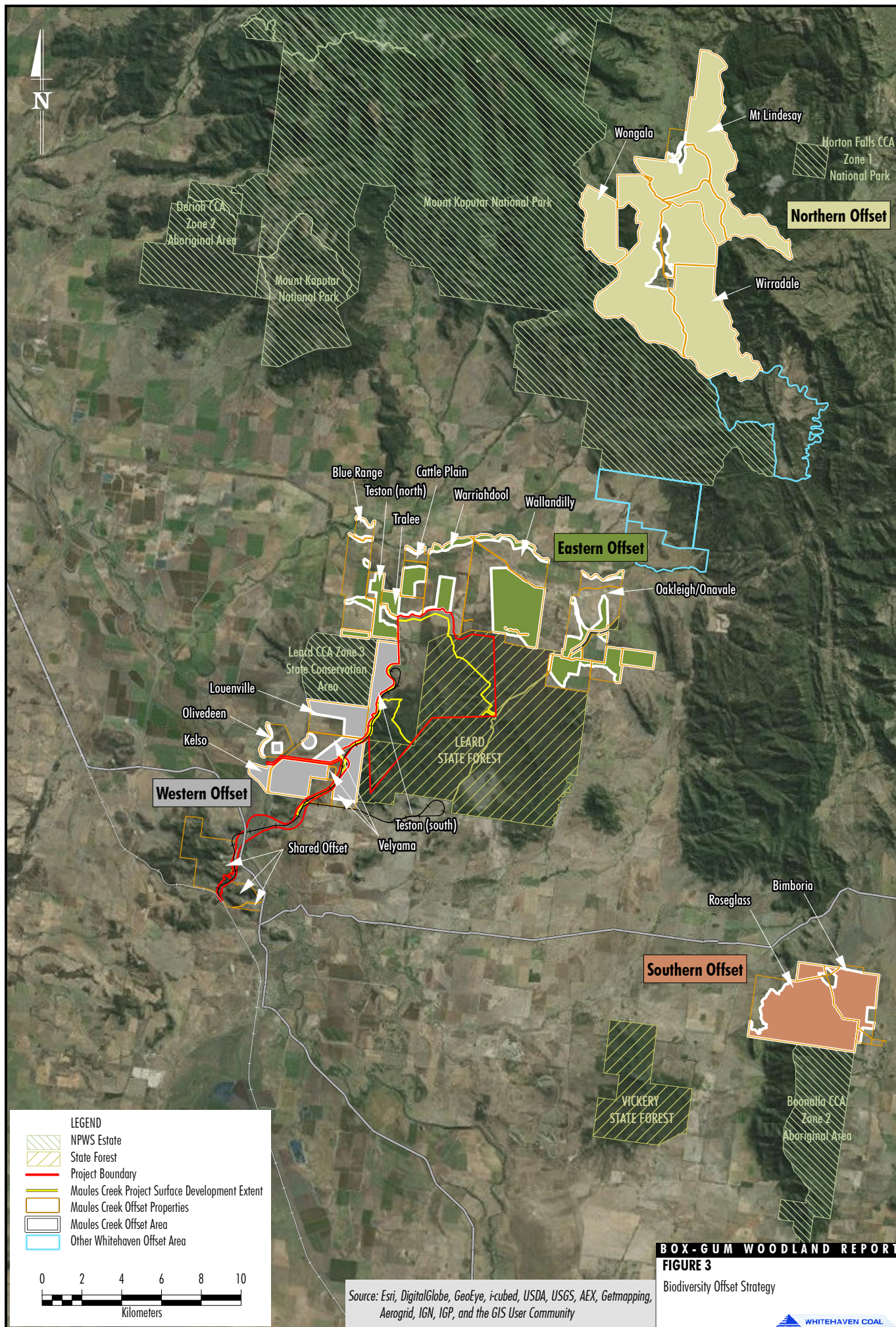
- *to protect and enhance existing native woodland/forest;*
- *to protect and enhance areas of semi-cleared woodland/forest;*
- *to restore self-sustaining vegetation communities within derived native grassland;*

¹ Less the area of the minimised final void.

² Note: Additional offset areas will be established for the MCCM under the EPBC Act approval. These additional offset areas are not subject to this investigation report. The Oakleigh/Onavale, Bimboria and Roseglass offset areas shown on Figure 3 are relevant to the offset required under the EPBC Act. The Oakleigh/Onavale, Bimboria and Roseglass offset areas may be used to satisfy the 1,000 ha additional offset requirement under Condition 44.







BOX-GUM WOODLAND REPORT
FIGURE 3

Biodiversity Offset Strategy

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

- *to restore the woodland form of Box Gum Woodland within existing areas of Box Gum Woodland EEC/CEEC (derived native grassland); and*
- *to restore self-sustaining vegetation communities within areas of low diversity derived native grassland, pasture improved and cultivated land.*

The Box-Gum Woodland EEC is present in the offset areas in woodland and derived grassland forms (Figure 4). The Biodiversity Offset Strategy aims to re-establish Box-Gum Woodland in various landscapes:

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

It is recognised that aiming to re-establish or restore Box-Gum Woodland is likely to be difficult, particularly in cleared (mostly cultivated) land with predominantly introduced ground cover. 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); and
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).

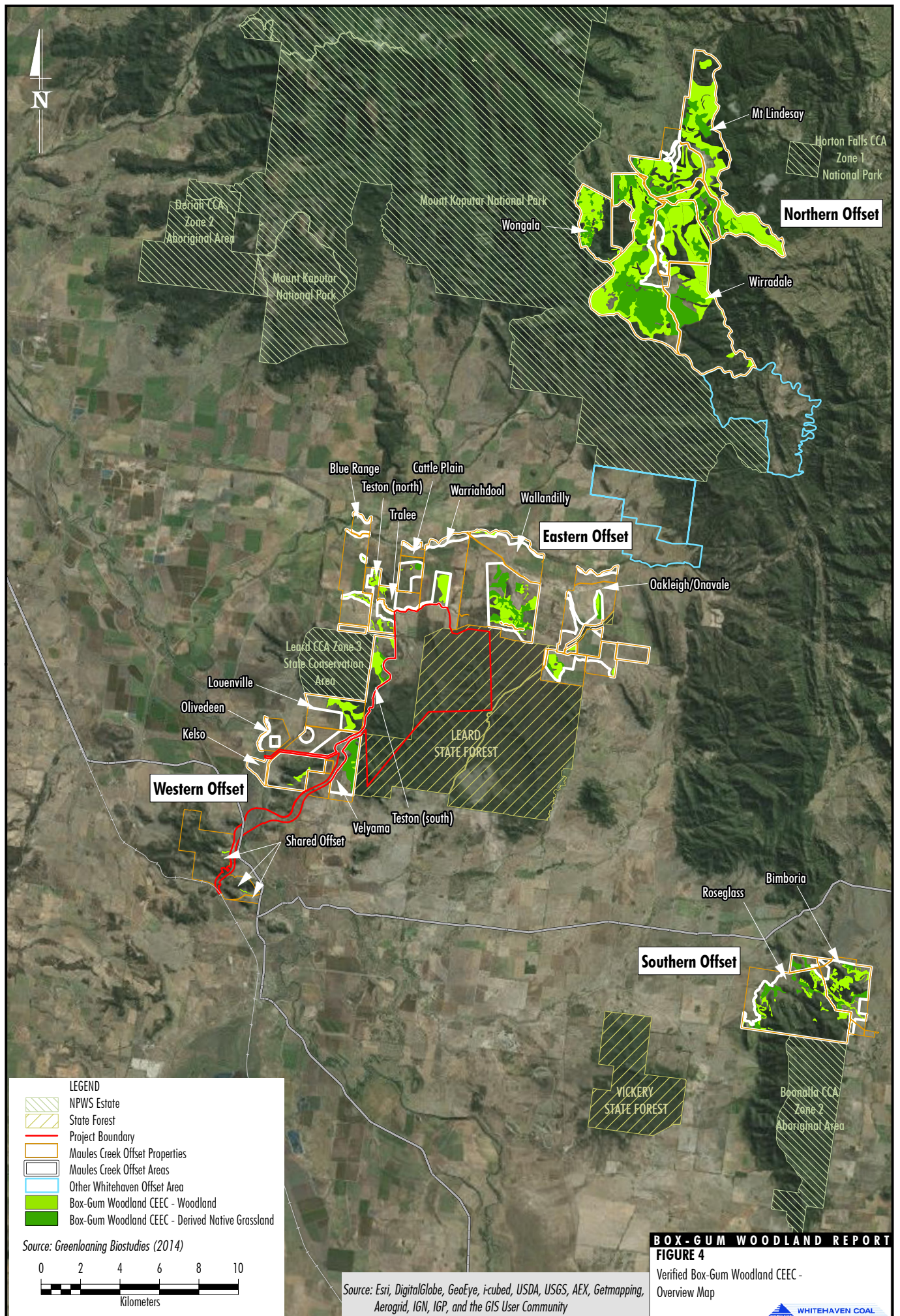
Box-Gum Woodland Investigation

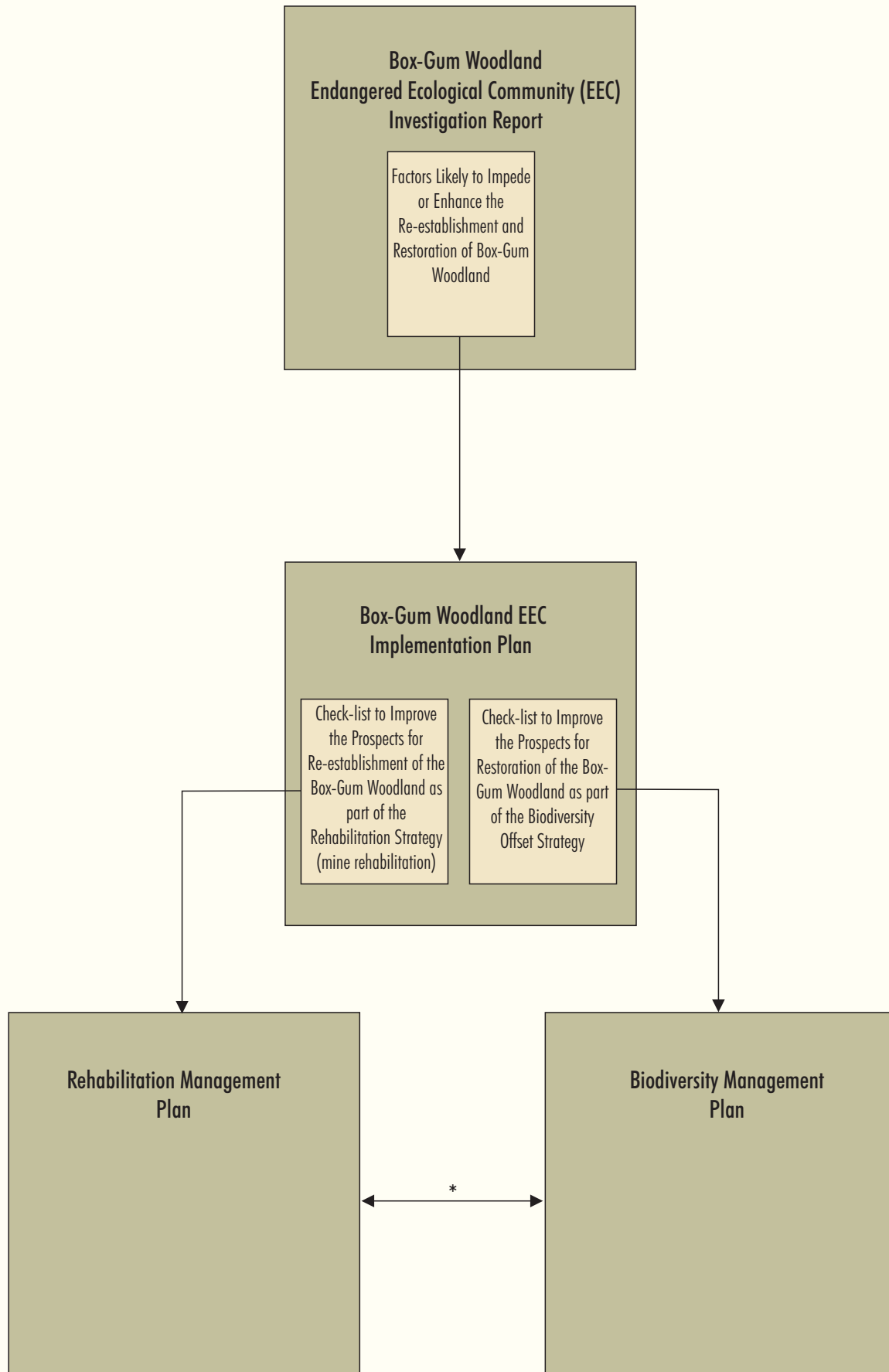
Condition 48(b) of MCCM Project Approval (PA 10_0138) requires:

1. an investigation on 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 (i.e. an Investigation Report);
2. an implementation plan to maximise the prospects for rehabilitation and regeneration of the Box-Gum Woodland EEC (i.e. an Implementation Plan – this document); and
3. revision of the BMP.

Figure 5 contains a flow diagram that shows how the Investigation Report, Implementation Plan and the BMP (and MCCM Rehabilitation Management Plan [RMP]) relate.

In 2014, a separate report (the Investigation Report) (Appendix A) was prepared by Whitehaven which documented an investigation that was undertaken on 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.*

BOX - GUM WOODLAND REPORT

FIGURE 5

Box-Gum Woodland EEC Investigation and Implementation Plan



This document (the Implementation Plan) provides actions to maximise the prospects for rehabilitation and regeneration of the Box-Gum Woodland EEC on the offset areas and the mine site. The outcomes of the Implementation Plan are 'checklists' for implementing the Rehabilitation Strategy and Biodiversity Offset Strategy (where they relate to Box-Gum Woodland EEC). The approved Implementation Plan will be incorporated into a revised BMP (due to be submitted to the Department of Planning and Environment in April 2015) and a revised RMP.

1.2 OBJECTIVES

The purpose of this report is to satisfy Condition 48(c) of Maules Creek Coal Mine Project Approval (PA 10_0138) (Table 1) by considering the MCCM Box-Gum EEC Investigation Report (Whitehaven, 2014b; Appendix A) and providing an implementation plan to maximise the prospects for rehabilitation and regeneration of the Box-Gum Woodland EEC on the offset areas and the mine site. The implementation plan will be incorporated into a revised BMP and revised RMP.

Table 1
Condition 48 of Project Approval (PA 10_0138)

Condition
<p>48. For the White Box – Yellow Box – Blakely's Red Gum Grassy Woodland Endangered Ecological Community the Proponent shall:</p> <ul style="list-style-type: none"> (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; (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); (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 (d) incorporate the approved implementation plan into the revised Biodiversity Management Plan, required under condition 52.

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 Tarrawonga Coal Mine.

1.3 CONSULTATION

Condition 48(b) of Maules Creek Coal Mine Project Approval (PA 10_0138) (Table 1) does not require consultation with stakeholders regarding this implementation plan, however, consultation was undertaken with:

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

This implementation plan 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 20 October 2014), OEH provided the following comments not directly related to this implementation plan:

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.*

MCCM 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 implementation plan was prepared by reviewing the factors likely to enhance the re-establishment and restoration of Box-Gum Woodland at the MCCM and offset areas.

3 PROPOSED ACTIONS RELATING TO FACTORS LIKELY TO IMPEDE AND ENHANCE

Table 2 provides a list of proposed actions relating to each factor likely to impede and enhance the re-establishment and restoration of Box-Gum Woodland.

Table 2
Proposed Actions Relating to Factors Likely to Impede and Enhance the Re-establishment and Restoration of Box-Gum Woodland

Broad Factor	Factors Likely to Impede	Relevant Objective	Factors Likely to Enhance	Actions
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 carbon³. 	<p>The RMP will:</p> <ul style="list-style-type: none"> provide parameters for the physical and chemical characteristics of topsoils and overburden based on likely suitable characteristics for establishment of Box-Gum Woodland. provide for soil testing to be undertaken on topsoil and overburden to identify issues with physical and chemical characteristics as well as determine amelioration requirements and rates. provide for rehabilitation trials (focusing on rehabilitation and revegetation of Box-Gum Woodland) to be undertaken on different rehabilitation substrates. provide for selective identification and placement (burial) of soils unsuitable for use as a growth media. describe options for ameliorating soils to improve the suitability of the soils as a growth media (e.g. amelioration with agricultural gypsum, compost (i.e. mulch saved during clearing activities) or fertilisers depending on the nutrient deficiency). describe the incorporation of vegetative material (cleared at the mine site) into the soil used for rehabilitation or as mulch. provide for selective use of slow-release native plant fertiliser (e.g. rock minerals) to promote plant growth (if required).
		Offset Areas – Re-establishment of Box-Gum Woodland on cleared (former agricultural) land (Condition States 3 and 4 [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). 	<p>The BMP will:</p> <ul style="list-style-type: none"> provide for soil testing to be undertaken on soils in revegetation areas to identify issues with physical and chemical characteristics as well as determine amelioration requirements and rates. provide for selective use of slow-release fertiliser to promote plant growth (if required). describe procedures to reuse timber/hollow logs salvaged during vegetation clearance (consistent with Condition 39[b] Schedule 3 of Project Approval 10_0138),
		Offset Areas – Re-establishment of Box-Gum Woodland from derived grasslands (Condition State 2 [Rawlings <i>et al.</i> , 2010])		
	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 26[b] of the Approval Decision EPBC 2010/5566). Soil surveys and inventories prior to soil stripping (Condition 27[c] of the Approval Decision EPBC 2010/5566 and Condition 39 Schedule 3 of Project Approval 10_0138). Soil handling processes for removal, storage and re-layering of topsoil and subsoil (Condition 27[d] of the Approval Decision EPBC 2010/5566). Annual soil balances to manage soil handling (Condition 39 Schedule 3 of Project Approval 10_0138). Rehabilitation trials focused on soil substrate. 	<p>The RMP will:</p> <ul style="list-style-type: none"> provide parameters for the physical and chemical characteristics of topsoils and overburden based on likely suitable characteristics for establishment of Box-Gum Woodland. provide for soil testing to be undertaken on topsoil and overburden to identify issues with physical and chemical characteristics as well as determine amelioration requirements and rates. provide for selective identification and placement (burial) of soils unsuitable for use as a growth media. describe minimum topsoil and subsoil depths for revegetation (consistent with Condition 26[b] of the Approval Decision EPBC 2010/5566). provide for soil surveys and inventories to be undertaken prior to soil stripping (consistent with Condition 27[c] of the Approval Decision EPBC 2010/5566 and condition 39 Schedule 3 of Project Approval 10_0138) provide soil handling processes for removal, storage and re-layering of topsoil and subsoil (consistent with Condition 27[d] of the Approval Decision EPBC 2010/5566), including the length and mode of topsoil storage. This will specifically detail the stripping of topsoil likely to contain seeds. provide for annual soil balances to be undertaken to facilitate management of soil handling (consistent with Condition 39 Schedule 3 of Project Approval 10_0138). provide for rehabilitation trials (focusing on rehabilitation and revegetation of Box-Gum Woodland) to be undertaken on different rehabilitation substrates.

³ Not proposed to be used due to preferential use of mulch and woody debris from clearing activities.

Table 2 (Continued)
Proposed Actions Relating to Factors Likely to Impede and Enhance the Re-establishment and Restoration of Box-Gum Woodland

Broad Factor	Factors Likely to Impede	Relevant Objective	Factors Likely to Enhance	Actions
1. Substrate (Cont.)	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 on cleared (former agricultural) land (Condition States 3 and 4 [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). Restriction of livestock access to limit further nutrient enrichment (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. 	<p>The BMP will:</p> <ul style="list-style-type: none"> provide for soil testing to be undertaken on soils in revegetation areas to identify issues with physical and chemical characteristics as well as determine amelioration requirements and rates. describe the following nutrient reduction options: <ul style="list-style-type: none"> crash grazing periodically to remove nutrients locked in weeds; restriction of livestock access to limit further nutrient enrichment; and controlled burns.
		Offset Areas – Re-establishment of Box-Gum Woodland from derived grasslands (Condition State 2 [Rawlings <i>et al.</i> , 2010])		
	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 10_0138). Application of minimum topsoil and subsoil depths (Condition 26[b] of the Approval Decision EPBC 2010/5566). 	<p>The RMP will:</p> <ul style="list-style-type: none"> provide for selective identification and placement (burial) of potentially acid forming interburden materials (consistent with Condition 39[c] Schedule 3 of Project Approval 10_0138). describe minimum topsoil and subsoil depths for revegetation (consistent with Condition 26[b] of the Approval Decision EPBC 2010/5566).
	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). Management of pressure from feral grazing animals and native grazing animals. 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). 	<p>The RMP will:</p> <ul style="list-style-type: none"> provide for establishing vegetation cover as soon as practicable following disturbance to minimise the potential for erosion and weeds. This will involve the application of a temporary sterile cover crop (or native grasses) using species that are not likely to impede revegetation of the Box-Gum Woodland. provide options for remediating erosion including adjust seed and planning densities to maximise ground cover. provide options for minimising the risk of erosion including treatment of dispersive soils and spoils, as well as use of structural erosion controls (e.g. channel banks, slope drains and energy dissipaters). describe how livestock will be excluded from areas undergoing active revegetation (i.e. planting or seeding). consider the use of benign (hard rock) mulch to stabilise batter surfaces that has been sourced onsite (i.e. salvaged from clearing areas or from waste material). include monitoring of landscape function. include provision to review the need for kangaroo control measures.
		Offset Areas – Re-establishment of Box-Gum Woodland on cleared (former agricultural) land (Condition States 3 and 4 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> Targeting revegetation along drainage lines. Remediation of scalded areas. Restriction of livestock access (particularly along drainage lines) (Rawlings <i>et al.</i>, 2010). Installation of new infrastructure in stable locations (e.g. access roads) (McIvor, 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). 	<p>The BMP will:</p> <ul style="list-style-type: none"> include a visual inspection of each mapped vegetation management unit in each offset area to identify constraints and requirements for specific management measures. describe targeted revegetation along drainage lines and scalded areas to minimise risk of erosion. describe restriction of livestock access to erosion prone areas (e.g. along watercourses). aim to locate new offset area management infrastructure (e.g. access roads) in stable locations. aim to maximise the re-use of existing infrastructure (e.g. access roads) instead of creating new infrastructure. provision to review the need for kangaroo control measures.
		Offset Areas – Re-establishment of Box-Gum Woodland from derived grasslands (Condition State 2 [Rawlings <i>et al.</i> , 2010])		
		Offset Areas - Restoration of Existing Box-Gum Woodland (Condition State 1 [Rawlings <i>et al.</i> , 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)
Proposed Actions Relating to Factors Likely to Impede and Enhance the Re-establishment and Restoration of Box-Gum Woodland

Broad Factor	Factors Likely to Impede	Relevant Objective	Factors Likely to Enhance	Actions
1. Substrate (Cont.)	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.	The RMP will: <ul style="list-style-type: none">describe that vehicle access will be predominantly restricted to designated tracks on mine landforms that have been revegetated to minimise ground disturbance (e.g. compaction).describe site preparation (e.g. ripping or use of spiked rollers) to reduce soil compaction impacting the success of the revegetation.describe how livestock will be excluded from areas undergoing active revegetation (i.e. planting or seeding).describe the incorporation of vegetative material (cleared at the mine site) into the soil used for rehabilitation or as mulch.
		Offset Areas – Re-establishment of Box-Gum Woodland on cleared (former agricultural) land (Condition States 3 and 4 [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 access (Rawlings <i>et al.</i>, 2010).Options for reducing compaction:<ul style="list-style-type: none">Mulching (Rawlings <i>et al.</i>, 2010)⁸.Hand aeration (Rawlings <i>et al.</i>, 2010)⁹.Deep air-jetting and mulching (Rawlings <i>et al.</i>, 2010)¹⁰.Cultivation followed by mulching (Rawlings <i>et al.</i>, 2010).	The BMP will: <ul style="list-style-type: none">describe that vehicle access will be predominantly restricted to designated tracks to minimise ground disturbance (e.g. compaction).describe how livestock will be excluded from areas undergoing active revegetation (i.e. planting or seeding).describe site preparation in cleared land (e.g. ripping or use of spiked rollers) and (where relevant) in derived grassland (e.g. use of spiked rollers) to reduce soil compaction impacting the success of the revegetation.
		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 access (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 on cleared (former agricultural) land (Condition States 3 and 4 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none">Restriction of vehicle access to avoid unnecessary ground disturbance (Eddy, 2002; DSE, 2005).Fencing and signage.	The BMP will: <ul style="list-style-type: none">describe that vehicle access will be predominantly restricted to designated tracks to minimise ground disturbance (e.g. compaction).describe provision of fencing and signage around the perimeter of the offset areas to manage livestock and avoid accidental clearance.restrict the use of revegetation techniques that involve high level of physical disturbance in existing Box-Gum Woodland and derived grasslands.
		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).	The RMP will: <ul style="list-style-type: none">provide soil handling processes for removal, storage and re-layering of topsoil and subsoil (consistent with Condition 27[d] of the Approval Decision EPBC 2010/5566). This will specifically detail the stripping of topsoil likely to contain seeds.provide for soil seed bank germination testing to be undertaken on topsoil stockpiles.describe a contingency for supplementary seeding/tube stock planting if the regeneration from the soil seed bank is not sufficient.
		Offset Areas	<ul style="list-style-type: none">Supplementary seeding/tube stock planting.	The BMP will: <ul style="list-style-type: none">favour natural regeneration in the derived grasslands and woodland areas over seeding or planting in the first instance followed by seeding or planting if required.

⁸ This method is not proposed to be undertaken due to the extensive areas required to be revegetated.

⁹ This method is not proposed to be undertaken due to the extensive areas required to be revegetated.

¹⁰ This method is not proposed to be undertaken due to the extensive areas required to be revegetated.

Table 2 (Continued)
Proposed Actions Relating to Factors Likely to Impede and Enhance the Re-establishment and Restoration of Box-Gum Woodland

Broad Factor	Factors Likely to Impede	Relevant Objective	Factors Likely to Enhance	Actions
1. Substrate (Cont.)	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 26[b] of the Approval Decision EPBC 2010/5566). Soil surveys and inventories prior to soil stripping (Condition 27[c] of the Approval Decision EPBC 2010/5566 and Condition 39 Schedule 3 of Project Approval 10_0138). Soil handling processes for removal, storage and re-layering of topsoil and subsoil (Condition 27[d] of the Approval Decision EPBC 2010/5566). Annual soil balances to manage soil handling (Condition 39 Schedule 3 of Project Approval 10_0138). 	<p>The RMP will:</p> <ul style="list-style-type: none"> describe minimum topsoil and subsoil depths for revegetation (consistent with Condition 26[b] of the Approval Decision EPBC 2010/5566). provide for soil surveys and inventories to be undertaken prior to soil stripping (consistent with Condition 27[c] of the Approval Decision EPBC 2010/5566 and condition 39 Schedule 3 of Project Approval 10_0138) provide soil handling processes for removal, storage and re-layering of topsoil and subsoil (consistent with Condition 27[d] of the Approval Decision EPBC 2010/5566). This will specifically detail the stripping of topsoil likely to contain seeds. provide for annual soil balances to be undertaken to facilitate management of soil handling (consistent with Condition 39 Schedule 3 of Project Approval 10_0138).
	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) 	<p>The RMP will:</p> <ul style="list-style-type: none"> describe options for ameliorating soils to improve the suitability of the soils as a growth media (e.g. amelioration with agricultural gypsum, compost or fertilisers depending on the nutrient deficiency). provide for selective identification and placement (burial) of soils unsuitable for use as a growth media. describe the incorporation of vegetative material (cleared at the mine site) into the soil used for rehabilitation or as mulch. describe matching flora to landform position.
	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. 	<p>The RMP will:</p> <ul style="list-style-type: none"> describe how the batter slopes have been designed to minimise instability of the final landform. provide for selective identification and placement (burial) of soils unsuitable for use as a growth media. consider the use of benign (hard rock) mulch to stabilise batter surfaces that has been sourced onsite (i.e. salvaged from clearing areas or from waste material)..
	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. 	<p>The RMP will</p> <ul style="list-style-type: none"> describe how the batter slopes have been designed to minimise instability of the final landform. describe options for ameliorating soils to improve the suitability of the soils as a growth media (e.g. amelioration with agricultural gypsum, compost or fertilisers depending on the nutrient deficiency).
	1m. Lack of soil mycorrhizae (Jasper, 2007)	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 26[b] of the Approval Decision EPBC 2010/5566). Soil surveys and inventories prior to soil stripping (Condition 27[c] of the Approval Decision EPBC 2010/5566 and Condition 39 Schedule 3 of Project Approval 10_0138). Soil handling processes for removal, storage and re-layering of topsoil and subsoil (Condition 27[d] of the Approval Decision EPBC 2010/5566). Use of rhizobial bacteria inoculants for acacia (CSIRO, 2005). 	<p>The RMP will:</p> <ul style="list-style-type: none"> describe minimum topsoil and subsoil depths for revegetation (consistent with Condition 26[b] of the Approval Decision EPBC 2010/5566). provide for soil surveys and inventories to be undertaken prior to soil stripping (consistent with Condition 27[c] of the Approval Decision EPBC 2010/5566 and condition 39 Schedule 3 of Project Approval 10_0138). provide soil handling processes for removal, storage and re-layering of topsoil and subsoil (consistent with Condition 27[d] of the Approval Decision EPBC 2010/5566), including the length and mode of topsoil storage. This will specifically detail the stripping of topsoil likely to contain seeds.

Table 2 (Continued)
Proposed Actions Relating to Factors Likely to Impede and Enhance the Re-establishment and Restoration of Box-Gum Woodland

Broad Factor	Factors Likely to Impede	Relevant Objective	Factors Likely to Enhance	Actions
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. 	<ul style="list-style-type: none"> The RMP will describe that revegetation at the mine would not be cleared (unless for ecological thinning, maintenance or access for monitoring).
		Offset Areas – Re-establishment of Box-Gum Woodland on cleared (former agricultural) land (Condition States 3 and 4 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> Restriction on clearing. Restriction on fire wood collection. Fencing and signage. Maximised re-use of existing infrastructure (e.g. access roads) instead of creating new infrastructure. Installation of new infrastructure in cleared land (e.g. access roads). 	<p>The BMP will:</p> <ul style="list-style-type: none"> describe a restriction of clearing (unless for ecological thinning of density regrowth [i.e. selective removal of regrowth trees or shrubs], maintenance or access for monitoring). not permit firewood collection. describe provision of fencing and signage around the perimeter of the offset areas to manage livestock (i.e. exclusion or controlled entry of livestock for specific purposes) and avoid accidental clearance. aim to maximise the re-use of existing infrastructure (e.g. access roads) instead of creating new infrastructure. aim to locate new offset area management infrastructure (e.g. access roads) preferentially in cleared land.
		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. 	<ul style="list-style-type: none"> The RMP will describe how livestock will be excluded from areas undergoing active revegetation (i.e. planting or seeding).
		Offset Areas – Re-establishment of Box-Gum Woodland on cleared (former agricultural) land (Condition States 3 and 4 [Rawlings <i>et al.</i> , 2010])	<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. 	<p>The BMP will:</p> <ul style="list-style-type: none"> describe restriction of livestock access to erosion prone areas (e.g. along watercourses). describe how livestock will be excluded from areas undergoing active revegetation (i.e. planting or seeding). describe restriction of livestock access to areas not already subject to grazing. describe management of livestock to maintain ground cover and diversity of native plants. describe restriction of livestock access to protect plants that are known to be sensitive to grazing. describe the following controlled grazing management options: <ul style="list-style-type: none"> Rotational grazing system to promote and maintain native plant diversity and cover. Removal of grazing livestock.
		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 livestock access (particularly along drainage lines) (Rawlings <i>et al.</i>, 2010). Restriction of livestock access to protect plants that are known to be sensitive to grazing (Rawlings <i>et al.</i>, 2010). Restriction of livestock access to maintain ground cover. Maintenance of fencing used to exclude livestock. Controlled grazing management options: <ul style="list-style-type: none"> Crash grazing periodically to remove nutrients locked in weeds (Rawlings <i>et al.</i>, 2010). High intensity short duration rotational grazing (Rawlings <i>et al.</i>, 2010). Removal of grazing livestock. Low stocking rates. 	
		Offset Areas - Restoration of Existing Box-Gum Woodland (Condition State 1 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> Exclusion of livestock grazing along watercourses (McIvor and McIntyre, 2002). Exclusion of livestock grazing in areas not already subject to grazing (DECCW, 2011). Maintenance of fencing used to exclude livestock. Controlled grazing management (low stocking rates). 	

Table 2 (Continued)
Proposed Actions Relating to Factors Likely to Impede and Enhance the Re-establishment and Restoration of Box-Gum Woodland

Broad Factor	Factors Likely to Impede	Relevant Objective	Factors Likely to Enhance	Actions
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 27[a] of the Approval Decision EPBC 2010/5566). Establishing vegetation cover as soon as practicable following disturbance (Condition 27[b] of the Approval Decision EPBC 2010/5566). 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 (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). Herbicides (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). 	<p>The RMP will</p> <ul style="list-style-type: none"> describe procedures to prevent, monitor and control weeds. The RMP will also describe relevant targets and performance indicators for weed management (consistent with Condition 27[a] of the Approval Decision EPBC 2010/5566). provide for establishing vegetation cover as soon as practicable following disturbance to minimise the potential for erosion and weeds. This will involve the application of a temporary sterile cover crop (or native grasses) using species that are not likely to impede revegetation of the Box-Gum Woodland. provide application rates for seeds as well as planting densities for tube stock to avoid excessive shading. include sowing of Kangaroo Grass (as this species is known to out-compete annual grass weeds and provide inter tussock spaces for a diversity of ground cover species [eg. wildflowers]).
		Offset Areas – Re-establishment of Box-Gum Woodland on cleared (former agricultural) land (Condition States 3 and 4 [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). Correct spacing for species when planting seedlings to avoid excessive shading (DECCW, 2011). Weed management options: <ul style="list-style-type: none"> Crash grazing periodically to reduce annual and perennial grass weeds (Rawlings <i>et al.</i>, 2010). Nutrient management (e.g. exclusion of grazing livestock which add nutrients) (Rawlings <i>et al.</i>, 2010). Controlled burns during spring to reduce annual and perennial grass weeds (not broadleaf exotics) (Rawlings <i>et al.</i>, 2010). Physical Removal (e.g. removing weeds by felling or pulling) (Gibson-Roy <i>et al.</i>, 2010; Rawlings <i>et al.</i>, 2010). Herbicides (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). Scalping to remove weed seed bank (Gibson-Roy <i>et al.</i>, 2010)¹¹. 	<p>The BMP will:</p> <ul style="list-style-type: none"> provide application rates for seeds as well as planting densities for tube stock to avoid excessive shading. provide the following weed management options: <ul style="list-style-type: none"> Crash grazing periodically to reduce annual and perennial grass weeds. Nutrient management (e.g. exclusion of grazing livestock which add nutrients). Controlled burns (except in revegetation areas) during spring to reduce annual and perennial grass weeds (not broadleaf exotics). Physical removal (e.g. removing weeds by felling or pulling). Targeted and timely herbicide application. include sowing of Kangaroo Grass (as this species is known to out-compete annual grass weeds and provide inter tussock spaces for a diversity of ground cover species [eg. wildflowers]). The BMP will include provision to lightly graze derived grasslands in times of suitable climatic conditions for weed growth (e.g. autumn and/or winter) to reduce vigour of annual grass weeds.

¹¹ This method is not proposed to be undertaken due to the extensive areas required to be revegetated.

Table 2 (Continued)
Proposed Actions Relating to Factors Likely to Impede and Enhance the Re-establishment and Restoration of Box-Gum Woodland

Broad Factor	Factors Likely to Impede	Relevant Objective	Factors Likely to Enhance	Actions
4. Introduced flora species (weeds) (Cont.)	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) (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"> 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 weeds (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 herbicides 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). 	<ul style="list-style-type: none"> The RMP and BMP will provide methods for the use of herbicides (minimised through spot-spraying, basal spraying, stem injection or cut and paint application methods).
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). 	<p>The RMP and BMP will:</p> <ul style="list-style-type: none"> describe procedures to prevent, monitor and control feral animals (including feral pigs, goats, rabbits and foxes). provide an option for using tree guards to protect young seedlings from browsing or grazing native animals.
	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). 	<ul style="list-style-type: none"> The RMP and BMP will describe procedures to prevent, monitor and control feral animals (including feral pigs, goats, rabbits and foxes).
	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. 	<p>The RMP and BMP will provide:</p> <ul style="list-style-type: none"> an option for using tree guards to protect young seedlings from browsing or grazing native animals. provision to review the need for kangaroo control measures.
	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). 	<ul style="list-style-type: none"> The RMP and BMP will describe procedures to prevent, monitor and control feral animals (including feral pigs, goats, rabbits and foxes).
	6e. Honeybees (DECCW, 2011)	All areas	<ul style="list-style-type: none"> Management of honeybees¹². 	-
	6f. Deer (DECCW, 2011)	All areas	<ul style="list-style-type: none"> Management of Deer. 	<ul style="list-style-type: none"> The BMP will provide monitoring of deer and feral cats and control (if required).
	6g. Feral Cat (Eddy, 2002; DECCW, 2011)	All areas	<ul style="list-style-type: none"> Management of the Feral Cat 	<ul style="list-style-type: none"> The BMP will provide monitoring of deer and feral cats and control (if required).
	6h. Other Invasive Fauna	All areas	<ul style="list-style-type: none"> Provisions to identify new invasive fauna species (e.g. fauna monitoring). 	<ul style="list-style-type: none"> The BMP will provide provisions to identify new invasive fauna species (e.g. fauna monitoring).
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. 	<ul style="list-style-type: none"> The RMP will describe measures to prevent fires such as maintaining fire breaks and access (i.e. no controlled burns would be undertaken on the mine rehabilitation whilst vegetation is establishing).
		Offset Areas – Re-establishment of Box-Gum Woodland on cleared (former agricultural) land (Condition States 3 and 4 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> No controlled burns whilst vegetation is establishing. Maintain fire breaks and access. Assess fuel loads. 	<p>The BMP will:</p> <ul style="list-style-type: none"> describe measures to prevent fires such as maintaining fire breaks and access (i.e. no controlled burns would be undertaken whilst vegetation is establishing). prescribe any controlled burns in patches of Box-Gum Woodland EEC to be no less than 5 years and then to occur in spring or autumn burns depending on a range of factors. schedule for maintenance of fire breaks and fire trails. provide a schedule for assessing fuel loads. provide an option for using controlled grazing to reduce biomass.
		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 biomass (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. 	

¹² Not proposed.

Table 2 (Continued)
Proposed Actions Relating to Factors Likely to Impede and Enhance the Re-establishment and Restoration of Box-Gum Woodland

Broad Factor	Factors Likely to Impede	Relevant Objective	Factors Likely to Enhance	Actions
7. Fire (Cont.)	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. 	<ul style="list-style-type: none"> The RMP will describe measures to prevent fires such as maintaining fire breaks and access (i.e. no controlled burns would be undertaken on the mine rehabilitation whilst vegetation is establishing).
		Offset Areas – Re-establishment of Box-Gum Woodland on cleared (former agricultural) land (Condition States 3 and 4 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> No controlled burns whilst vegetation is establishing. Assess fuel loads. 	<ul style="list-style-type: none"> The BMP will prescribe any controlled burns in patches of Box-Gum Woodland EEC to be no less than 5 years and then to occur in spring or autumn burns depending on a range of factors.
		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 reseedling of absent species. 	The RMP will <ul style="list-style-type: none"> describe how the growth and survival of the vegetation sown or planted will be monitored. describe procedures for strategic and long term seed collection, management and storage following the relevant Florabank guidelines. The RMP will describe procedures for sowing seed (e.g. appropriate sowing depths).
		Offset Areas – Re-establishment of Box-Gum Woodland on cleared (former agricultural) land (Condition States 3 and 4 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> Strategic and long term seed collection, management and storage. Site preparation and depth of sowing seed. Supplementary planting or reseedling of absent species. 	The BMP will: <ul style="list-style-type: none"> describe procedures for strategic and long term seed collection, management and storage following the relevant Florabank guidelines. describe procedures for sowing seed (e.g. appropriate sowing depths). favour natural regeneration in the derived grasslands and woodland areas over seeding or planting in the first instance followed by seeding or planting if required.
		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). 	<ul style="list-style-type: none"> The RMP will provide for the preferential use of local endemic (adapted) species, however consideration would be given to the use of a high quality seed source further from the site over a low quality more local seed source.
		Offset Areas – Re-establishment of Box-Gum Woodland on cleared (former agricultural) land (Condition States 3 and 4 [Rawlings <i>et al.</i> , 2010])	<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). 	The BMP will <ul style="list-style-type: none"> provide for the preferential use of local endemic (adapted) species, however consideration would be given to the use of a high quality seed source further from the site over a low quality more local seed source.
		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). 	<ul style="list-style-type: none"> favour natural regeneration in the derived grasslands and woodland areas over seeding or planting in the first instance followed by seeding or planting if required.
	8c. Shortage of sufficient seed or tube stock	All areas	<ul style="list-style-type: none"> Review commercial seed and tube stock availability. 	<ul style="list-style-type: none"> The RMP and BMP will describe a seed and tube stock supply strategy including calculation of the amount and species of seed and tube stock required each year and how the seed and tube stock will be sourced and managed to meet the demand.

Table 2 (Continued)
Proposed Actions Relating to Factors Likely to Impede and Enhance the Re-establishment and Restoration of Box-Gum Woodland

Broad Factor	Factors Likely to Impede	Relevant Objective	Factors Likely to Enhance	Actions
8. Floristics (Cont.)	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). 	<p>The RMP and BMP will</p> <ul style="list-style-type: none"> provide application rates for seeds as well as planting densities for tube stock to avoid excessive shading. provide for the preferential use of local endemic (adapted) species, however consideration would be given to the use of a high quality seed source further from the site over a low quality more local seed source. include provision to assess vegetation density and undertake ecological thinning (e.g. through selective clearance or fire) if necessary. provide measures to improve understorey diversity (e.g. replanting, causing disturbance through fire or grazing). aim to include a wide diversity of species in the seed mix.
	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>, 2006a; Broadhurst <i>et al.</i>, 2006b; Broadhurst <i>et al.</i>, 2008 in DECCW, 2011). 	<p>The RMP and BMP will</p> <ul style="list-style-type: none"> describe a seed and tube stock supply strategy including calculation of the amount and species of seed and tube stock required each year and how the seed and tube stock will be sourced and managed to meet the demand. provide for the preferential use of local endemic (adapted) species, however consideration would be given to the use of a high quality seed source further from the site over a low quality more local seed source.
	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). 	The RMP and BMP will describe revegetation and regeneration measures.
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 (Condition 15 of the Approval Decision EPBC 2010/5566). 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. 	<p>The RMP will</p> <ul style="list-style-type: none"> describe procedures for strategic and long term seed collection, management and storage following the relevant Florabank guidelines. The RMP will describe procedures for sowing seed (e.g. appropriate sowing depths). describe how livestock will be excluded from areas undergoing active revegetation (i.e. planting or seeding). provide application rates for seeds as well as planting densities for tube stock to avoid excessive shading. describe research that will aim to identify effective methodologies for achieving rehabilitation and revegetation of Box-Gum Woodland on the mine rehabilitation (consistent with Condition 15 of the Approval Decision EPBC 2010/5566). provide for the preferential use of local endemic (adapted) species, however consideration would be given to the use of a high quality seed source further from the site over a low quality more local seed source. provide for selective use of slow-release fertiliser to promote plant growth (if required) including the use of trace elements. .
		Offset Areas – Re-establishment of Box-Gum Woodland on cleared (former agricultural) land (Condition States 3 and 4 [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. 	<p>The BMP will</p> <ul style="list-style-type: none"> describe procedures for strategic and long term seed collection, management and storage following the relevant Florabank guidelines. The BMP will describe procedures for sowing seed (e.g. appropriate sowing depths). describe how livestock will be excluded from areas undergoing active revegetation (i.e. planting or seeding). provide application rates for seeds as well as planting densities for tube stock to avoid excessive shading. favour natural regeneration in the derived grasslands and woodland areas over seeding or planting in the first instance followed by seeding or planting if required. provide for the preferential use of local endemic (adapted) species, however consideration would be given to the use of a high quality seed source further from the site over a low quality more local seed source.
		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"> 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). 	

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

Table 2 (Continued)
Proposed Actions Relating to Factors Likely to Impede and Enhance the Re-establishment and Restoration of Box-Gum Woodland

Broad Factor	Factors Likely to Impede	Relevant Objective	Factors Likely to Enhance	Actions
9. Native plant growth (Cont.)	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. 	<p>The RMP and BMP will:</p> <ul style="list-style-type: none"> favour natural regeneration in the derived grasslands and woodland areas over seeding or planting in the first instance followed by seeding or planting if required. The RMP and BMP will provide for the preferential use of local endemic (adapted) species, however consideration would be given to the use of a high quality seed source further from the site over a low quality more local seed source.
	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). 	<ul style="list-style-type: none"> The RMP and BMP will include provision to assess vegetation density and undertake ecological thinning (e.g. through selective clearance or fire) if necessary.
	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). 	<ul style="list-style-type: none"> The RMP and BMP will provide measures to improve understorey diversity (e.g. replanting, causing disturbance through fire or grazing).
	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). 	<ul style="list-style-type: none"> The RMP and BMP will include hygiene protocols to minimise the risk of plant diseases (i.e. restricting site access).
	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). 	<ul style="list-style-type: none"> The RMP and BMP will provide for the preferential use of local endemic (adapted) species, however consideration would be given to the use of a high quality seed source further from the site over a low quality more local seed source.
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 (Condition 39[b] Schedule 3 of Project Approval 10_0138). 	<ul style="list-style-type: none"> The RMP and BMP will describe procedures to reuse bush rocks salvaged during vegetation clearance (consistent with Condition 39[b] Schedule 3 of Project Approval 10_0138).
	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 (Condition 39[b] Schedule 3 of Project Approval 10_0138). 	<ul style="list-style-type: none"> The RMP and BMP will describe procedures to reuse timber/hollow logs salvaged during vegetation clearance (consistent with Condition 39[b] Schedule 3 of Project Approval 10_0138), including: <ul style="list-style-type: none"> placement of hollow limbs or artificial hollows in select trees without hollows; and use of artificial stag trees on the mine rehabilitation.
	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 (Condition 39[b] Schedule 3 of Project Approval 10_0138) and placement of hollow limbs in trees without hollows. Increase woodland patch size within the offset area (Prober <i>et al.</i> 2002). 	<p>The RMP and BMP will</p> <ul style="list-style-type: none"> describe that seed and tube stock used in revegetation will include a variety of grasses, low shrubs, mid-sized shrubs and tall trees to create structurally diverse habitat. describe procedures to reuse bush rocks salvaged during vegetation clearance (consistent with Condition 39[b] Schedule 3 of Project Approval 10_0138). describe procedures to reuse timber/hollow logs salvaged during vegetation clearance (consistent with Condition 39[b] Schedule 3 of Project Approval 10_0138), including: <ul style="list-style-type: none"> placement of hollow limbs or artificial hollows in select trees without hollows; and use of artificial stag trees on the mine rehabilitation. focus on increasing woodland patch size within the offset area.
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). 	<p>The BMP will:</p> <ul style="list-style-type: none"> focus on increasing woodland patch size within the offset area and aim to enhance ecological connectivity. include a description of the Community Consultative Committee.
	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. 	

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

Table 2 (Continued)
Proposed Actions Relating to Factors Likely to Impede and Enhance the Re-establishment and Restoration of Box-Gum Woodland

Broad Factor	Factors Likely to Impede	Relevant Objective	Factors Likely to Enhance	Actions
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). Management of pressure from feral grazing animals and native grazing animals. Irrigation. Mulch. 	<p>The RMP will:</p> <ul style="list-style-type: none"> describe how the growth and survival of the vegetation sown or planted will be monitored. describe the incorporation of vegetative material (cleared at the mine site) into the soil used for rehabilitation or as mulch. include provision to review the need for kangaroo control measures. describe procedures to prevent, monitor and control feral animals (including feral pigs, goats, rabbits and foxes).
		Offset Areas – Re-establishment of Box-Gum Woodland on cleared (former agricultural) land (Condition States 3 and 4 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> Monitoring for signs of water stress (dieback). Limit grazing livestock during drought periods¹⁵ (DECCW, 2011). Management of pressure from feral grazing animals and native grazing animals. Irrigation¹⁶ Mulch¹⁷. 	<p>The BMP will:</p> <ul style="list-style-type: none"> describe how the growth and survival of the vegetation sown or planted will be monitored. discuss an adaptive management framework and monitoring programme for the management of the Box-Gum Woodland EEC. provide a mechanism to reduce livestock grazing during drought periods. include provision to review the need for kangaroo control measures. describe procedures to prevent, monitor and control feral animals (including feral pigs, goats, rabbits and foxes).
		Offset Areas – Re-establishment of Box-Gum Woodland from derived grasslands (Condition State 2 [Rawlings <i>et al.</i> , 2010])		
	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). 	<ul style="list-style-type: none"> The RMP and BMP will provide an option for using tree guards to protect young seedlings from browsing or grazing native animals. The RMP will provide for establishing vegetation cover as soon as practicable following disturbance to minimise the potential for erosion and weeds. This will involve the application of a temporary sterile cover crop (or native grasses) using species that are not likely to impede revegetation of the Box-Gum Woodland.
	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 cleared land. 	<p>The RMP and BMP will:</p> <ul style="list-style-type: none"> focus on increasing woodland patch size within the offset area aim to enhance ecological connectivity. provide for the preferential use of local endemic (adapted) species, however consideration would be given to the use of a high quality seed source further from the site over a low quality more local seed source. <p>An aim of the offset strategy is to provide connectivity through the eastern and western offset areas and includes improve connectivity by revegetation of low diversity derived native grassland, pasture improved and cultivated land.</p>

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.

Table 2 (Continued)
Proposed Actions Relating to Factors Likely to Impede and Enhance the Re-establishment and Restoration of Box-Gum Woodland

Broad Factor	Factors Likely to Impede	Relevant Objective	Factors Likely to Enhance	Actions
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).	The RMP and BMP will: <ul style="list-style-type: none">define the objectives for the Box-Gum Woodland EEC.discuss an adaptive management framework and monitoring programme for the management of the Box-Gum Woodland EEC.
	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	The RMP and BMP will describe roles for suitability qualified personnel (e.g. restoration ecologist to provide direction about the rehabilitation and restoration of the Box-Gum Woodland EEC).

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

4 IMPLEMENTATION PLAN

There are two parts to the implementation plan:

- the first part of the implementation plan relates to re-establishment of Box-Gum Woodland on the mine rehabilitation (Rehabilitation Strategy) (Table 3); and
- the second part of the implementation plan relates to re-establishment and restoration of Box-Gum Woodland in the offset areas (Biodiversity Offset Strategy) (Table 4).

The investigation has resulted in the identification of 46 individual actions relating to the Rehabilitation Strategy (Table 3) and 52 individual actions relating to the Biodiversity Offset Strategy (Table 4). Once approved by DP&E, the actions in Table 3 will be addressed in a revised RMP and the actions in Table 4 will be addressed in a revised BMP (due to submission to the Department of Planning and Environment in April 2015) (Figure 5).

The actions listed in Table 3 will apply to different situations associated with rehabilitation of the mine disturbance areas. For example, some actions may be relevant to the revegetation of less disturbed areas (such as the soil stockpile locations or infrastructure areas) and others would be relevant to the revegetation of more disturbed areas (such as the backfilled mine void and waste dumps). The application of the actions will be described in the RMP.

Similarly, all of the actions listed in Table 4 may not necessarily apply across the entire offset area and will depend on the situation such as the current condition of the vegetation. For example, weed control may only be relevant to particular weed infested areas. Particular actions may also be trialled in certain areas to determine which are more effective. The application of the actions will be further detailed in a revision to the BMP.

The actions listed in Tables 3 and 4 are not necessarily the only actions that will be considered in the future to improve the prospects of the Rehabilitation Strategy and Biodiversity Offset Strategy. Actions may be modified over time to adapt to management outcomes, new threatening processes (e.g. a new weed incursion) or to apply new techniques and technologies. Any changes will be facilitated through revisions to the BMP.

As described in Section 1, the aims are to re-establish Box-Gum Woodland in various landscapes:

1. on the post-mine landforms that have a highly disturbed substrate;
2. in cleared (mostly cultivated) land with predominantly introduced groundcover;
3. in cleared (mostly grazing) land with predominantly native grassland groundcover (derived grasslands); and
4. through enhancement of existing remnants of the Box-Gum Woodland in varying conditions.

These landscapes have different degrees of ecological resilience and management requirements. However, regardless of the landscape, it is recognised that detailed planning from the outset can help improve the prospects for achieving the aims (refer to Actions 1-5 in Table 3 and Actions 1 to 9 in Table 4). For example, the BMP will include a visual inspection of each mapped vegetation management unit in each offset area to identify constraints and requirements for specific management measures (refer to Action 3 in Table 4).

A brief description of each landscape is provided below in relation to the actions in Tables 3 and 4. These actions would be detailed in a special explicit manner within the revised RMP and revised BMP.

Landscape 1 - Post-mine Landform

Landscape 1 (the post-mine landform) will require the greatest attention to achieve a suitable substrate through landform design, dedicated soil stripping and handling, soil testing and amelioration as well as surface preparation (refer to Actions 5 to 18 in Table 3).

Adaptive management and research will be integral to successful revegetation of the post-mine landforms (refer to Actions 19 to 21 in Table 3). In accordance with Condition 15 of the Approval Decision EPBC 2010/5566, MCC will invest \$1 million for research that will aim to identify effective methodologies for achieving rehabilitation and restoration of Box-Gum Woodland on the post-mine landform.

Landscape 1 will likely have little ecological resilience (except that which may be provided through maintenance of the soil seed bank in topsoil) so this landscape will require active revegetation using seed or tube stock (refer to Actions 22 to 41 in Table 3).

Habitat features (logs, rocks, hollows and nest boxes) also need to be purposely added into Landscape 1 (refer to Actions 42 to 43 in Table 3).

Table 3
Implementation Plan for Re-establishing Box-Gum Woodland in the Mine Rehabilitation Phase

Actions for Implementing the Rehabilitation Strategy in the RMP	
<i>Planning</i>	
1.	The RMP will define the objectives for the Box-Gum Woodland EEC.
2.	The RMP will discuss an adaptive management framework and monitoring programme for the management of the Box-Gum Woodland EEC.
3.	The RMP will include monitoring of landscape function.
4.	The RMP will describe roles for suitability qualified personnel (e.g. restoration ecologist to provide direction about the rehabilitation and restoration of the Box-Gum Woodland EEC).
<i>Landform Design</i>	
5.	The RMP will describe how the batter slopes have been designed to minimise instability of the final landform.
<i>Soil Stripping and Handling</i>	
6.	The RMP will provide for soil surveys and inventories to be undertaken prior to soil stripping (consistent with Condition 27[c] of the Approval Decision EPBC 2010/5566 and condition 39 Schedule 3 of Project Approval 10_0138).
7.	The RMP will provide for selective identification and placement (burial) of potentially acid forming interburden materials (consistent with Condition 39[c] Schedule 3 of Project Approval 10_0138).
8.	The RMP will provide for selective identification and placement (burial) of soils unsuitable for use as a growth media.
9.	The RMP will provide soil handling processes for removal, storage and re-layering of topsoil and subsoil (consistent with Condition 27[d] of the Approval Decision EPBC 2010/5566). This will specifically detail the stripping of topsoil likely to contain seeds.
10.	The RMP will provide for annual soil balances to be undertaken to facilitate management of soil handling (consistent with Condition 39 Schedule 3 of Project Approval 10_0138).
11.	The RMP will provide options for minimising the risk of erosion including treatment of dispersive soils and spoils, as well as use of structural erosion controls (e.g. channel banks, slope drains and energy dissipaters).
12.	The RMP will describe minimum topsoil and subsoil depths for revegetation (consistent with Condition 26[b] of the Approval Decision EPBC 2010/5566).
13.	The RMP will describe the incorporation of vegetative material (cleared at the mine site) into the soil used for rehabilitation or as mulch.

Table 3 (Continued)
Implementation Plan for Re-establishing Box-Gum Woodland in the Mine Rehabilitation Phase

Actions for Implementing the Rehabilitation Strategy in the RMP	
Soil Testing	
14.	The RMP will provide parameters for the physical and chemical characteristics of topsoils and overburden based on likely suitable characteristics for establishment of Box-Gum Woodland.
15.	The RMP will provide for soil testing to be undertaken on topsoil and overburden to identify issues with physical and chemical characteristics as well as determine amelioration requirements and rates.
Soil Amelioration	
16.	The RMP will describe options for ameliorating soils to improve the suitability of the soils as a growth media (e.g. amelioration with agricultural gypsum, compost (i.e. mulch saved during clearing activities) or native plant fertilisers depending on the nutrient deficiency).
Surface Preparation	
17.	The RMP will describe site preparation (e.g. ripping or use of spike rollers) to reduce soil compaction impacting the success of the revegetation.
18.	The RMP will consider the use of benign (hard rock) mulch to stabilise batter surfaces that has been sourced onsite (i.e. salvaged from clearing areas or from waste material).
Research Trials	
19.	The RMP will describe research that will aim to identify effective methodologies for achieving rehabilitation and revegetation of Box-Gum Woodland on the mine rehabilitation (consistent with Condition 15 of the Approval Decision EPBC 2010/5566).
20.	The RMP will provide for soil seed bank germination testing to be undertaken on topsoil stockpiles.
21.	The RMP will provide for rehabilitation trials (focusing on rehabilitation and revegetation of Box-Gum Woodland) to be undertaken on different rehabilitation substrates.
Seed and Tube Stock Supply	
22.	The RMP will describe procedures for strategic and long term seed collection, management (including pre-treatment) and storage following the relevant Florabank guidelines. The RMP will describe procedures for sowing seed (e.g. appropriate sowing depths).
23.	The RMP will describe a seed and tube stock supply strategy including calculation of the amount and species of seed and tube stock required each year and how the seed and tube stock will be sourced and managed to meet the demand.
24.	The RMP will provide for the preferential use of local endemic (adapted) species, however consideration would be given to the use of a high quality seed source further from the site over a low quality more local seed source.
Revegetation	
25.	The RMP will provide for establishing vegetation cover as soon as practicable following disturbance to minimise the potential for erosion and weeds. This will involve the application of a temporary sterile cover crop (or native grasses) using species that are not likely to impede revegetation of the Box-Gum Woodland.
26.	The RMP will provide options for remediating erosion including adjust seed and planting densities to maximise ground cover.
27.	The RMP will describe that vehicle access will be predominantly restricted to designated tracks on mine landforms that have been revegetated to minimise ground disturbance (e.g. compaction).
28.	The RMP will provide for selective use of slow-release native plant fertiliser to promote plant growth (if required).
29.	The RMP will describe a contingency for supplementary seeding/tube stock planting if the regeneration from the soil seed bank is not sufficient.
30.	The RMP will provide application rates for seeds as well as planting densities for tube stock to avoid excessive shading.
31.	The RMP will provide measures to improve understorey diversity (e.g. replanting, causing disturbance through fire or grazing).
32.	The RMP will describe that revegetation at the mine would not be cleared (unless for ecological thinning, maintenance or access for monitoring).
33.	The RMP will include provision to assess vegetation density and undertake ecological thinning (e.g. through selective clearance or fire) if necessary.
34.	The RMP include sowing of Kangaroo Grass (as this species is known to out-compete annual grass weeds and provide inter tussock spaces for a diversity of ground cover species [eg. wildflowers]).
35.	The RMP will describe that seed and tube stock used in revegetation will include a variety of grasses, low shrubs, mid-sized shrubs and tall trees to create structurally diverse habitat.

Table 3 (Continued)
Implementation Plan for Re-establishing Box-Gum Woodland in the Mine Rehabilitation Phase

Actions for Implementing the Rehabilitation Strategy in the RMP	
Revegetation (Cont.)	
36.	The RMP will provide an option for using tree guards to protect young seedlings from browsing or grazing native animals.
37.	The RMP will describe how livestock will be excluded from areas undergoing active revegetation (i.e. planting or seeding).
38.	The RMP will describe how the growth and survival of the vegetation sown or planted will be monitored.
39.	The RMP will aim to include a wide diversity of species in the seed mix.
40.	The RMP will include hygiene protocols to minimise the risk of plant diseases (i.e. restricting site access).
41.	The RMP will include provision to review the need for kangaroo control measures.
Habitat Features	
42.	The RMP will describe procedures to reuse bush rocks salvaged during vegetation clearance (consistent with Condition 39[b] Schedule 3 of Project Approval 10_0138).
43.	The RMP will describe procedures to reuse timber/hollow logs salvaged during vegetation clearance (consistent with Condition 39[b] Schedule 3 of Project Approval 10_0138), including: <ul style="list-style-type: none"> - placement of hollow limbs or artificial hollows in select trees without hollows; and - use of artificial stag trees on the mine rehabilitation.
Feral Animal Management	
44.	The RMP will describe procedures to prevent, monitor and control feral animals (including feral pigs, goats, rabbits and foxes).
Weed Management	
45.	The RMP will provide methods for the use of herbicides (minimised through spot-spraying, basal spraying, stem injection or cut and paint application methods).
Fire Management	
46.	The RMP will describe measures to prevent fires such as maintaining fire breaks and access (i.e. no controlled burns would be undertaken on the mine rehabilitation whilst vegetation is establishing).

Table 4
Implementation Plan for the Box-Gum Woodland in the Offset Areas

Actions for Implementing the Biodiversity Offset Strategy in the BMP	
Planning	
1.	The BMP will define the objectives for the Box-Gum Woodland EEC.
2.	The BMP will discuss an adaptive management framework and monitoring programme for the management of the Box-Gum Woodland EEC.
3.	The BMP will include a visual inspection of each mapped vegetation management unit in each offset area to identify constraints and requirements for specific management measures.
4.	The BMP will describe targeted revegetation along drainage lines and scalded areas to minimise risk of erosion.
5.	The BMP will aim to maximise the re-use of existing infrastructure (e.g. access roads) instead of creating new infrastructure.
6.	The BMP will aim to locate new offset area management infrastructure (e.g. access roads) preferentially in cleared land.
7.	The BMP will aim to locate new offset area management infrastructure (e.g. access roads) in stable locations.
8.	The BMP will describe provision of fencing and signage around the perimeter of the offset areas to manage livestock and avoid accidental clearance.
9.	The BMP will describe roles for suitability qualified personnel (e.g. restoration ecologist to provide direction about the rehabilitation and restoration of the Box-Gum Woodland EEC).

Table 4 (Continued)
Implementation Plan for the Box-Gum Woodland in the Offset Areas

Actions for Implementing the Biodiversity Offset Strategy in the BMP	
<i>Soil Testing and Nutrient Management</i>	
10.	The BMP will provide for soil testing to be undertaken on soils in revegetation areas to identify issues with physical and chemical characteristics as well as determine amelioration requirements and rates.
11.	The BMP will describe the following nutrient reduction options and the relevant situations where they would be applied: <ul style="list-style-type: none"> - crash grazing periodically to remove nutrients locked in weeds; - restriction of livestock access to limit further nutrient enrichment; and - controlled burns.
<i>Surface Preparation</i>	
12.	The BMP will describe site preparation in cleared land (e.g. ripping or use of spiked rollers) and (where relevant) in derived grassland (e.g. use of spiked rollers) to reduce soil compaction impacting the success of the revegetation.
13.	The BMP will restrict the use of revegetation techniques that involve high level of physical disturbance in existing Box-Gum Woodland and derived grasslands.
<i>Revegetation, Seeds and Tube Stock</i>	
14.	The BMP will describe a seed and tube stock supply strategy including calculation of the amount and species of seed and tube stock required each year and how the seed and tube stock will be sourced and managed to meet the demand.
15.	The BMP will describe procedures for strategic and long term seed collection, management (including pre-treatment) and storage following the relevant Florabank guidelines. The BMP will describe procedures for sowing seed (e.g. appropriate sowing depths).
16.	The BMP will favour natural regeneration in the derived grasslands and woodland areas over seeding or planting in the first instance followed by seeding or planting if required.
17.	The RMP will provide for the preferential use of local endemic (adapted) species, however consideration would be given to the use of a high quality seed source further from the site over a low quality more local seed source.
18.	The BMP will provide application rates for seeds as well as planting densities for tube stock to avoid excessive shading.
19.	The BMP will focus on increasing woodland patch size within the offset area and aim to enhance ecological connectivity.
20.	The BMP will describe that seed and tube stock used in revegetation will include a variety of grasses, low shrubs, mid-sized shrubs and tall trees to create structurally diverse habitat.
21.	The BMP include sowing of Kangaroo Grass (as this species is known to out-compete annual grass weeds and provide inter tussock spaces for a diversity of ground cover species [eg. wildflowers]).
22.	The BMP will aim to include a wide diversity of species in the seed mix.
23.	The BMP will include provision to review the need for kangaroo control measures.
<i>Maintenance</i>	
24.	The BMP will include provision to assess vegetation density and undertake ecological thinning (e.g. through selective clearance or fire) if necessary.
25.	The BMP will provide measures to improve understorey diversity (e.g. replanting, causing disturbance through fire or grazing).
26.	The BMP will provide for selective use of slow-release native plant fertiliser to promote plant growth (if required).
27.	The RMP and BMP will provide an option for using tree guards to protect young seedlings from browsing or grazing native animals.
28.	The BMP will describe how the growth and survival of the vegetation sown or planted will be monitored.
29.	The BMP will include hygiene protocols to minimise the risk of plant diseases (i.e. restricting site access).
30.	The BMP will describe a restriction of clearing (unless for ecological thinning, maintenance or access for monitoring).
<i>Habitat Features</i>	
31.	The BMP will describe procedures to reuse bush rocks salvaged during vegetation clearance (consistent with Condition 39[b] Schedule 3 of Project Approval 10_0138).
32.	The BMP will describe procedures to reuse timber/hollow logs salvaged during vegetation clearance (consistent with Condition 39[b] Schedule 3 of Project Approval 10_0138), including placement of hollow limbs or artificial hollows in select trees without hollows.
33.	The BMP will not permit firewood collection.

Table 4 (Continued)
Implementation Plan for the Box-Gum Woodland in the Offset Areas

Actions for Implementing the Biodiversity Offset Strategy in the BMP	
<i>Grazing Management</i>	
34.	The BMP will describe restriction of livestock access to erosion prone areas (e.g. along watercourses).
35.	The BMP will describe how livestock will be excluded from areas undergoing active revegetation (i.e. planting or seeding).
36.	The BMP will describe restriction of livestock access to areas not already subject to grazing.
37.	The BMP will describe management of livestock to maintain ground cover and diversity of native plants.
38.	The BMP will describe restriction of livestock access to protect plants that are known to be sensitive to grazing.
39.	The BMP will include provision to lightly graze derived grasslands in times of suitable climatic conditions for weed growth (e.g. autumn and/or winter) to reduce vigour of annual grass weeds.
40.	The BMP will provide a mechanism to reduce livestock grazing during drought periods.
41.	The BMP will describe the following controlled grazing management options and the relevant situations where they would be applied: <ul style="list-style-type: none"> - Rotational grazing system to promote and maintain native plant diversity and cover. - Removal of grazing livestock.
<i>Weed Management</i>	
42.	The BMP will provide the following weed management options and the relevant situations where they would be applied: <ul style="list-style-type: none"> - Crash grazing periodically to reduce annual and perennial grass weeds. - Nutrient management (e.g. exclusion of grazing livestock which add nutrients). - Controlled burns during spring to reduce annual and perennial grass weeds (not broadleaf exotics). - Physical removal (e.g. removing weeds by felling or pulling). - Targeted and timely herbicide application.
43.	The BMP will provide methods for the use of herbicides (minimised through spot-spraying, basal spraying, stem injection or cut and paint application methods).
<i>Feral Animal Management</i>	
44.	The BMP will describe procedures to prevent, monitor and control feral animals (including feral pigs, goats, rabbits and foxes).
45.	The BMP will provide monitoring of deer and feral cats and control (if required).
<i>Fire Management</i>	
46.	The BMP will describe measures to prevent fires such as maintaining fire breaks and access (i.e. no controlled burns would be undertaken whilst vegetation is establishing).
47.	The BMP will prescribe any controlled burns in patches of Box-Gum Woodland EEC (existing woodland) to be no less than 5 years and then to occur in spring or autumn burns depending on a range of factors.
48.	The BMP will schedule for maintenance of fire breaks and fire trails.
49.	The BMP will provide a schedule for assessing fuel loads.
50.	The BMP will provide an option for using controlled grazing to reduce biomass or controlled burns of derived grasslands.
<i>General</i>	
51.	The BMP will describe that vehicle access will be predominantly restricted to designated tracks to minimise ground disturbance (e.g. compaction).
52.	The BMP will include a description of the Community Consultative Committee.

Maintenance of weeds, feral animals and fire are required in all landscapes (refer to Actions 43 to 45 in Table 3). Disturbed landscapes (such as Landscape 1), will require more intensive management of these factors than less disturbed remnants of existing Box-Gum Woodland.

Landscape 2 - Cleared (Mostly Cultivated) Land with Predominantly Introduced Groundcover

Landscape 2 is consistent with Condition States 3 and 4 in the State and Transition Model described by Rawlings *et al.* (2010) (Appendix B). Key factors relevant to Landscape 2 are:

- soil testing and nutrient management (refer to Actions 10 to 11 in Table 4);
- grazing management (refer to Actions 34 to 41 in Table 4);
- weed control (refer to Actions 42 to 43 in Table 4); and
- surface preparation and revegetation (refer to Actions 12 to 30 in Table 4).

Landscape 3 - Cleared (Mostly Grazing) Land with Predominantly Native Grassland Groundcover (Derived Grasslands)

Landscape 3 is consistent with Condition State 2 in the State and Transition Model described by Rawlings *et al.* (2010) (Appendix B). Landscape 3 already meets the definition of the Box-Gum Woodland EEC in derived native grassland form. Key factors relevant to Landscape 3 are:

- grazing management (refer to Actions 34 to 41 in Table 4); and
- weed control (refer to Actions 42 to 43 in Table 4);

Landscape 3 has some resilience and left alone might progress towards woodland, but it is more likely to progress towards woodland with the help of:

- supplementary plantings (refer to Action 16 in Table 4).
- addition of structural components (e.g. placement of hollow limbs or artificial hollows in select trees without hollows) (refer to Action 31 to 32 in Table 4).

Landscape 4 - Remnants of the Box-Gum Woodland in Varying Conditions

Landscape 4 is consistent with Condition State 1 in the State and Transition Model described by Rawlings *et al.* (2010) (Appendix B). These existing woodland patches are subject to grazing livestock and therefore an important factor in managing their restoration will be related to grazing management (refer to Actions 34 to 41 in Table 4).

5 CONCLUSION

This 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. The investigation has resulted in the identification of 46 individual actions relating to the Rehabilitation Strategy and 52 individual actions relating to the Biodiversity Offset Strategy. The approved implementation plan will be incorporated into the RMP and a revised BMP (due to submission to the Department of Planning and Environment in April 2015).

6 REFERENCES

- Broadhurst, L.M., Lowe, A., Coates, D.J., Cunningham, S.A., McDonald, M., Vesk, P.A. and Yates, C. (2008) Seed supply for broadscale restoration: maximizing evolutionary potential. *Evolutionary Applications*. 1: 587-597.
- Broadhurst, L.M., North, T. and Young, A.G. (2006a) Should we be more critical of remnant seed sources being used for revegetation? *Ecological Management and Restoration*. 7(3):211-217.
- Broadhurst, L.M., Young, A.G., Thrall, P.H. and Murray, B.G. (2006b) Sourcing Seed for *Acacia acinacea*, a Key Revegetation Species in South Eastern Australia. *Conservation Genetics*. 7(1):49-63.
- CSIRO (2005) *Bacteria Boosted Wattles Help 'Re-green' Australia*.
Website: <http://www.csiro.au/Outcomes/Environment/Biodiversity/WattleMicrobes.aspx>
Date Accessed – October 2014
- Debeljak, M. (2006) Coarse woody debris in virgin and managed forest. *Ecological Indicators*. 6: 733-742.
- Department of Environment, Climate Change and Water (2011) *National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland*.
Department of Environment, Climate Change and Water, Sydney, New South Wales.
- Department of Sustainability and the Environment (2005) *Grassy Woodland Threatened in the Goulburn Broken Catchment*. Department of Sustainability and the Environment, Melbourne, Victoria.
- Eddy, D. (2002) *Managing native grassland: a guide to management for conservation, production and landscape protection*. WWF Australia, Sydney.
- Freudenberger, D., Harvey, J. and Drew, A. (2004). Predicting biodiversity benefits of the Saltshaker Project, Boorowa, NSW. *Ecological Management and Restoration*. 5: 5-14.
- Gibson-Roy, P., Moore, G., Delpratt, J. and Gardner, J. (2010) Expanding horizons for herbaceous ecosystem restoration: the Grassy Groundcover Restoration Project. *Ecological Management & Restoration*. 11(3): 176-186.
- Goldin, S.R. and Brookhouse, M.T. (2014) Effects of coarse woody debris on understorey plants in a temperate Australian woodland. *Applied Vegetation Science*. 25 (4): 1-9.
- Hansen Bailey (2013) *Maules Creek Coal Project Environmental Assessment*. Prepared for Aston Coal Pty Ltd.
- Harmon, M.E., Franklin, J.F., Swanson, F.J., Sollins, P., Gregory, S.V., Lattin, J.D., Anderson, N.H., Cline, S.P., Aumen, N.G., Sedell, J.R., Lienkaemper, G.W., Cromack, K., Cummins, J.R., Cummins, K.W. (1986) Ecology of coarse woody debris in temperate ecosystems. *Advances in Ecological Research*. 15: 133–302.
- Jasper, D.A. (2007) Beneficial soil microorganisms of the Jarrah Forest and their recovery in bauxite mine restoration in southwestern Australia. *Restoration Ecology*. 15: 74-84.

- Manning, A.D., Wood, J.T., Cunningham, R.B., McIntyre, S., Shorthouse, D.J., Gordon, I.J. and Lindenmayer, D.B. (2011) Integrating research and restoration the establishment of a long-term woodland experiment in south-eastern Australia. *Zoologist*. 35(3): 633 – 648.
- Manning, A.D., Cunningham, R.B. and Lindenmayer, D.B. (2013) Bringing forward the benefits of coarse woody debris in ecosystem recovery under different levels of grazing and vegetation density. *Biological Conservation*. 157: 204-214.
- McIntyre, S. (2002) Trees. In: *Managing & Conserving Grassy Woodlands*. CSIRO Publishing, Collingwood, Victoria.
- McIvor, J.G. and McIntyre, S. (2002) Understanding grassy woodland ecosystems. In: *Managing & Conserving Grassy Woodlands*. CSIRO Publishing, Collingwood, Victoria.
- McIvor, J.G. (2002) Soils. In: *Managing & Conserving Grassy Woodlands*. CSIRO Publishing, Collingwood, Victoria.
- Michael, D.R, Cunningham, R.B. and Lindenmayer, D.B. (2011) Regrowth and revegetation in temperate Australia presents a conservation challenge for reptile fauna in agricultural landscapes. *Biological Conservation*. 144: 407-415.
- Prober, S.M., Thiele, K.R. and Lunt, I.D. (2002) Identifying ecological barriers to restoration in temperate grassy woodlands: soil changes associated with different degradation states. *Australian Journal of Botany*. 50: 699-712.
- Rawlings, K., Freudenberger, D. And Carr, D. (2010) *A Guide to Managing Box Gum Grassy Woodlands*.
Website: <http://www.shanespark.com/documents/Rawlings%20%282010%29%20A%20guide%20to%20managing%20Box%20Gum%20Grassy%20Woodlands.pdf>
Date Accessed – October 2014.
- Tongway, D.J. and Ludwig, J.A. (2011) *Restoring Disturbed Landscapes: Putting Principles into Practice*. Island Press, Washington.
- Whitehaven Coal Limited (2014a) *Maules Creek Coal Mine Biodiversity Management Plan*.
- Whitehaven Coal Limited (2014b) *Maules Creek Coal Mine Box-Gum EEC Investigation Report*.

APPENDIX A

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

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



PREPARED BY
WHITEHAVEN COAL LIMITED

JANUARY 2015
Project No. WHC-21
Document No. 00646566.docx

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
EXECUTIVE SUMMARY	ES-1
1 INTRODUCTION	1
1.1 BACKGROUND	1
1.2 OBJECTIVES	8
1.3 CONSULTATION	8
2 METHODS	10
3 RESULTS	10
4 CONCLUSION	18
5 REFERENCES	19

LIST OF TABLES

Table 1	Condition 48 of Project Approval (PA 10_0138)
Table 2	Factors Likely to Impede and Enhance the Re-establishment and Restoration of Box-Gum Woodland

LIST OF FIGURES

Figure 1	Project Location
Figure 2	Project Layout
Figure 3	Biodiversity Offset Strategy
Figure 4	Verified Box-Gum Woodland CEEC – Overview Map
Figure 5	Box-Gum Woodland EEC Investigation and Implementation Plan

EXECUTIVE SUMMARY

Maules Creek Coal Pty Ltd (MCC) owns the Maules Creek Coal Mine (MCCM) located approximately 40 kilometres south-east of Narrabri, New South Wales (NSW). The MCCM commenced construction in December 2013 under State (NSW) and Commonwealth Project approvals.

As part of the NSW Project approval for the MCCM, MCC will implement:

1. a Rehabilitation Strategy on the post-mine landforms that aims to re-establish 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 restore or re-establish Box-Gum Woodland EEC on disturbed (former agricultural) land.

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 (Whitehaven) (a joint venture partner of MCC). This report documents the outcomes of that investigation to satisfy Condition 48(b) and (c) of the MCCM NSW Project Approval (PA 10_0138).

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 MCCM);
- 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 MCCM Project Approval (PA 10_0138) and Commonwealth Approval Decision 2010/5566.

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 Maules Creek Coal Mine (MCCM) an open cut coal mining operation is located approximately 40 kilometres south-east of Narrabri, New South Wales (NSW) (Figures 1 and 2). The MCCM is owned by Maules Creek Coal Pty Ltd (MCC), a joint venture between Aston Coal 2 Pty Limited (a wholly owned subsidiary of Whitehaven Coal Limited [Whitehaven]) (75 percent [%]), ITOCHU Corporation (15%) and J-Power Corporation Pty Limited (10%).

In October 2012, the MCCM 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 MCCM was granted approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 11 February 2013 (Commonwealth Approval Decision 2010/5566). The MCCM commenced construction in December 2013 under State (NSW) and Commonwealth Project approvals.

As part of the NSW Project approval for the MCCM, MCC 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 44 of Maules Creek Coal Mine Project Approval (PA 10_0138) requires 2,078 hectares (ha)¹ 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 grassy woodland, shrubby woodland/open forest, riparian forest and 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* (Hansen Bailey, 2013). The Rehabilitation Strategy also includes the creation of riparian areas (Hansen Bailey, 2013). Condition 44 of Maules Creek Coal Mine Project Approval (PA 10_0138) requires a total of 544 ha to be revegetated with species characteristic of the Box-Gum Woodland EEC.

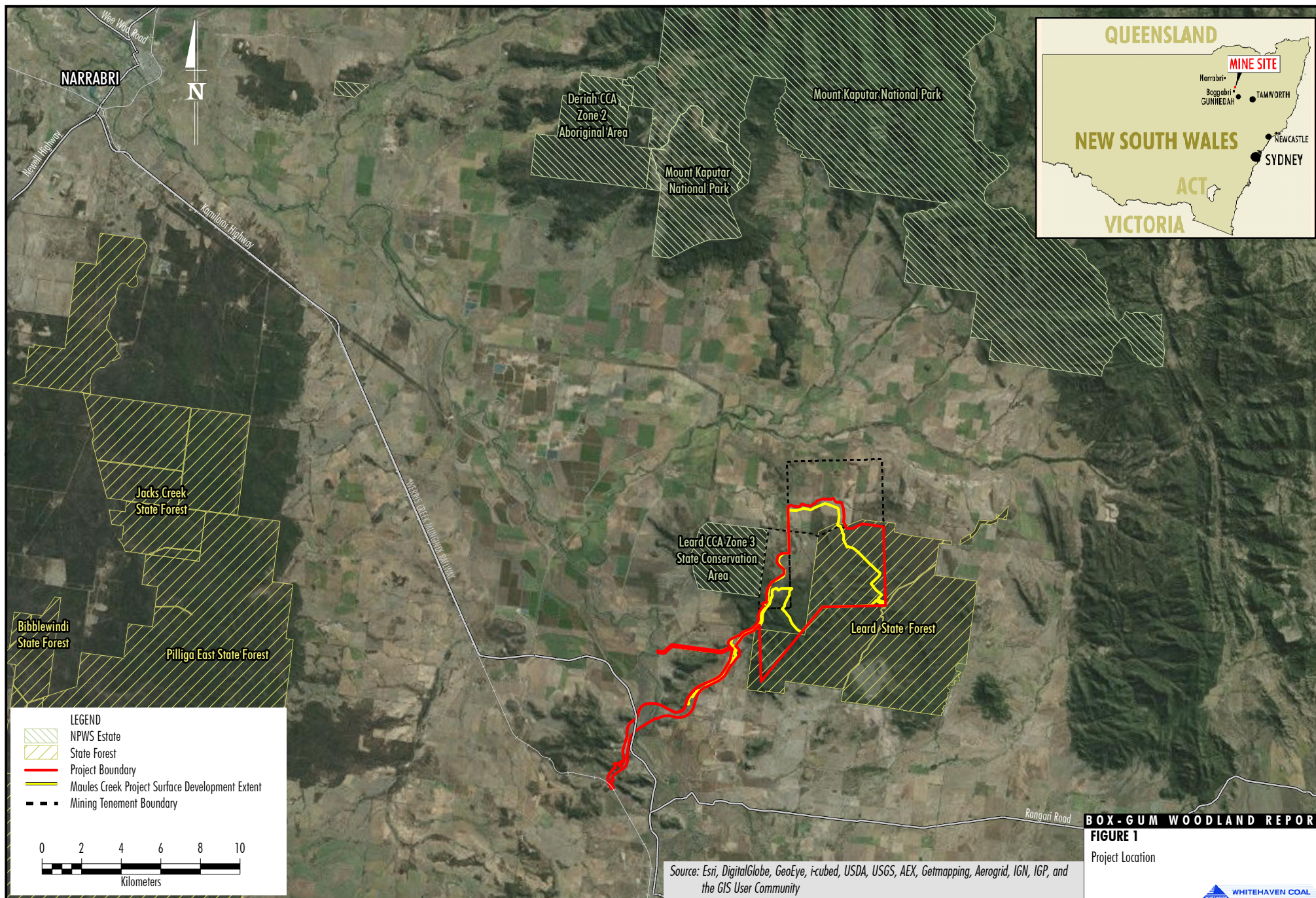
Biodiversity Offset Strategy

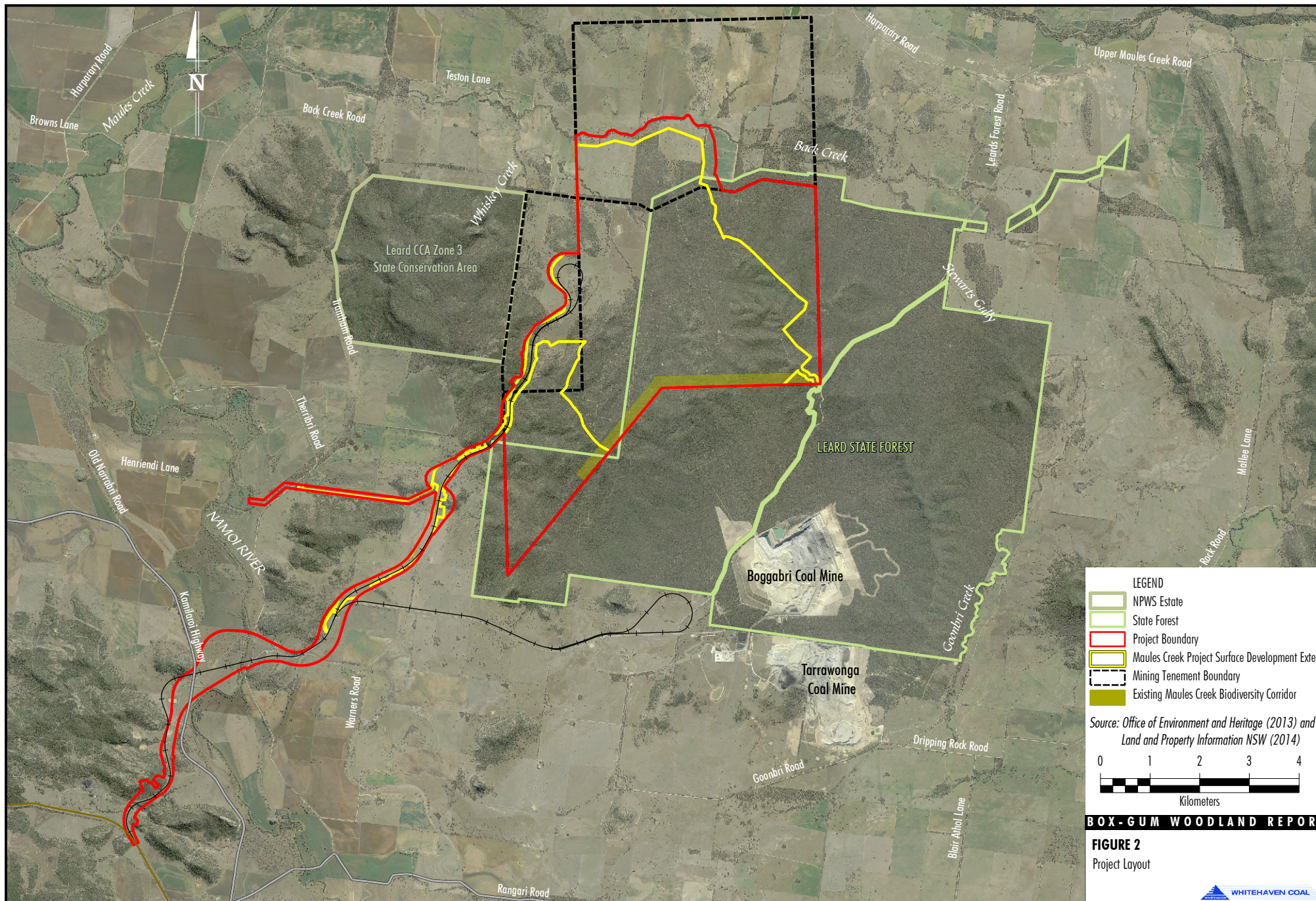
The biodiversity offset areas under Condition 44 of Maules Creek Coal Mine Project Approval (PA 10_0138) are required to cover a minimum of 10,333 ha² of land (Figure 3). The objectives of the offset areas are defined in the MCCM Biodiversity Management Plan (BMP) (Whitehaven, 2014a):

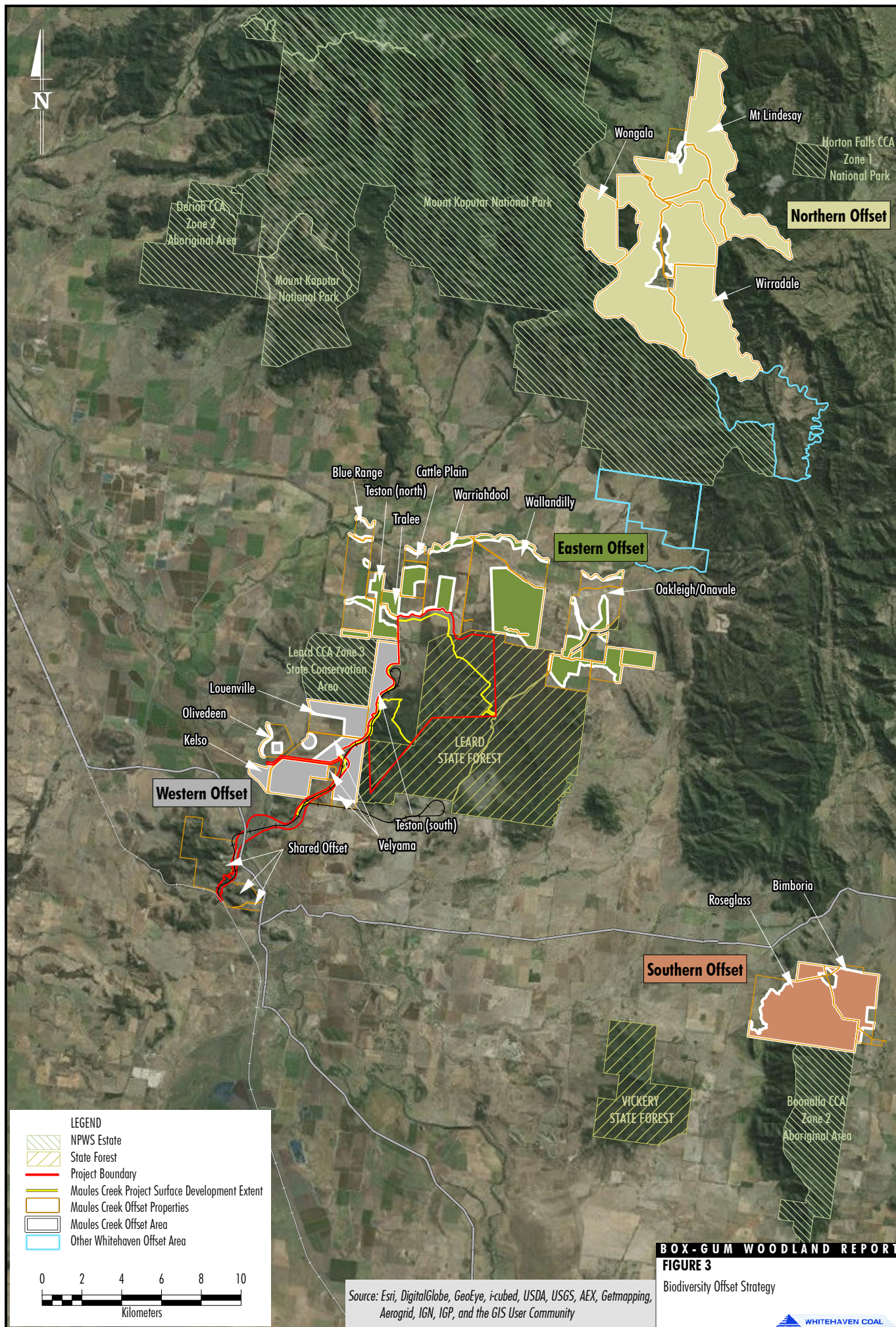
- *to protect and enhance existing native woodland/forest;*
- *to protect and enhance areas of semi-cleared woodland/forest;*
- *to restore self-sustaining vegetation communities within derived native grassland;*

¹ Less the area of the minimised final void.

² Note: Additional offset areas will be established for the MCCM under the EPBC Act approval. These additional offset areas are not subject to this investigation report. The Oakleigh/Onavale, Bimboria and Roseglass offset areas shown on Figure 3 are relevant to the offset required under the EPBC Act. The Oakleigh/Onavale, Bimboria and Roseglass offset areas may be used to satisfy the 1,000 ha additional offset requirement under Condition 44.







BOX-GUM WOODLAND REPORT
FIGURE 3

Biodiversity Offset Strategy

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

- *to restore the woodland form of Box Gum Woodland within existing areas of Box Gum Woodland EEC/CEEC (derived native grassland); and*
- *to restore self-sustaining vegetation communities within areas of low diversity derived native grassland, pasture improved and cultivated land.*

The Box-Gum Woodland EEC is present in the offset areas in woodland and derived grassland forms (Figure 4). The Biodiversity Offset Strategy aims to re-establish Box-Gum Woodland in various landscapes:

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

It is recognised that aiming to re-establish or restore Box-Gum Woodland is likely to be difficult, particularly in cleared (mostly cultivated land with predominantly introduced groundcover. 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:

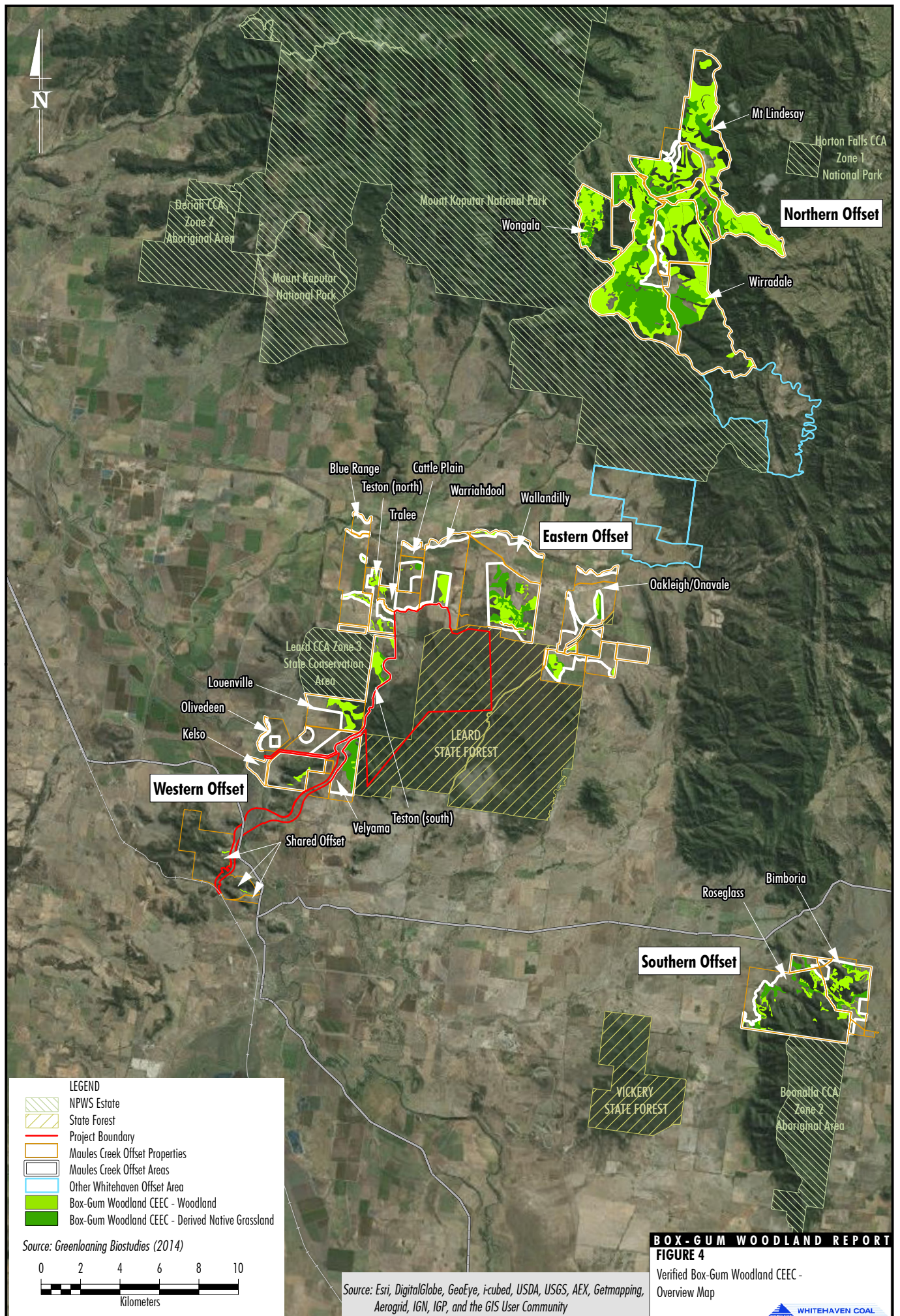
1. long-term security of the offset areas and woodland on the rehabilitation areas by the mechanisms specified in the Project Approval (i.e. management will be required to be undertaken in accordance with a conservation agreement and/or protected area [e.g. National Park or Nature Reserve] management arrangement); and
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).

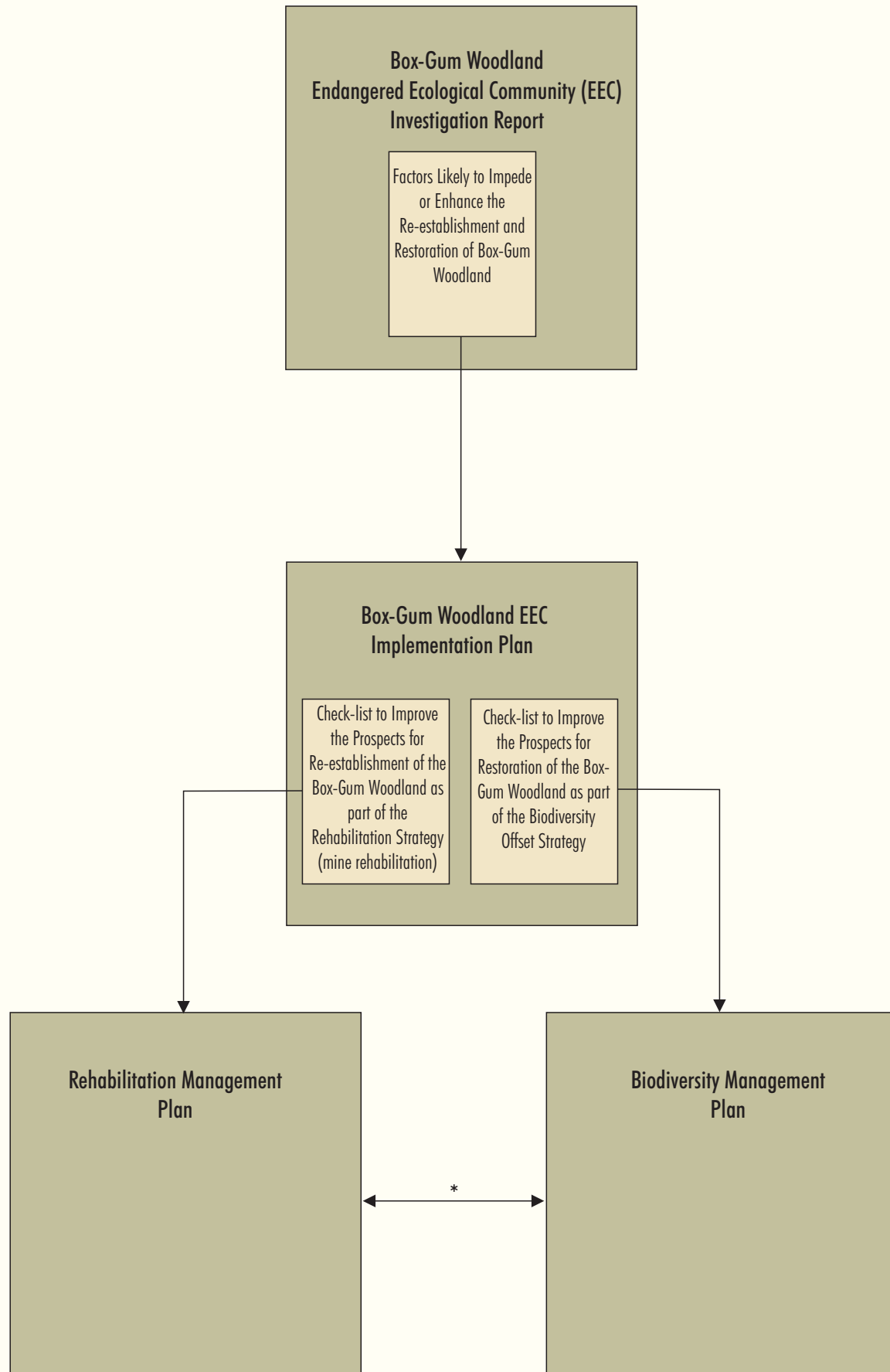
Box-Gum Woodland Investigation

Condition 48 of MCCM Project Approval (PA 10_0138) requires:

1. an investigation on 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 – this document); and
3. revision of the BMP.

Figure 5 contains a flow diagram that shows how the Investigation Report, Implementation Plan and the BMP (and MCCM Rehabilitation Management Plan [RMP]) relate.





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

BOX - GUM WOODLAND REPORT

FIGURE 5

Box-Gum Woodland EEC Investigation and Implementation Plan

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 (due to be submitted to the Department of Planning and Environment [DP&E] in April 2015) and a revised RMP.

1.2 OBJECTIVES

The purpose of this report is to satisfy Condition 48(b) and (c) of MCCM Project Approval (PA 10_0138) (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).

Table 1
Condition 48 of Project Approval (PA 10_0138)

Condition
<p>48. 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 52.</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 Tarrawonga Coal Mine.

1.3 CONSULTATION

This investigation report was finalised following consultation with the following stakeholders in accordance with Condition 48(b) 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 20 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.*

MCCM 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 MCCM);
- consultation with suitably qualified restoration specialists;
- consultation with OEH and North West Local Land Services;
- consideration of relevant conditions under the MCCM Project Approval (PA 10_0138) and Commonwealth Approval Decision 2010/5566; 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 carbon³.
		Offset Areas – Re-establishment of Box-Gum Woodland on cleared (former agricultural) land (Condition States 3 and 4 [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).
		Offset Areas – Re-establishment of Box-Gum Woodland from derived grasslands (Condition State 2 [Rawlings <i>et al.</i> , 2010])	
	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 26[b] of the Approval Decision EPBC 2010/5566). Soil surveys and inventories prior to soil stripping (Condition 27[c] of the Approval Decision EPBC 2010/5566 and Condition 39 Schedule 3 of Project Approval 10_0138). Soil handling processes for removal, storage and re-layering of topsoil and subsoil (Condition 27[d] of the Approval Decision EPBC 2010/5566). Annual soil balances to manage soil handling (Condition 39 Schedule 3 of Project Approval 10_0138). Rehabilitation trials focused on soil substrate.
	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 on cleared (former agricultural) land (Condition States 3 and 4 [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). Restriction of livestock access to limit further nutrient enrichment (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.
		Offset Areas – Re-establishment of Box-Gum Woodland from derived grasslands (Condition State 2 [Rawlings <i>et al.</i> , 2010])	
	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 10_0138). Application of minimum topsoil and subsoil depths (Condition 26[b] of the Approval Decision EPBC 2010/5566).
	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 rock to stabilise batter surfaces. Ecological function analysis to identify constraints and requirements for specific management measures (Tongway and Ludwig, 2011).

³ Not proposed to be used due to preferential use of mulch and woody debris from clearing activities.

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 on cleared (former agricultural) land (Condition States 3 and 4 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> Targeting revegetation along drainage lines. Remediation of scalded areas. Restriction of livestock access (particularly along drainage lines) (Rawlings <i>et al.</i>, 2010). Installation of new infrastructure in stable locations (e.g. access roads) (McIvor, 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 – Re-establishment of Box-Gum Woodland from derived grasslands (Condition State 2 [Rawlings <i>et al.</i> , 2010])	
		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 on cleared (former agricultural) land (Condition States 3 and 4 [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 access (Rawlings <i>et al.</i>, 2010). Options for reducing compaction: <ul style="list-style-type: none"> Mulching (Rawlings <i>et al.</i>, 2010)⁸. Hand aeration (Rawlings <i>et al.</i>, 2010)⁹. Deep air-jetting and mulching (Rawlings <i>et al.</i>, 2010)¹⁰. Cultivation followed by mulching (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"> Restriction of vehicle access to avoid compacting soil (Eddy, 2002; DSE, 2005). Restriction of livestock access (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 on cleared (former agricultural) land (Condition States 3 and 4 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> Restriction of vehicle access to avoid unnecessary ground disturbance (Eddy, 2002; DSE, 2005). Fencing and signage.
		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).
		Offset Areas - Restoration of Existing Box-Gum Woodland (Condition State 1 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> Restriction of vehicle access to avoid unnecessary ground disturbance (DSE, 2005; Eddy, 2002). Fencing and signage.
	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	<ul style="list-style-type: none"> Supplementary seeding/tube stock planting.

⁸ This method is not proposed to be undertaken due to the extensive areas required to be revegetated.

⁹ This method is not proposed to be undertaken due to the extensive areas required to be revegetated.

¹⁰ 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
1. Substrate (Cont.)	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 26[b] of the Approval Decision EPBC 2010/5566). Soil surveys and inventories prior to soil stripping (Condition 27[c] of the Approval Decision EPBC 2010/5566 and Condition 39 Schedule 3 of Project Approval 10_0138). Soil handling processes for removal, storage and re-layering of topsoil and subsoil (Condition 27[d] of the Approval Decision EPBC 2010/5566). Annual soil balances to manage soil handling (Condition 39 Schedule 3 of Project Approval 10_0138).
	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 rock 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 (Condition 26[b] of the Approval Decision EPBC 2010/5566). Soil surveys and inventories prior to soil stripping (Condition 27[c] of the Approval Decision EPBC 2010/5566 and Condition 39 Schedule 3 of Project Approval 10_0138). Soil handling processes for removal, storage and re-layering of topsoil and subsoil (Condition 27[d] of the Approval Decision EPBC 2010/5566). Use of rhizobial bacteria inoculants for acacia (CSIRO, 2005).
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 on cleared (former agricultural) land (Condition States 3 and 4 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> Restriction on clearing. Restriction on fire wood collection. Fencing and signage. Maximised re-use of existing infrastructure (e.g. access roads) instead of creating new infrastructure. Installation of new infrastructure in cleared land (e.g. access roads).
		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. Use of low disturbance methods for site preparation in derived grasslands and existing Box-Gum Woodland.
		Offset Areas - Restoration of Existing Box-Gum Woodland (Condition State 1 [Rawlings <i>et al.</i> , 2010])	
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 – Re-establishment of Box-Gum Woodland on cleared (former agricultural) land (Condition States 3 and 4 [Rawlings <i>et al.</i> , 2010])	<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 – 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 livestock access (particularly along drainage lines) (Rawlings <i>et al.</i>, 2010). Restriction of livestock access to protect plants that are known to be sensitive to grazing (Rawlings <i>et al.</i>, 2010). Restriction of livestock access to maintain ground cover. Maintenance of fencing used to exclude livestock. Controlled grazing management options: <ul style="list-style-type: none"> Crash grazing periodically to remove nutrients locked in weeds (Rawlings <i>et al.</i>, 2010). High intensity short duration rotational grazing (Rawlings <i>et al.</i>, 2010). Removal of grazing livestock. Low stocking rates.

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
3. Livestock (Cont.)	3a. Grazing by cattle – ground disturbance, remove or destroy seeds, seedlings or plantings (DSE, 2005; Rawlings <i>et al.</i> , 2010) (Cont.)	Offset Areas - Restoration of Existing Box-Gum Woodland (Condition State 1 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> Exclusion of livestock grazing along watercourses (McIvor and McIntyre, 2002). Exclusion of livestock grazing in areas not already subject to grazing (DECCW, 2011). Maintenance of fencing used to exclude livestock. Controlled grazing management (low stocking rates).
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 27[a] of the Approval Decision EPBC 2010/5566). Establishing vegetation cover as soon as practicable following disturbance (Condition 27[b] of the Approval Decision EPBC 2010/5566). 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 on cleared (former agricultural) land (Condition States 3 and 4 [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). Correct spacing for species when planting seedlings to avoid excessive shading (DECCW, 2011). Weed management options: <ul style="list-style-type: none"> Crash grazing periodically to reduce annual and perennial grass weeds (Rawlings <i>et al.</i>, 2010). Nutrient management (e.g. exclusion of grazing livestock which add nutrients) (Rawlings <i>et al.</i>, 2010). Controlled burns during spring to reduce annual and perennial grass weeds (not broadleaf exotics) (Rawlings <i>et al.</i>, 2010). 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). Scalping to remove weed seed bank (Gibson-Roy <i>et al.</i>, 2010)¹¹.
		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 weeds (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.

¹¹ 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
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"> 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 honeybees¹².
	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).
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 on cleared (former agricultural) land (Condition States 3 and 4 [Rawlings <i>et al.</i> , 2010])	<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 biomass (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 on cleared (former agricultural) land (Condition States 3 and 4 [Rawlings <i>et al.</i> , 2010])	<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 reseedling of absent species.
		Offset Areas – Re-establishment of Box-Gum Woodland on cleared (former agricultural) land (Condition States 3 and 4 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> Strategic and long term seed collection, management and storage. Site preparation and depth of sowing seed. Supplementary planting or reseedling 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).

¹² Not specifically 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
8. Floristics (Cont.)	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 on cleared (former agricultural) land (Condition States 3 and 4 [Rawlings <i>et al.</i> , 2010])	<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).
			<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>, 2006a; Broadhurst <i>et al.</i>, 2006b; Broadhurst <i>et al.</i>, 2008 in DECCW, 2011).
	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>, 2006a; Broadhurst <i>et al.</i>, 2006b; 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).
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). 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 (Condition 15 of the Approval Decision EPBC 2010/5566). 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 on cleared (former agricultural) land (Condition States 3 and 4 [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).
		Offset Areas – Re-establishment of Box-Gum Woodland from derived grasslands (Condition State 2 [Rawlings <i>et al.</i> 2010])	
	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 water¹³. 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).

¹³ 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
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 (Condition 39[b] Schedule 3 of Project Approval 10_0138).
	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 (Condition 39[b] Schedule 3 of Project Approval 10_0138).
	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 (Condition 39[b] Schedule 3 of Project Approval 10_0138) including placement of hollow limbs in some 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.
	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 on cleared (former agricultural) land (Condition States 3 and 4 [Rawlings <i>et al.</i> , 2010])	<ul style="list-style-type: none"> Monitoring for signs of water stress (dieback). Limit grazing livestock during drought periods (DECCW, 2011). Management of pressure from feral grazing animals and native grazing animals. Irrigation¹⁴. Mulch¹⁵.
		Offset Areas – Re-establishment of Box-Gum Woodland from derived grasslands (Condition State 2 [Rawlings <i>et al.</i> , 2010])	
	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 cleared land.
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.

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

¹⁵ 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.

5 REFERENCES

- Broadhurst, L.M., Lowe, A., Coates, D.J., Cunningham, S.A., McDonald, M., Vesk, P.A. and Yates, C. (2008) Seed supply for broadscale restoration: maximizing evolutionary potential. *Evolutionary Applications*. 1: 587-597.
- CSIRO (2005) *Bacteria Boosted Wattles Help 'Re-green' Australia*.
Website: <http://www.csiro.au/Outcomes/Environment/Biodiversity/WattleMicrobes.aspx>
Date Accessed – October 2014
- Debeljak, M. (2006) Coarse woody debris in virgin and managed forest. *Ecological Indicators*. 6: 733-742.
- Department of Environment, Climate Change and Water (2011) *National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland*.
Department of Environment, Climate Change and Water, Sydney, New South Wales.
- Department of the Environment (2014) *Species Profile and Threats Database*.
Website: <http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl>
Date Accessed – August 2014
- Department of Sustainability and the Environment (2005) *Grassy Woodland Threatened in the Goulburn Broken Catchment*. Department of Sustainability and the Environment, Melbourne, Victoria.
- Eddy, D. (2002) *Managing native grassland: a guide to management for conservation, production and landscape protection*. WWF Australia, Sydney.
- Freudenberger, D., Harvey, J. and Drew, A. (2004). Predicting biodiversity benefits of the Saltshaker Project, Boorowa, NSW. *Ecological Management and Restoration*. 5: 5-14.
- Gibson-Roy, P., Moore, G., Delpratt, J. and Gardner, J. (2010) Expanding horizons for herbaceous ecosystem restoration: the Grassy Groundcover Restoration Project. *Ecological Management & Restoration*. 11(3): 176-186.
- Goldin, S.R. and Brookhouse, M.T. (2014) Effects of coarse woody debris on understorey plants in a temperate Australian woodland. *Applied Vegetation Science*. 25 (4): 1-9.
- Hansen Bailey (2013) *Maules Creek Coal Project Environmental Assessment*. Prepared for Aston Coal Pty Ltd.
- Harmon, M.E., Franklin, J.F., Swanson, F.J., Sollins, P., Gregory, S.V., Lattin, J.D., Anderson, N.H., Cline, S.P., Aumen, N.G., Sedell, J.R., Lienkaemper, G.W., Cromack, K., Cummins, J.R., Cummins, K.W. (1986) Ecology of coarse woody debris in temperate ecosystems. *Advances in Ecological Research*. 15: 133–302.
- Manning, A.D., Wood, J.T., Cunningham, R.B., McIntyre, S., Shorthouse, D.J., Gordon, I.J. and Lindenmayer, D.B. (2011) Integrating research and restoration the establishment of a long-term woodland experiment in south-eastern Australia. *Zoologist*. 35(3): 633 – 648.
- Manning, A.D., Cunningham, R.B. and Lindenmayer, D.B. (2013) Bringing forward the benefits of coarse woody debris in ecosystem recovery under different levels of grazing and vegetation density. *Biological Conservation*. 157: 204-214.

- McIntyre, S. (2002) Trees. In: *Managing & Conserving Grassy Woodlands*. CSIRO Publishing, Collingwood, Victoria.
- McIvor, J.G. and McIntyre, S. (2002) Understanding grassy woodland ecosystems. In: *Managing & Conserving Grassy Woodlands*. CSIRO Publishing, Collingwood, Victoria.
- McIvor, J.G. (2002) Soils. In: *Managing & Conserving Grassy Woodlands*. CSIRO Publishing, Collingwood, Victoria.
- Michael, D.R., Cunningham, R.B. and Lindenmayer, D.B. (2011) Regrowth and revegetation in temperate Australia presents a conservation challenge for reptile fauna in agricultural landscapes. *Biological Conservation*. 144: 407-415.
- Noss, R.F. (1990) Indicators for Monitoring Biodiversity: A Hierarchical Approach. *Conservation Biology*. 4(4):355-364.
- Office of the Environment and Heritage (2014) *Saving NSW threatened Species*.
Website: <http://www.environment.nsw.gov.au/threatenedspecies/>
Date Accessed – August 2014
- Prober, S.M. and Thiele, K.R. (2005) Restoring Australia's temperate grasslands and grassy woodlands: integrating function and diversity. *Ecological Management and Restoration*. 6: 16-25.
- Prober, S.M., Thiele, K.R. and Lunt, I.D. (2002) Identifying ecological barriers to restoration in temperate grassy woodlands: soil changes associated with different degradation states. *Australian Journal of Botany*. 50: 699-712.
- Rawlings, K., Freudenberger, D. And Carr, D. (2010) *A Guide to Managing Box Gum Grassy Woodlands*.
Website: <http://www.shanespark.com/documents/Rawlings%20%282010%29%20A%20guide%20to%20managing%20Box%20Gum%20Grassy%20Woodlands.pdf>
Date Accessed – October 2014.
- Society for Ecological Restoration International Science & Policy Working Group (2004) SER International Primer on Ecological Restoration.
Website: <http://www.ser.org/resources/resources-detail-view/ser-international-primer-on-ecological-restoration>
Date Accessed – October 2014.
- Tongway, D.J. and Ludwig, J.A. (2011) *Restoring Disturbed Landscapes: Putting Principles into Practice*. Island Press, Washington.
- Whitehaven (2014) *Maules Creek Coal Mine Biodiversity Management Plan*.

APPENDIX B

BOX-GUM WOODLAND STATE AND TRANSITION MODEL

(SOURCE: Rawlings *et al.*, 2010)

